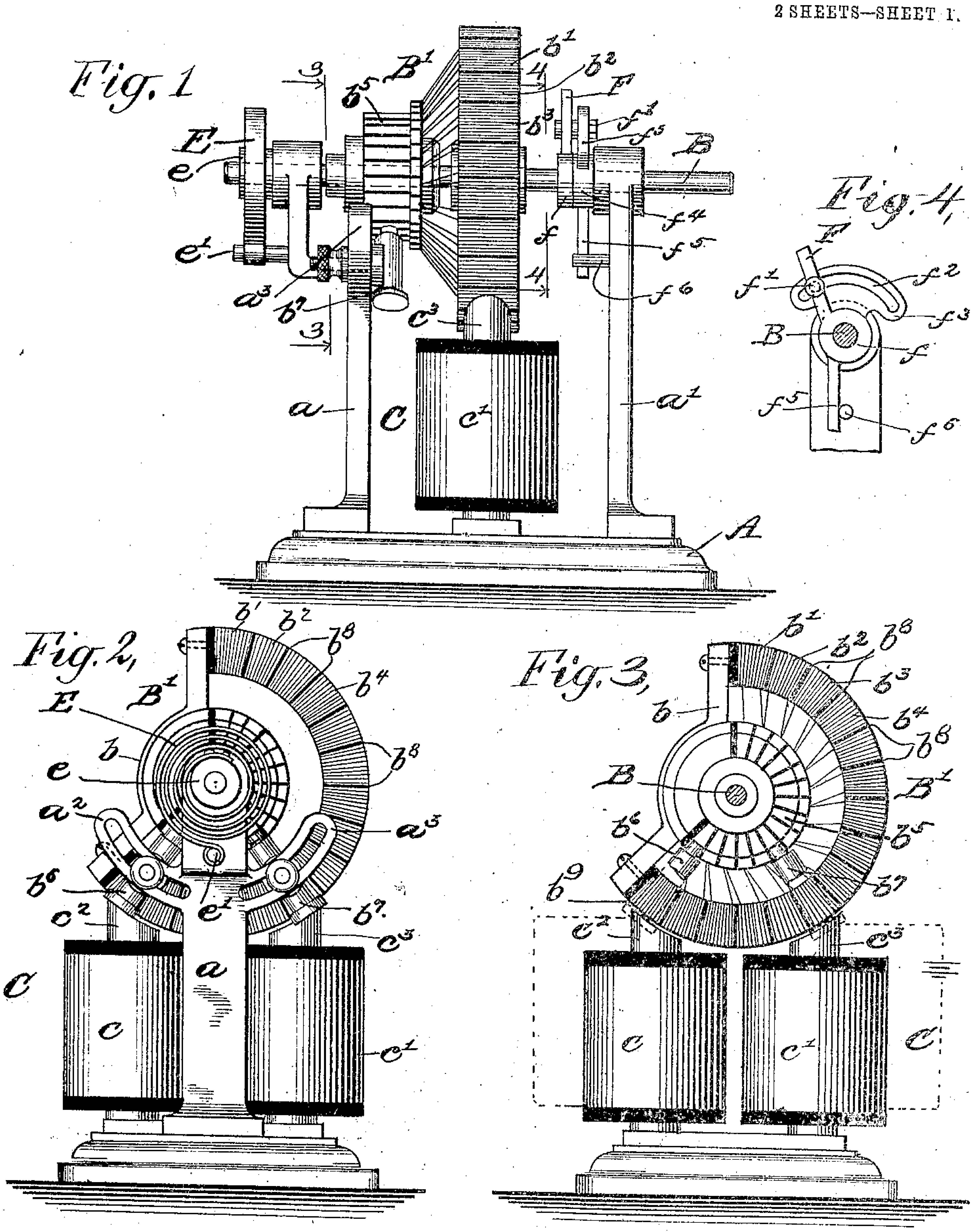
No. 775,560. PATENTED NOV. 22, 1904.

T. M. FOOTE.

OSCILLATING MOTOR.

APPLICATION FILED MAR. 17, 1904.

NO MODEL. 2 SHEETS—SHEET 1.



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NO MODEL.

2 SHEETS—SHEET 2.

Fig. 5,

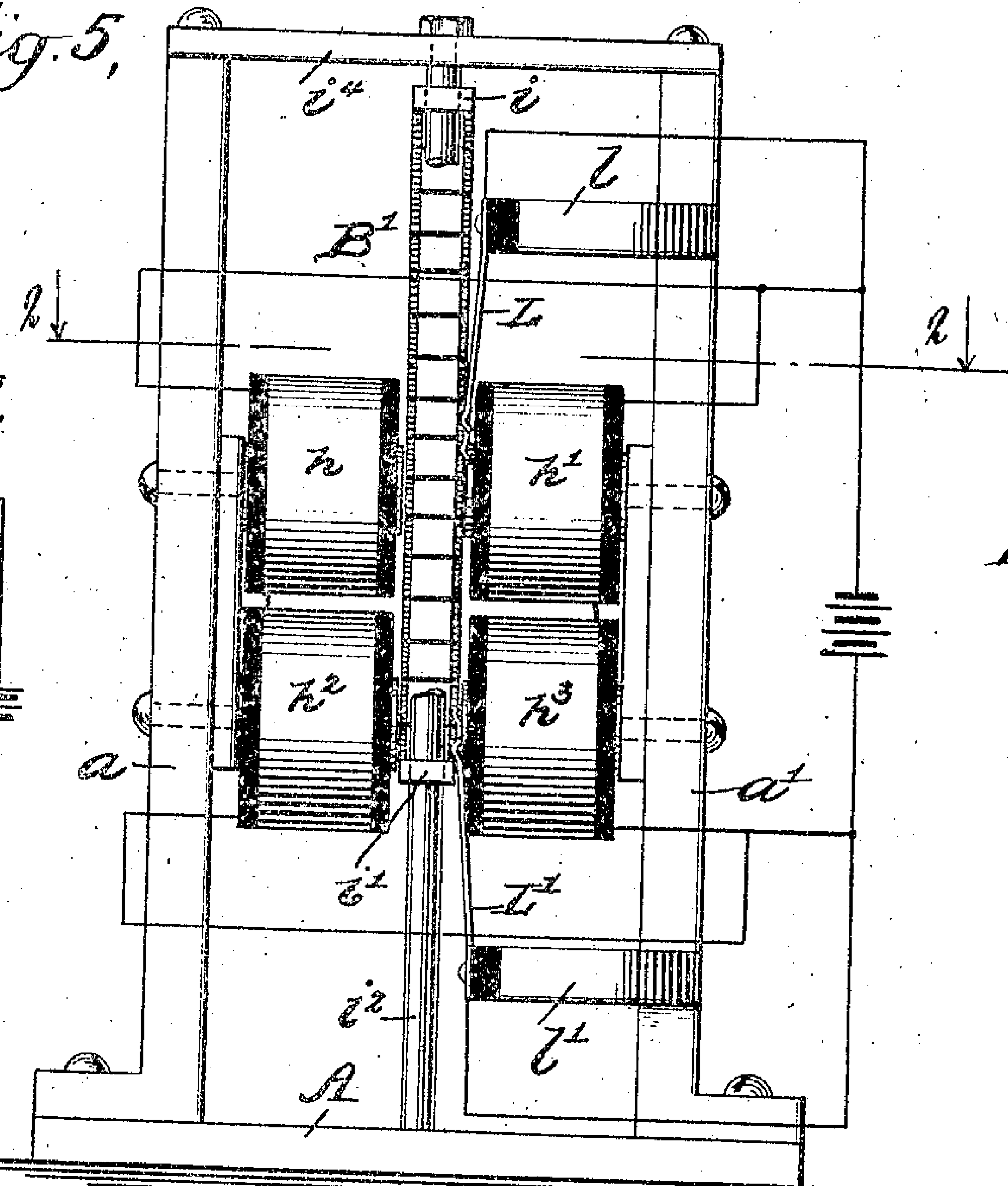


Fig. 8.

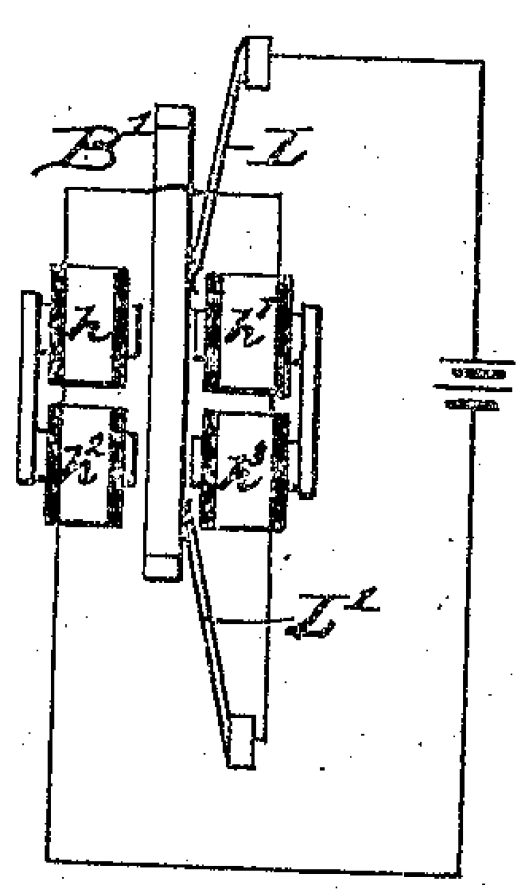


Fig. 9.

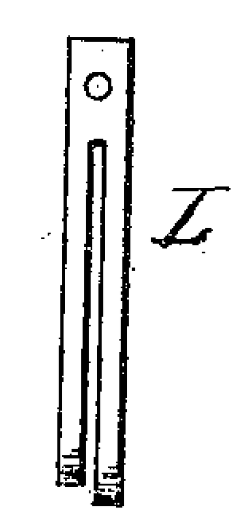


Fig. 6,

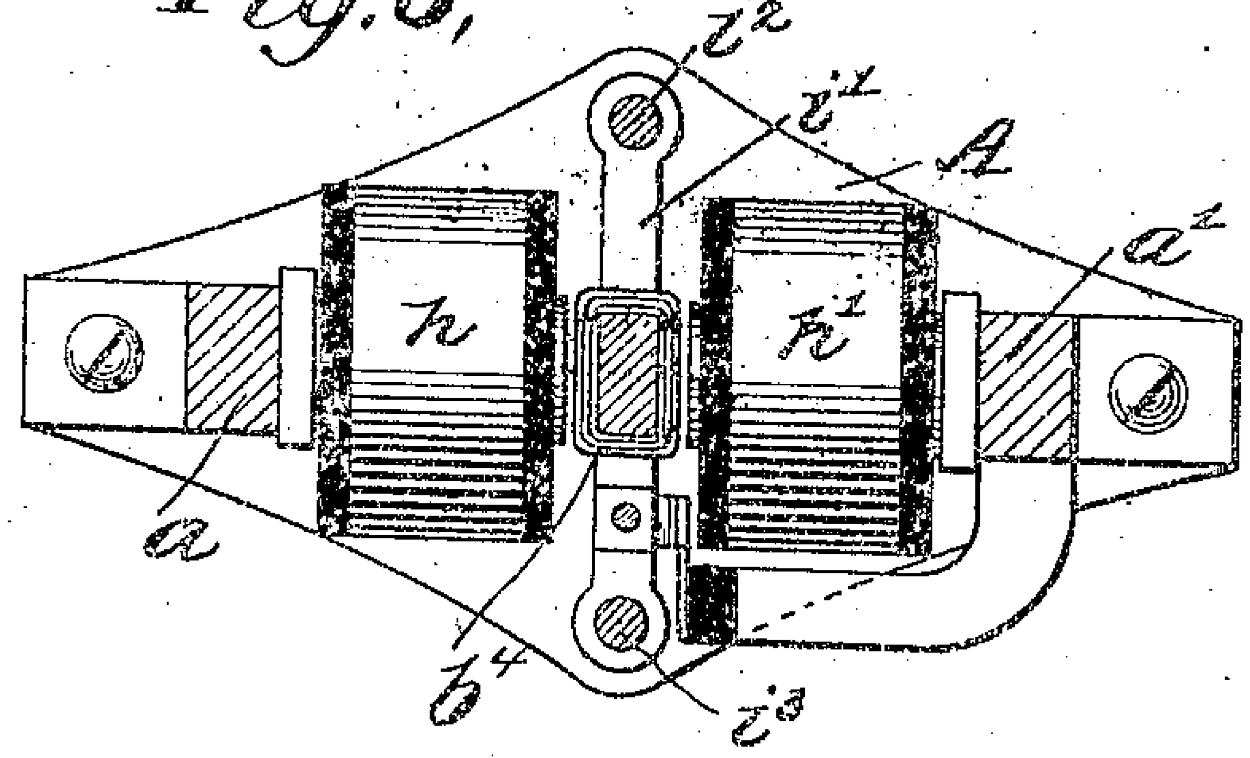
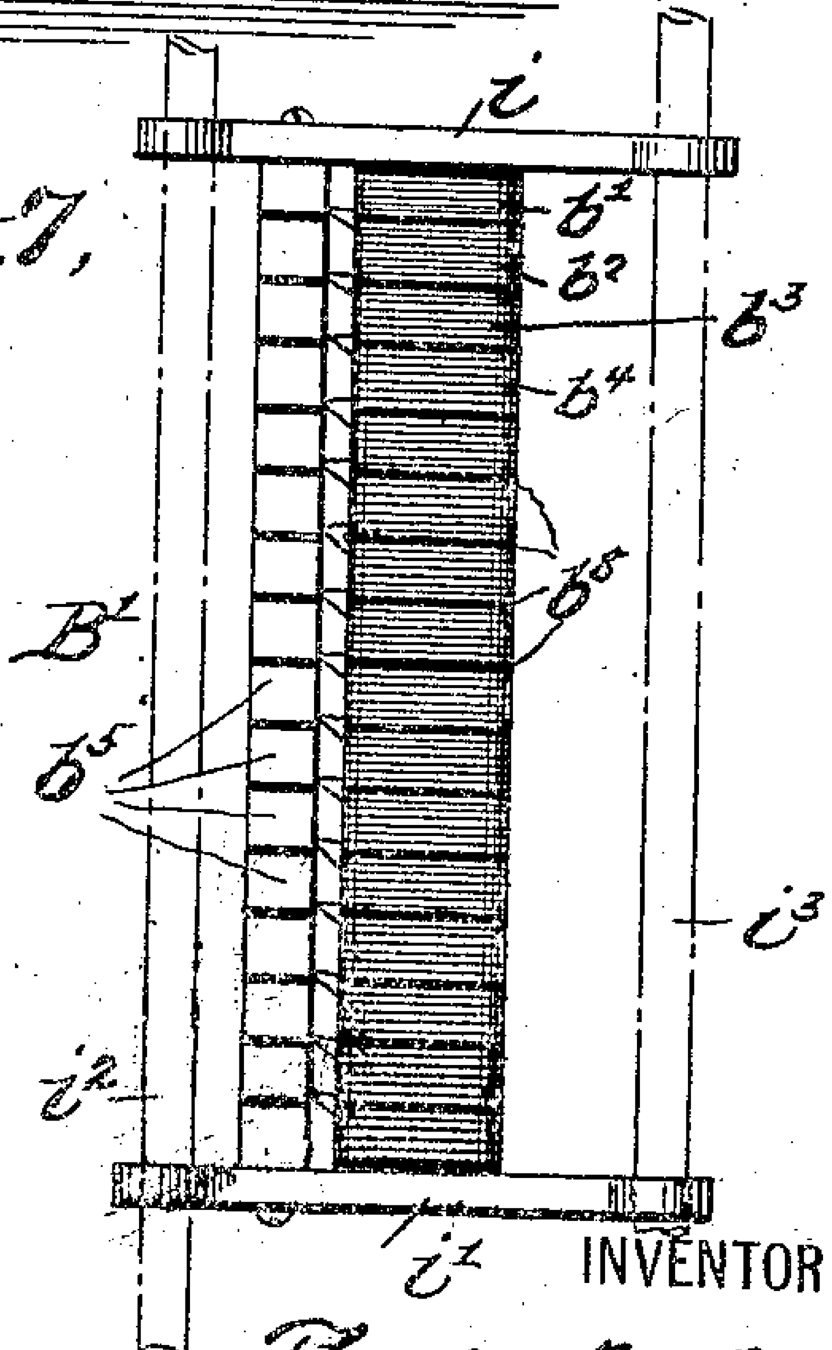


Fig. 7,



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No. 775,560. Patented November 22, 1904.

UNITED STATES PATENT OFFICE.

THEODORE M. FOOTE, OF NEW YORK, N. Y.

OSCILLATING MOTOR.

SPECIFICATION forming part of Letters Patent No. 775,560, dated November 22, 1904.

Application filed March 17, 1904. Serial No. 198,578. (No model.)

To all whom it may concern:

Be it known that I, THEODORE M. FOOTE, a citizen of the United States of America, and a resident of the borough of Brooklyn, New York city, county of Kings, and State of New York, have invented certain new and useful Improvements in Oscillating Motors, of which the following is a specification, reference being had to the accompanying drawings, forming a part thereof.

My invention relates to electric motors, and particularly to electric motors of the oscillating type capable of a limited movement only in opposite directions.

My improved motor comprises means for producing a magnetic field and an armature capable of being magnetized in sections and having a limited movement within said magnetic field at the expenditure of a substantially uniform amount of current throughout its entire range of movement.

I will now proceed to describe in detail and with reference to the accompanying drawings an electric motor embodying my invention and will then point out the novel features in claims.

In the drawings, Figure 1 is a view in side elevation of a motor embodying my invention. Fig. 2 is a view in end elevation thereof. Fig. 3 is a view thereof, partly in end elevation and partly in vertical section, the section being taken upon the plane of the line 3 3 of Fig. 1. Fig. 4 is a detail sectional view, the plane of section being taken upon the line 4 4 of Fig. 1. Fig. 5 is a view in front elevation of another embodiment of my invention of somewhat modified form. Fig. 6 is a transverse sectional view thereof, taken on the plane of the line 2 2 of Fig. 5. Fig. 7 is a detail view showing certain parts of the structure shown in Fig. 5, including the armature and commutator secured thereto. Fig. 8 is a diagrammatic view showing an arrangement of circuits which may be employed. Fig. 9 is a detail view of a brush employed.

Referring to the drawings, and particularly at first to Figs. 1 to 4 thereof, C designates a field-magnet comprising coils c c', wound in series upon cores c^2 c^3, the whole mounted upon a base A. Suitably journaled in the upper ends of standards a a', secured upon the base A, is a shaft B. This shaft B forms a support for an armature, designated as a whole by the reference character B'. The armature B' comprises a core of magnetic material, such as soft iron, and a number of windings b' b^2 b^3, &c., inclosing said core. The windings b' b^2 b^3, &c., are separate from each other and may conveniently be separated by washers b^8, interposed between them. The core is supported upon a frame-piece b, preferably of some non-magnetic material, such as brass, such frame-piece being securely fixed to the shaft B. The armature in the structure shown in Figs. 1 to 4 is arc-shaped, and the core thereof may be of any number of degrees less than three hundred and sixty. If the core is mechanically in the form of a complete circle, its ends will be separated from each other by a piece of non-magnetic material.

A commutator b^5 is carried by the shaft, the several metallic sections of which are insulated from each other and are connected with the several windings b' b^2 b^3, &c., of the armature, the several windings being in series with each other through the commutator-sections. Commutator-brushes b^6 and b^7 engage the said commutator-sections and are carried by arms a^2 a^3, extending from one of the standards a. These arms are preferably slotted, as shown, so that the commutator-brushes may be adjusted with reference thereto for the purpose of causing them to include more or less of the commutator-sections between them, as desired, or to have the section of the core to be energized displaced more or less with relation to the cores c^2 c^3 of the field-magnet. The brushes are to be connected with a battery or other source of electrical supply in order that the several windings may be energized to thereby magnetize the portion of the core inclosed by them. The windings of the field-magnet coils c c' may conveniently be in series with each other and with the windings b' b^2 b^3, &c., of the armature, or, if desired, the windings b' b^2 b^3, &c., may be in one circuit and the winding of the coils of the field-magnet in another, or, again, the windings of the field-magnet and armature-coils may be arranged in multiple with each other instead of in series. A coil-spring E, secured at one of its ends to a collar e upon the shaft B and at its other end secured to a pin e', carried by the standard a, constitutes means for rotating the shaft B and armature B′ in one direction—that is to say, in a direction reverse or opposite to the direction of movement thereof caused by the electromagnetic action. Other forms for producing the reverse direction of the shaft B and armature B′ may be provided as desired.

F designates an arm carried by a collar f, which is fixed upon the shaft B.

f' designates a pin or stud carried by the arm F and extending in a slot f^2, provided in a segmentally-shaped arm f^3, which is carried by a collar f^4, loosely mounted on the shaft B. The collar f^4 is also provided with a downwardly-extending arm f^5.

f^6 designates a pin carried by the standard a' with which the arm f^5 engages.

The several parts F f' f^3 f^5, &c., constitute a means for limiting the rotation of the shaft B and the part B′ in reverse or opposite directions. Any other means for accomplishing this purpose may be employed.

To produce a rotation of the shaft B, the current is passed through a few of the windings b' b^2 b^3, &c., and the electromagnets c c' to magnetize a section of the core and produce a magnetic field at the ends of the cores of the electromagnets. The polarity of the section of core energized by the few windings is the reverse of the polarity of the cores c^2 c^3—that is, if the core of the electromagnet c is of a negative polarity the adjacent end of the core inclosed by the energized windings will be of a positive polarity. Consequently if the magnetized section of the core is outside the strongest magnetic field of the electromagnets it will be drawn into the strongest magnetic field, thereby causing a partial rotation of the shaft. As the magnetized section of the core is drawn into the magnetic field of the electromagnets other commutator-sections are brought under the brush b^7, and other windings on the core are successively energized to magnetize the sections of the core inclosed by these windings. As these successive magnetized sections of the core are outside the magnetic field produced by the electromagnets, they are successively drawn into the magnetic field, and the rotation of the shaft is thereby continued until the shaft is prevented from having further rotation.

It will be noted that while the windings of the armature magnetizing-coils are connected in series from one end to the other the opposite ends of the terminal coils are free or unconnected. Hence it will be understood that current will only be established at any time through the section included between the brushes on one side thereof.

Referring now particularly to Fig. 3, the brushes b^6 b^7 are so arranged upon two of the sections of the commutator b^5 that the portion of the core inclosed by the several windings connected to and intermediate of the commutator-sections on which the brushes rest will be outside of the strongest magnetic field produced by the electromagnets c' c^2. It will be seen, therefore, that the tendency of the magnetic field set up by the electromagnets c' c^2 is to draw that portion of the core directly into its strongest field. In doing so other commutator-sections are brought beneath the brush b^7, so that a part of the core will always be outside of the strongest magnetic field of the electromagnets c' c^2. The action of the magnetic field in drawing within it the core produces a rotation of the shaft in one direction, which rotation of the shaft may be employed in doing work—that is, it may be employed to operate a mechanism or mechanisms. The rotation of the shaft in this direction will be limited by the engagement of the pin f^6 by the arm f^3, which is moved into engagement with the pin f^6 by the stud f' engaging the arm f^3 at the end of the slot. As soon as the arm f^3 engages the pin f^6 further rotation of the shaft will be prevented, and so long as current is passing through the windings and electromagnets c c' the shaft will be held in the position to which it has been rotated. As soon as the electromagnets c c' are deënergized or current is cut off from the windings of the core the shaft B and the parts carried thereby are rotated in a reverse direction under the action of the coiled spring E, which was put under tension or an increased tension by the rotation of the shaft produced by the magnetic field of the electromagnets.

The shaft may be connected by gearing of any description with any work to be done. The gearing may be such that the amount of rotation of the shaft B may be transmitted to the work to be done without increase or decrease, or the gearing may be such that the amount of rotation be multiplied, increased, or decreased. Also the work to be done or the transmitting-gearing, or both, may be such as to produce a reverse movement of the shaft B and parts carried thereby. It will be seen, therefore, that I am enabled to obtain a short or a long stroke or range of movement of the armature B′ with a uniform and minimum amount of current, for it is evident that no increase in current is required to finish or complete the rotation of the shaft B or armature B′ than is required to start it. There will therefore be no current wasted in the operation of the motor.

If desired, the movement of the armature B′ in one direction may be limited by disconnecting any of the series of windings on the core from the commutator. If this is done, there will be a limit to the sections of the core which will be energized by the windings inclosing the core, and when this limit is reached the field-magnet C will have no effect whatever to further move the armature B'.

Referring now to Figs. 5, 6, 7, and 9, instead of two electromagnets c c', I show four electromagnets h h' h^2 h^3, which are suitably secured to the standards a a'. Instead, also, of employing an arc-shaped core in the armature B', I employ a straight core. The core is suitably secured at its ends to cross-pieces i i', and the commutator-sections b^5 are mounted on a rod which is secured at its end to the cross-pieces i i'. These cross-pieces are provided with openings at their ends through which extend rods i^2 i^3, which are secured at their ends in the base A, and a cross-brace i^4, provided at the upper ends of the standards a a'. The several windings b' b^2 b^3, &c., are secured to the commutator-sections, so as to be in series with each other through the commutator-sections. L L' designate contact-brushes (see Fig. 9) which are secured to supports l l'. They bear upon the commutator-sections at their free ends, and they are formed as shown in Fig. 9 in order that an open circuit be prevented by reason of the brush resting on a piece of insulation b^8. The magnets are preferably wound so that the ends of the cores of the upper pair of magnets adjacent the core will be of the same polarity and the ends of the cores of the lower pair of magnets adjacent the core will be of the same polarity, but different from the polarity of the ends of the cores of the upper pair of magnets. Consequently the magnetization of the core at its ends will be the reverse of the adjacent cores of the electromagnets. It will be seen from Fig. 5 that the contact-brushes L L' rest on commutator-sections connected with windings inclosing a section of the core which is outside of the strongest magnetic field produced by the electromagnets h h' h^2 h^3 and that the tendency of the field is to draw the magnetized section of the core within it. In doing so new commutator-sections are brought beneath the brushes, so that a continuous movement will be produced of the core in one direction. A reverse movement of the core may be produced by reversing the direction of current therethrough with respect to the direction of current through the field-magnet or by shifting the relationship of the magnetized section of the armature with relation to the field, which may be done by an adjustment or change of location of the brushes or by other means or through mechanical means, such as by a spring or weight. The base A and the cross-brace i act as means to limit the movement of the core in this form of my invention, though other means may be provided.

In Fig. 5 the electromagnets and the windings are arranged in three circuits in multiple with the battery, while in Fig. 8 the magnets and windings are arranged in series with each other.

What I claim as my invention is—

1. In a motor, the combination of electromagnetic means for producing a magnetic field, a shaft suitably journaled, an arc-shaped core carried by said shaft, a series of windings inclosing said core, a commutator to which said windings are connected, and means for limiting the rotation of said core and shaft in reverse directions.

2. In a motor, the combination of a shaft suitably journaled, an arc-shaped core carried by said shaft, a series of windings inclosing said core, means whereby said windings may be successively energized, and a field-magnet for causing said core and shaft to rotate upon the energization of the windings.

3. In a motor, the combination of a shaft suitably journaled, an arc-shaped core carried by said shaft, a series of windings inclosing said core, means whereby said windings may be successively energized, a field-magnet for causing said core and shaft to rotate upon energization of the windings thereof, and means for limiting the rotation of said core and shaft.

4. In a motor, the combination of a shaft suitably journaled, an arc-shaped core carried by said shaft, a series of windings inclosing said core, a commutator carried by said shaft with which the windings are connected, and a field-magnet for causing said core and shaft to rotate upon the energization of the windings from the commutator.

5. In a motor, the combination of a shaft suitably journaled, an arc-shaped core carried by said shaft, a series of windings inclosing said core, means whereby said windings may be successively energized, a field-magnet for causing a rotation of the core with its shaft in one direction upon the energizing successively of the windings of the core, and means for causing a reverse rotation of the core and its shaft upon a deënergization of the windings of the core or upon a cessation of the electromagnetic field.

6. In a motor, the combination of a shaft suitably journaled, an arc-shaped core carried by said shaft, a series of windings inclosing said core, means whereby said windings may be successively energized, a field-magnet for causing a rotation of the core with its shaft in one direction upon the energizing successively of the windings of the core, and means for limiting the rotation of the core and shaft in reverse directions.

7. The combination with a field-magnet, and an armature including magnetizing-coils, of means for magnetizing same to cause said armature to move within the magnetic field of said field-magnet, and means for limiting the movement of said armature.

8. The combination with a field-magnet, and an armature including magnetizing-coils, the said armature mounted on a shaft and adapted to be rotated with the shaft within the mag-

netic field of said field-magnet, of means for limiting the rotation of said armature, and means for reversely rotating said armature.

9. The combination with a field-magnet, an armature including magnetizing-coils, mounted on a shaft and adapted to be rotated with said shaft within the magnetic field, of means for rotating the said armature in a reverse direction, and means for limiting the rotation of said armature in reverse directions.

10. The combination of a field-magnet, an armature mounted to be moved within the magnetic field, said armature comprising a core and a series of windings insulated from each other and which are successively energized, and means for limiting the movement of said armature.

11. The combination of a field-magnet, an armature mounted to be moved within the magnetic field thereof, said armature comprising a core, and a series of windings insulated from each other, a commutator with which the windings are connected and means for limiting the movement of said armature.

12. In a motor, the combination of means for producing a magnetic field, and a rotatable armature comprising a plurality of sections adapted to be successively energized as it is moved into the field of the magnetic means, means for successively energizing the said sections and means for reversely moving said armature to return it to a normal rest position.

13. In a motor, the combination of means for producing a magnetic field, and a rotatable armature comprising a plurality of sections adapted to be successively energized as they are moved into the field of the magnetic means, means for successively energizing said sections, and mechanical means for returning the armature to its normal rest position.

14. In a motor, the combination of means for producing a magnetic field, a rotatable armature comprising a plurality of sections adapted to be successively energized as it is moved in the field of the magnetic means, means for successively energizing the said sections, and means for limiting the rotation of said armature.

15. In a motor, the combination with means for producing a magnetic field, of an armature comprising a core composed of a section of a ring, and a plurality of separate magnetizing-coils wound thereon, the ends of the core magnetically insulated from each other by a section of non-magnetic material, means for rotatably supporting the armature, and means for successively energizing the coils of said armature.

16. In a motor, the combination with means for producing a magnetic field, of an armature comprising a core composed of a section of a ring, and a plurality of separate magnetizing-coils wound thereon, the ends of the core magnetically insulated from each other by a section of non-magnetic material, means for rotatably supporting the armature, means for successively energizing the coils of said armature, and means for mechanically lifting the armature in one direction.

In testimony whereof I have signed my name in the presence of two subscribing witnesses.

THEODORE M. FOOTE.

Witnesses:
L. E. DOUGLAS,
GEO. E. CRUSE.