No. 698,676. Patented Apr. 29, 1902.

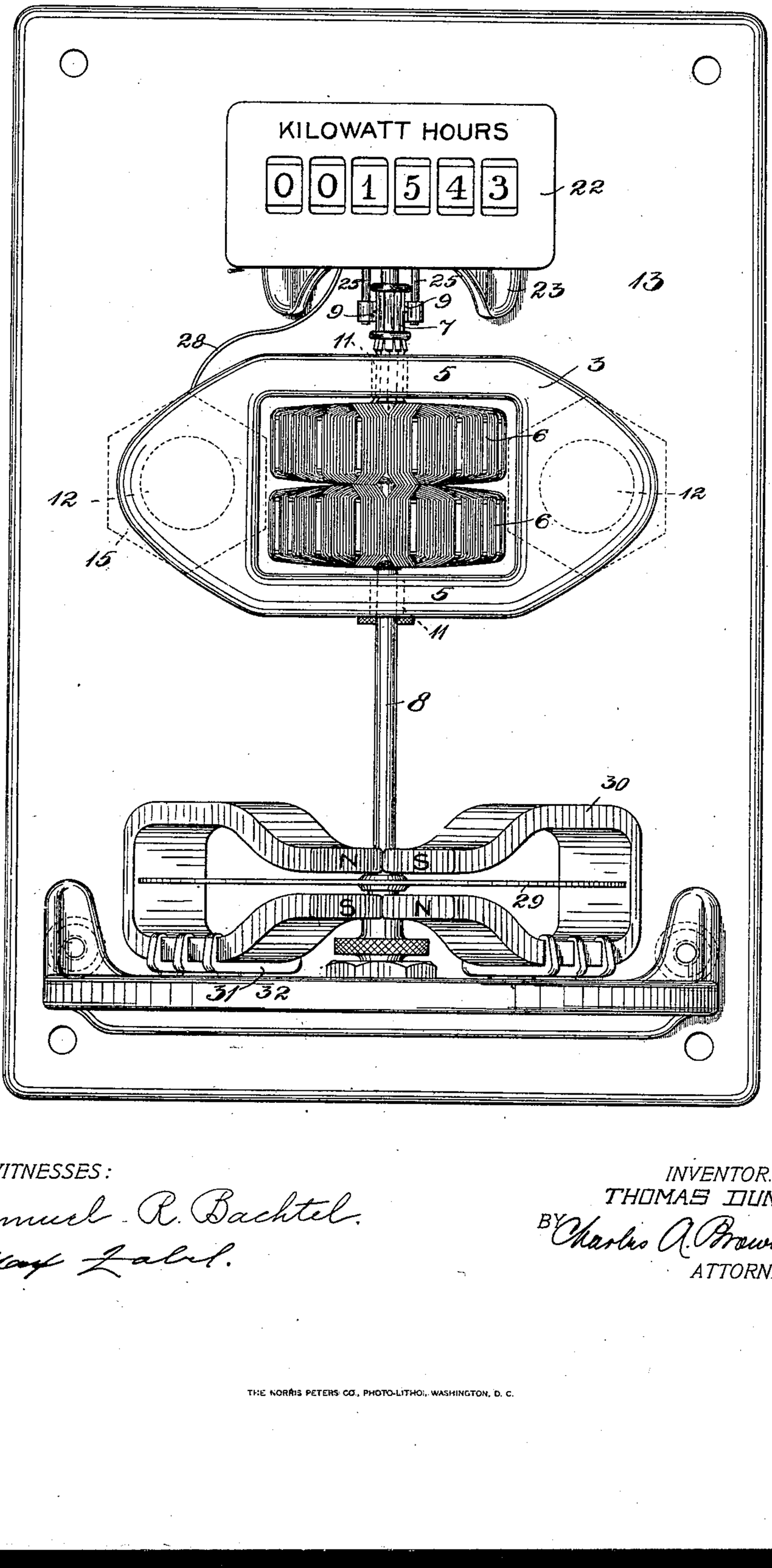
T. DUNCAN.

ELECTRIC METER.

(Application filed Jan. 2, 1900. Renewed Jan. 6, 1902.)

(No Model.) 5 Sheets—Sheet 1.

Fig. 1.



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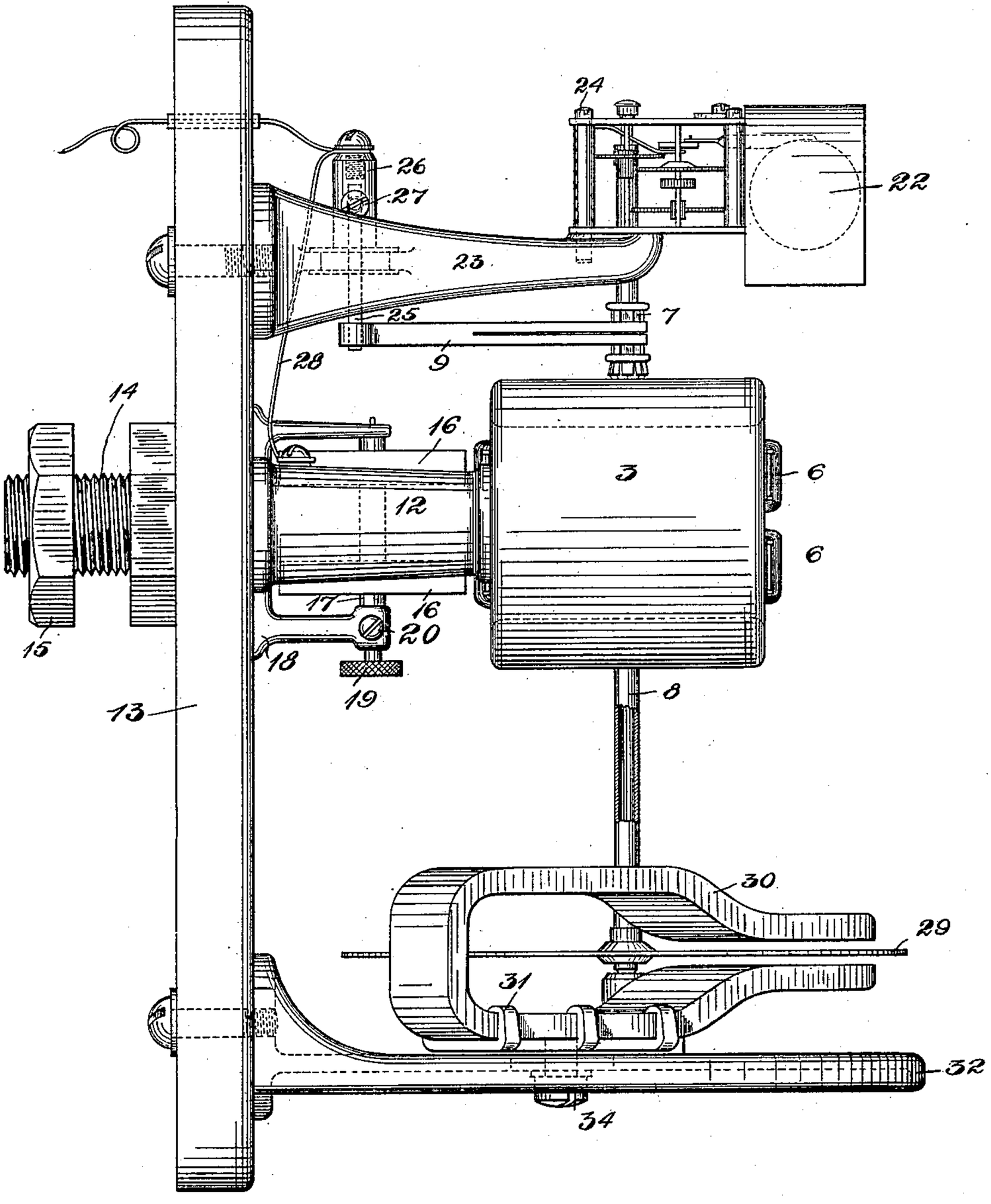
(No Model.) 5 Sheets—Sheet 2.

Fig. 2.



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(No Model.) 5 Sheets—Sheet 3.

Fig. 3.

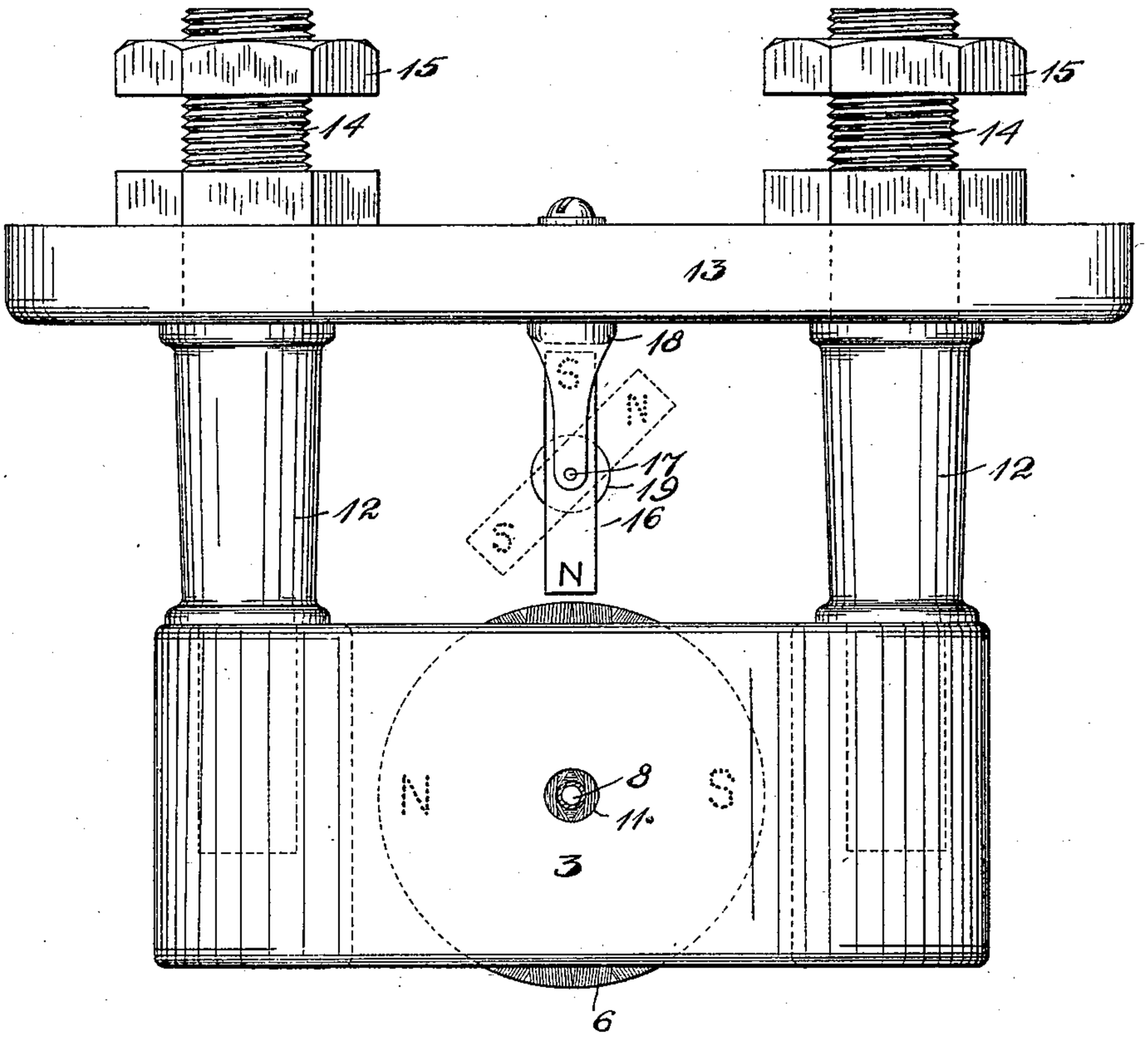
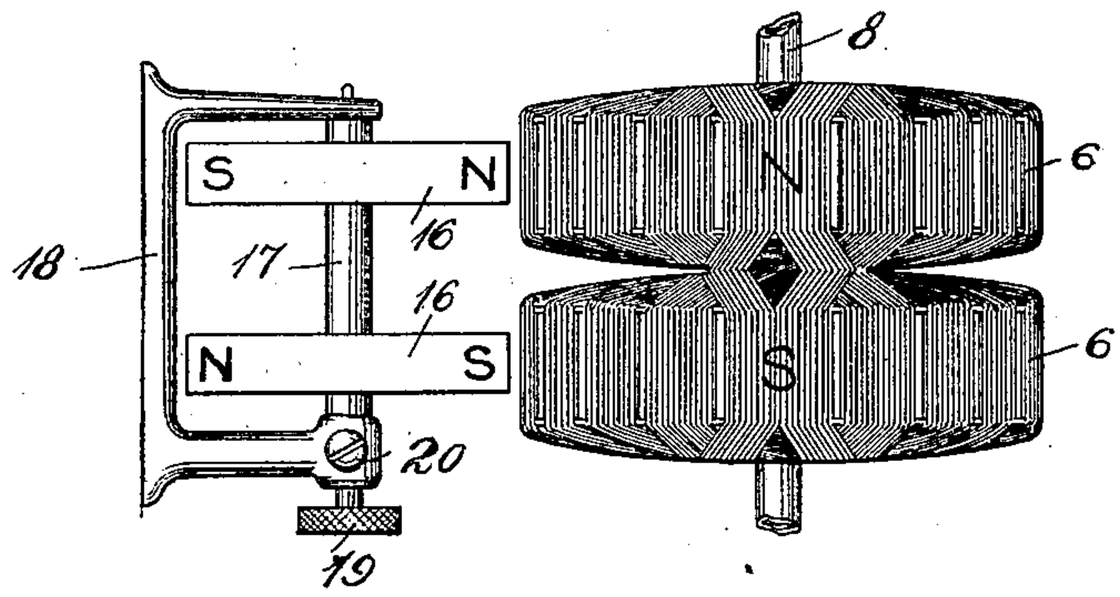


Fig. 4.



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(No Model.) 5 Sheets—Sheet 4.

Fig. 5.

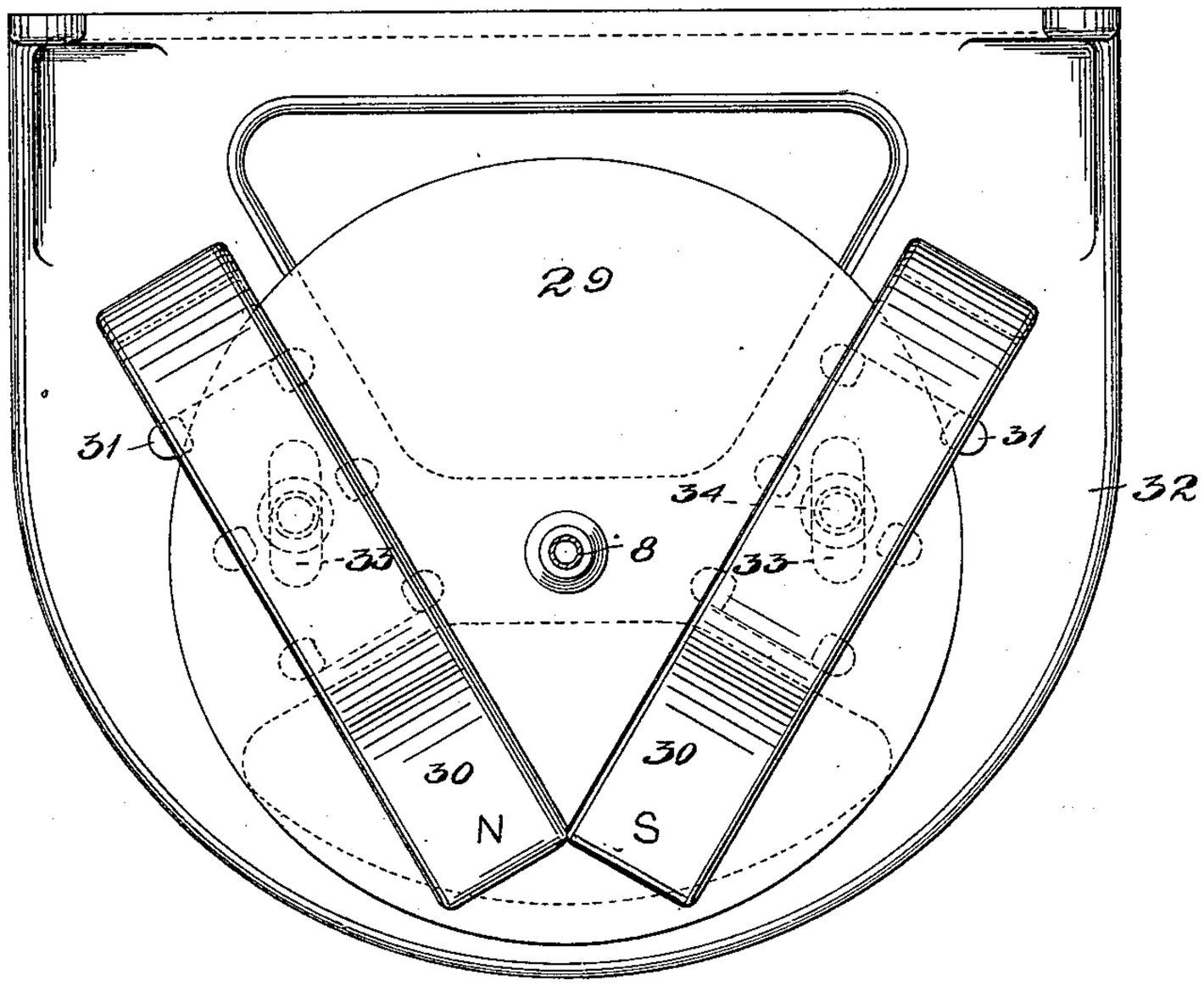
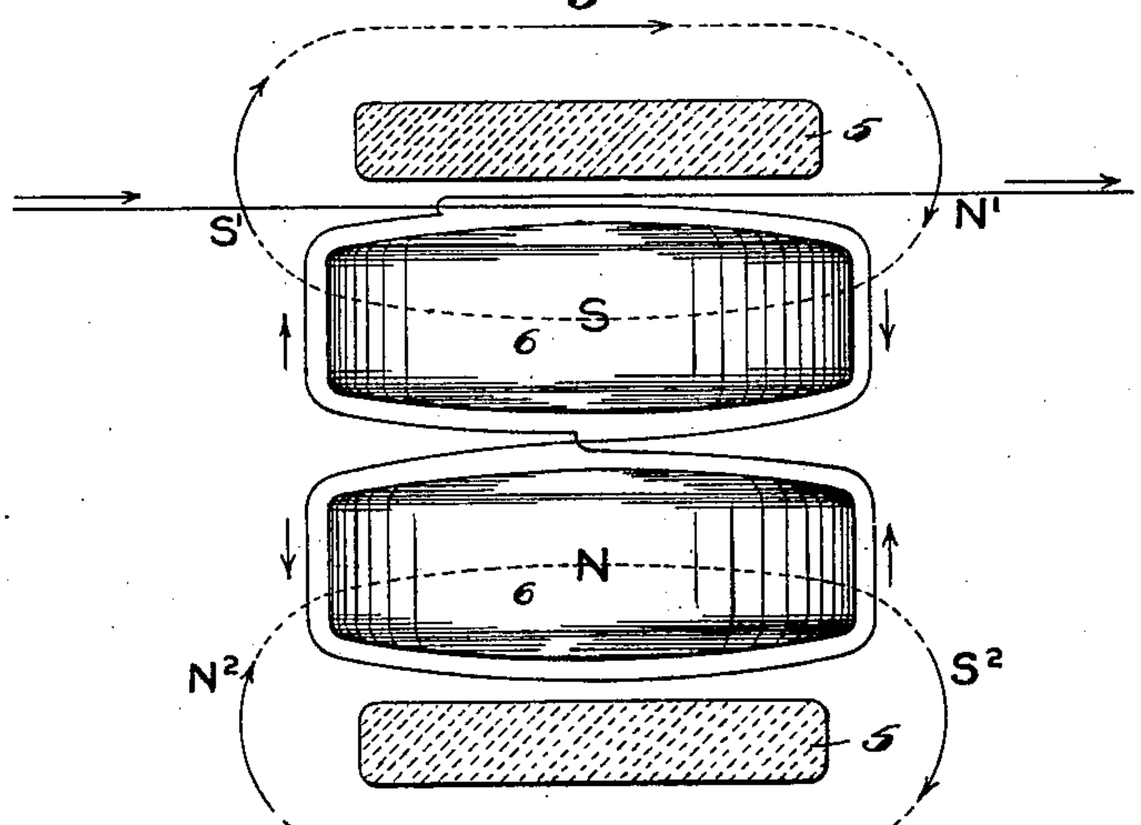


Fig. 6.



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(No Model.) 5 Sheets—Sheet 5.

Fig. 7.

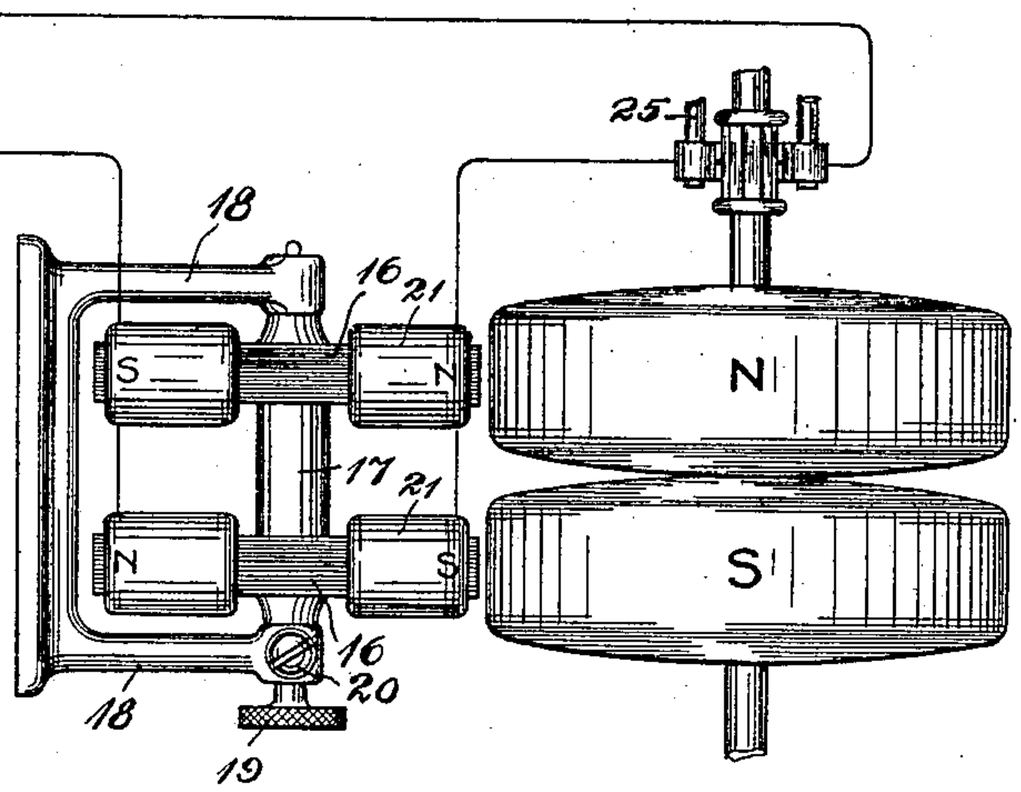


Fig. 8.

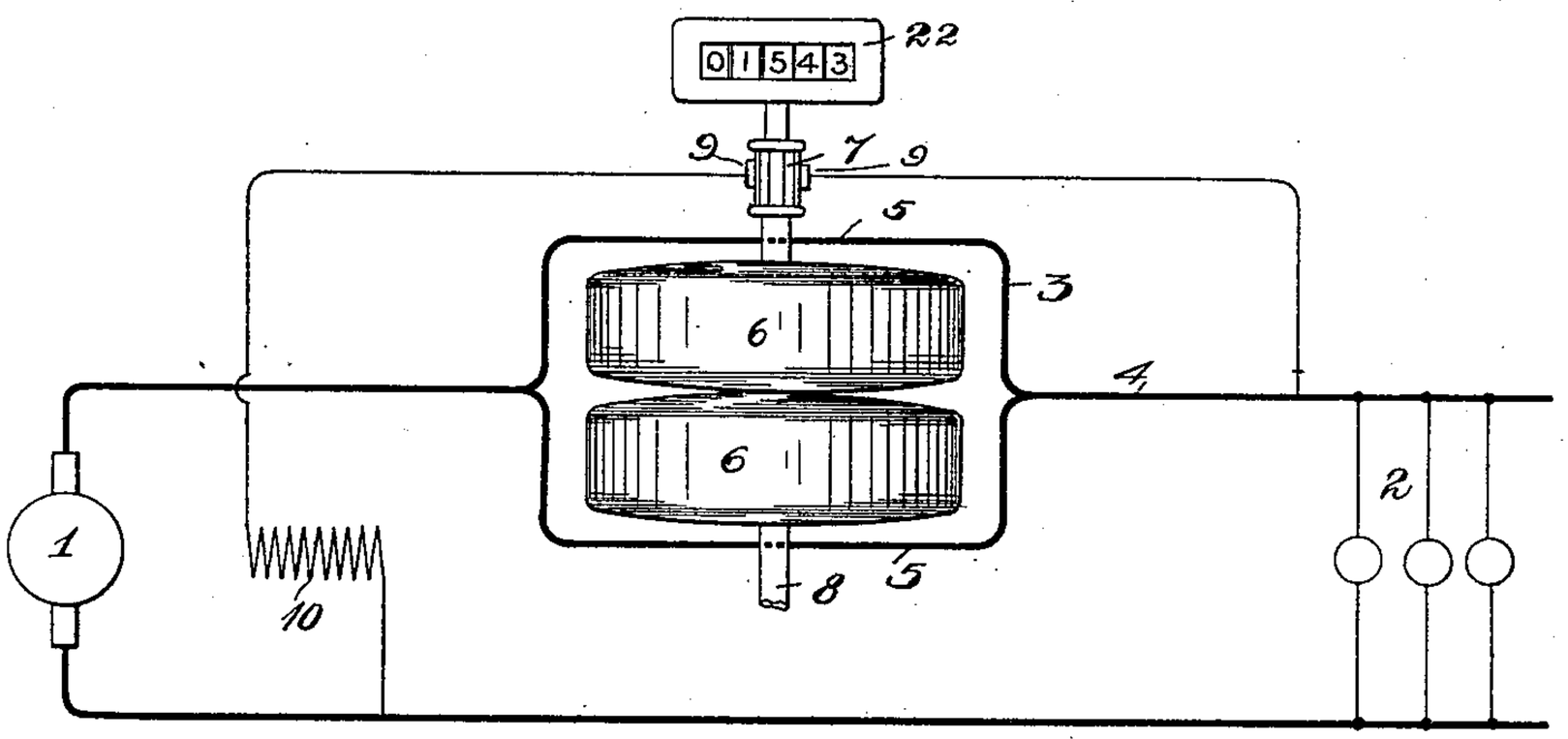
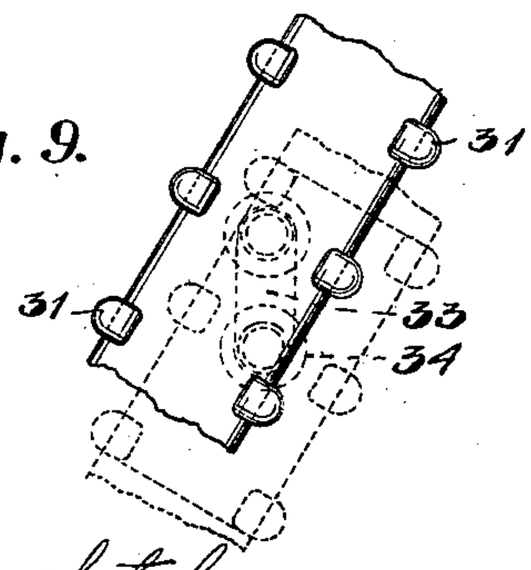


Fig. 9.



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UNITED STATES PATENT OFFICE.

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ELECTRIC METER.

SPECIFICATION forming part of Letters Patent No. 698,676, dated April 29, 1902.

Application filed January 2, 1900. Renewed January 6, 1902. Serial No. 88,487. (No model.)

To all whom it may concern:

Be it known that I, THOMAS DUNCAN, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Electric Meters, (Case No. 323,) of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to meters, and more particularly to that class of meters in which motors are employed for actuating counting-trains or totalizing mechanisms or indicators, my invention having generally for its object the provision of a meter of improved construction and circuit arrangements.

More particularly, my invention relates to wattmeters for measuring heavy direct current, although I do not wish to be limited to this application of the invention, as features thereof may be employed in connection with other meters.

More particularly, my invention has for its object, first, an improvement upon direct-current meters as at present constructed, whereby heavy currents may be accurately and safely measured; second, the employment of a double armature coacting with a series winding for measuring current; third, the provision of an improved magnetic drag for retarding the motion of the motor portion of the instrument wherein the permanent magnet or magnets employed for this purpose are provided with a permanently-closed path for lines of force, whereby the aging or the permanency of the strength of the magnets is maintained; fourth, the reduction in weight of moving parts of instruments; fifth, the provision of a device for furnishing starting torque which is adjustable, to provide variable compensation; sixth, the provision of a torque-producing device which may be adjusted to counteract any tendency the armature may have to rotate upon no load, thus providing for reversible compensation.

In practicing certain features of my invention I preferably employ a heavy conductor, which may be formed in the shape of a hollow rectangular bar-conductor the opposite ends of which may be connected with a main transmission-conductor, so that the current will flow through the remaining sides of the conductor in parallel paths in the same direction. I interpose an armature provided with two windings or sets of coils between these parallel sides of the series or current conductor. The windings of the armature preferably have common connection with a commutator or other collecting device, the windings being so relatively arranged that current flows through the coils thereof in opposite directions, whereby the effect of the current flowing through the parallel sides of the rectangular conductor upon the armature will not be neutralized. A shaft is employed upon which the duplicated armature-windings are mounted, this shaft being preferably hollow and preferably rotatably mounted at its ends. A damping portion is supported at one end of the shaft, preferably the lower end, this damping portion being preferably in the form of a disk of aluminium. I preferably associate a pair of permanent magnets with the damping-disk and provide a closed path for lines of force thereof preferably by causing the corner portions of the permanent magnet to touch, the remainder being forced to thread the disk owing to the reluctance of the magnetic circuit. I provide an improved adjusting device whereby the damping-magnets may be adjusted relatively to the disk without breaking the magnetic circuit. This I preferably accomplish by providing a pair of parallel guiding-slots in a base portion of the meter-frame through which clamping-screws engaging clamps holding the magnets pass, these clamping-screws being adjustable longitudinally of the slots. I preferably place the counting-train or totalizing mechanism above the commutator to permit ready access thereto.

The torque-adjusting device that I preferably employ consists of two magnets each with a pole presented to an armature-winding, the poles of the magnets presented to the armature-windings being preferably of unlike sign. The magnets are preferably rotatably mounted to secure proper relative ad-

justment between the armature-windings and the poles presented thereto, or where there is a tendency of the armature to rotate upon no load the magnets may be swung completely about to present the opposite poles to the armature-windings to counteract this tendency. I do not wish to be limited, however, to the employment of two magnets.

I will more fully explain all the features of my invention by reference to the accompanying drawings, which illustrate the preferred embodiment thereof, in which—

Figure 1 is a front elevation of a meter constructed in accordance with the invention. Fig. 2 is a side view thereof, a portion of the armature-shaft being broken away to show its construction. Fig. 3 is a plan view of parts of the mechanism. Fig. 4 is a side elevation of the armature-windings and a pair of compensating magnets associated therewith. Fig. 5 is a plan view showing my improved damping device. Fig. 6 is a diagrammatic view illustrating the circuit relations between the series or current winding and the armature-windings, the relative directions of current through the armature-windings being indicated by the full line inclosing the same, while the direction of the field lines of force created by the current in the current field-winding is indicated by the closed dotted lines. Fig. 7 is a diagrammatic view illustrating another type of compensating mechanism that may be cöoperatively associated with the armature. Fig. 8 is a diagrammatic view illustrating the circuit connections of the armature and field. Fig. 9 is a detailed view illustrating the manner of adjusting the clamp that supports a permanent damping-magnet.

Like parts are indicated by similar characters of reference throughout the several figures.

In Fig. 8 I have indicated a generator 1 of heavy current-supplying translating devices 2. A series winding or conductor 3 is included in circuit with one of the mains 4, this current-conductor being provided with parallel paths 5 5, between which the armature-windings 6 6 are placed. The armature-windings are preferably duplicates of each other, the connections thereof being such that current will flow through coils of the armatures in opposite directions. I preferably employ a commutator 7, which is common to both of the armature-windings, the armature-windings and commutator being mounted upon a common hollow shaft 8, provided with suitable bearings at its ends. The commutator-brushes 9 9 serve to engage the commutator-segments and to include the armature-windings in bridge between the sides of the transmission-circuit. In order to prevent too much current from flowing through the armature-windings, I employ ohmic resistance 10, which is included in series therewith in the same bridge between the main conductors. The conductor 3 is preferably formed, as shown most clearly in Figs. 1, 2, and 3, where I have disclosed the conductor as being rigid and having an interior rectangular contour, the armature-windings being disposed within the space inclosed by the conductor 3. Vertically-alined holes 11 are provided in the upper and lower horizontal sides 5 5 of the current-conductor, through which the hollow armature-shaft 8 is passed. Two metallic terminal posts 12 12 are provided for supporting the current-conductor 3 at points midway between the horizontal sides 5 5, the terminal posts preferably being supported upon a vertical back piece 13, composed of marble or other suitable material. Threaded stems 14 of the posts are provided, these stems extending through the back piece to the rear thereof. Nuts 15 are screwed upon the said threaded stems for the purpose of connecting the terminals of a main conductor with said posts. The posts and the field-conductor supported thereby are preferably formed of copper. A magnet 16 is preferably associated with each armature-winding 6, these magnets being preferably mounted upon a vertically-disposed and rotatable shaft 17, supported at its upper and lower ends in the horizontally-extending arms of a bracket 18, also preferably secured to the back piece 13. A knurled thumb-piece 19 is secured to the lower end of the shaft 17. A set-screw 20 serves to secure the shaft and the magnets supported thereby in any position to which they have been adjusted. As the current flows through the armature-coils in opposite directions, in this instance, the poles presented to the armature-windings are of unlike sign. When the instrument is adjusted, as indicated in Figs. 3 and 7, the magnets will cause a starting-torque to be exerted upon the armature to overcome the friction. If, however, there is a normal tendency on the part of the armature to rotate when there is no load—as, for example, due to the vibrations of the instrument owing to the operation of machinery in its neighborhood—the magnets are rotated approximately through a half-circle to cause the said magnets to act as brakes to prevent the armature from rotating under no load.

In Figs. 2, 3, and 4 I have indicated permanent bar-magnets for effecting these results.

In Fig. 7 I have shown two electromagnets, soft-iron cores provided with windings 21 and 21, wound to produce the proper polarities, being connected in the same bridge with the armature-windings. I preferably support a totalizing or counting mechanism 22 upon the outer, upper, and horizontal face of a bracket 23, projecting horizontally from the back piece 13. I preferably form the bracket 23 separately from the back piece and secure the back piece and bracket by means of screws. Fastening-screws 24 may project through the framework of the totalizing mechanism into the bracket to secure the totaliz-

ing or counting mechanism in place. The commutator is located beneath the totalizing mechanism, so that access may be readily had thereto, the commutator-brushes being secured at their rear ends to spindles 25, inserted within vertical bores provided in the posts 26, secured upon the bracket 23. Set-screws 27 are employed for securing the spindles 25 in any position to which they have been rotated or vertically adjusted. The shaft 7 is provided with bearings at its ends, the upper bearing being carried by the frame of the totalizing mechanism. A wire 28 is shown in Fig. 2 connected to the posts 12 and 26 to connect one of the brushes 9 with a main. I preferably provide a damping-disk 29 upon the lower end of the armature-shaft. I preferably employ a pair of permanent magnets 30, coöperating with the disk, and in order that the magnets may not lose strength I provide a permanent path for lines of force thereof, preferably by bringing the corner portions of the magnets into contact, as indicated most clearly in Figs. 1 and 5. By this arrangement sufficient lines of force thread the damping or retarding disk to retard the rotation of the armature, while at the same time the magnets do not lose their strength. By providing a path for the lines of force of the damping-magnets I am enabled to construct a meter which may remain without recalibration for a very long period. In order that the damping effect of the magnet may be adjusted, I preferably mount each magnet upon a clamp 31, which may be secured to a bracket 32, preferably extending horizontally from the vertical back piece 13, parallel slots 33 being provided in the bracket or base 32, through which clamping-screws 34 are passed from beneath the base into engagement with the clamps 31. When it is desired to adjust the damping action of the magnets, the screws 34 are loosened and the magnets are simultaneously shifted, whereupon the screws 34 are retightened when the desired adjustment has been secured, the slots 33 serving to permit the permanent magnets to remain in contact irrespective of their adjustment.

In Fig. 9 I have indicated a clamp containing a portion of a permanent damping-magnet, an alternative position of the clamp being indicated by dotted lines.

While I have herein disclosed an electromagnet for correcting error in the rotation of the armature as being provided with a core, I do not wish to limit myself to a magnet employing a magnet-core.

In some of the claims I use the term "collector" in the sense of a commutator or other conducting device for conveying current to the armature.

It is obvious that changes may be readily made in the apparatus herein shown and particularly described without departing from the spirit of my invention, and I do not, therefore, wish to be limited to the precise construction shown or to the particular application of specific features of my invention; but,

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. In a meter, the combination with a current-conductor having parallel paths and adapted for inclusion in series with a main conductor, of an armature adapted for interposition between the sides of the circuit, the said armature being disposed between the said parallel paths, the armature being provided with two adjacent windings free of a current-field portion between them and so related that current will pass through the same in opposite directions, substantially as described.

2. In a meter, the combination with a closed conductor 3, of terminal posts 12, 12, securing the conductor in place and connected with opposite sides thereof, whereby parallel paths are afforded for current passing through the conductor, and an armature inclosed by the conductor, the armature having two adjacent windings free of a current-field portion between them and so relatively arranged that current will pass through the same in opposite directions, said windings being adapted for inclusion in bridge between the sides of the distributing-circuit, substantially as described.

3. In a meter, the combination, with a current-conductor having parallel paths and adapted for inclusion in series with a main conductor, of an armature adapted for interposition between the sides of the circuit, said armature being disposed between the said parallel conductors, the armature being provided with two adjacent windings free of a current-field portion between them, a collector common to the said windings, and means for effecting connection between the said windings and the sides of the distribution-circuit, substantially as described.

4. In a meter, the combination, with a current-conductor having parallel paths and adapted for inclusion in series with a main conductor, of an armature adapted for interposition between the sides of the circuit, said armature being disposed between the said parallel conductors, the armature being provided with two adjacent windings free of a current-field portion between them, a commutator common to the said windings, and commutator-brushes engaging the commutator for including the said windings between the sides of the distribution-circuit, substantially as described.

5. In a meter, the combination, with a current-conductor having parallel paths and adapted for inclusion in series with a main conductor, of an armature adapted for interposition between the sides of the circuit, said armature being disposed between the said parallel conductors, the armature being provided with two adjacent windings free of a current-field portion between them, a collec-

tor common to the said windings, and means for effecting connection between the said windings and the sides of the distribution-circuit, the windings of the armature being so relatively disposed that current will flow through the same in opposite directions, substantially as described.

6. In a meter, the combination, with a current-conductor having parallel paths and adapted for inclusion in series with a main conductor, of an armature adapted for interposition between the sides of the circuit, said armature being disposed between the said parallel conductors, the armature being provided with two adjacent windings free of a current-field portion between them, a commutator common to the said windings, and commutator-brushes engaging the commutator for including the said windings between the sides of the distribution-circuit, the windings of the armature being so relatively disposed that current will flow through the same in opposite directions, substantially as described.

7. In a meter, the combination with the rotatable retarding element thereof, of a permanent magnet coöperating therewith to check the speed of rotation of the movable member of the meter, and a portion of magnetic material in metallic contact with the poles of said magnet for short-circuiting lines of force threading the magnet away from the retarding element and confining them to the closed magnetic circuit including the permanent magnet, substantially as described.

8. In a meter, the combination with the rotatable retarding element thereof, of two permanent magnets for retarding the rotation of the movable member of the meter included in a closed magnetic circuit to short-circuit lines of force threading the magnets, to reduce the number of lines of force threading the rotatable element, substantially as described.

9. In a meter, the combination with the rotatable retarding element thereof, of two permanent magnets therefor, having direct contact with each other to short-circuit lines of force threading the magnets to reduce the number of lines of force threading the disk, substantially as described.

10. In a meter, the combination with the rotatable retarding element thereof, of two permanent magnets therefor, having direct contact with each other to short-circuit lines of force threading the magnets to reduce the number of lines of force threading the disk, and a support for the magnets provided with parallel guiding-slots and clamping-screws passing through the guiding-slots for securing the magnets in place, whereby the magnets may be adjusted with relation to the rotatable retarding element without being removed from contact with each other, substantially as described.

12. In a meter, the combination with a rotatable armature adapted to be supplied with current through its coils from a distribution-circuit, of an adjustable magnet coöperating therewith for correcting the movement of the armature, substantially as described.

13. In a meter, the combination with a rotatable armature adapted to be supplied with current through its coils from a distribution-circuit, of magnetic means coöperating therewith to correct the movement thereof, the said magnetic means being adjustable, whereby a pole of either sign may be presented to the armature, substantially as described.

14. In an electric meter, the combination with a rotatable armature having a winding adapted to receive current from a distribution-circuit, of a rotatably-adjustable magnetic device for correcting the movement of the armature, substantially as described.

15. In a meter, the combination with an armature provided with two windings or sets of coils, of a pair of magnets each coöperating with an armature-winding, whereby error in the movement of the armature may be corrected, substantially as described.

16. In a meter, the combination with an armature provided with windings through which current is adapted to flow in opposite directions, of a pair of magnets presenting unlike poles to the said windings, substantially as described.

17. In a meter, the combination with an armature provided with windings, through which current is adapted to flow in opposite directions, of a pair of magnets presenting unlike poles to the said windings, the said windings being rotatably mounted, whereby the poles presented to the armature-windings may be reversed, substantially as described.

18. In a meter, the combination with the rotatable armature thereof, adapted to receive current from a distribution-circuit, of an electromagnetic device having a winding included in circuit with the said armature, the said magnet serving to create poles of unlike sign, the said magnet serving to correct error in the movement of the armature, substantially as described.

19. In a meter, the combination with the rotatable armature thereof, adapted to receive current from a distribution-circuit, of an electromagnetic device having a winding included in circuit with the said armature, the said magnet serving to create poles of unlike sign, the said magnet serving to correct error in the movement of the armature, the magnet

being rotatable, whereby a pole of either sign may be presented to the armature, substantially as described.

20. In a meter, the combination with a rotatable armature adapted to be supplied with current through its coils from a distribution-circuit, of a magnetic device coöperating therewith for correcting the movement of the armature, and means for reversing the polarity of the magnet as it is presented to the armature, substantially as described.

21. In a meter, the combination with the rotatable retarding element thereof, of a permanent magnet coöperating therewith to check the speed of rotation of the movable member of the meter, and a portion of magnetic material opposed to portions of both poles of the permanent magnet and conveying lines of force from one pole of said magnet to the other, whereby lines of force threading the magnet are short-circuited away from the retarding element and confined to the magnetic circuit comprising the magnet and the said portion of magnetic material, substantially as described.

In witness whereof I hereunto subscribe my name this 20th day of December, A. D. 1899.

THOMAS DUNCAN.

Witnesses:
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JAMES W. DALTON.