No. 698,677. Patented Apr. 29, 1902.

T. DUNCAN.

ELECTRIC METER.

(Application filed Jan. 2, 1900. Renewed Dec. 16, 1901.)

(No Model.) 4 Sheets—Sheet 1.

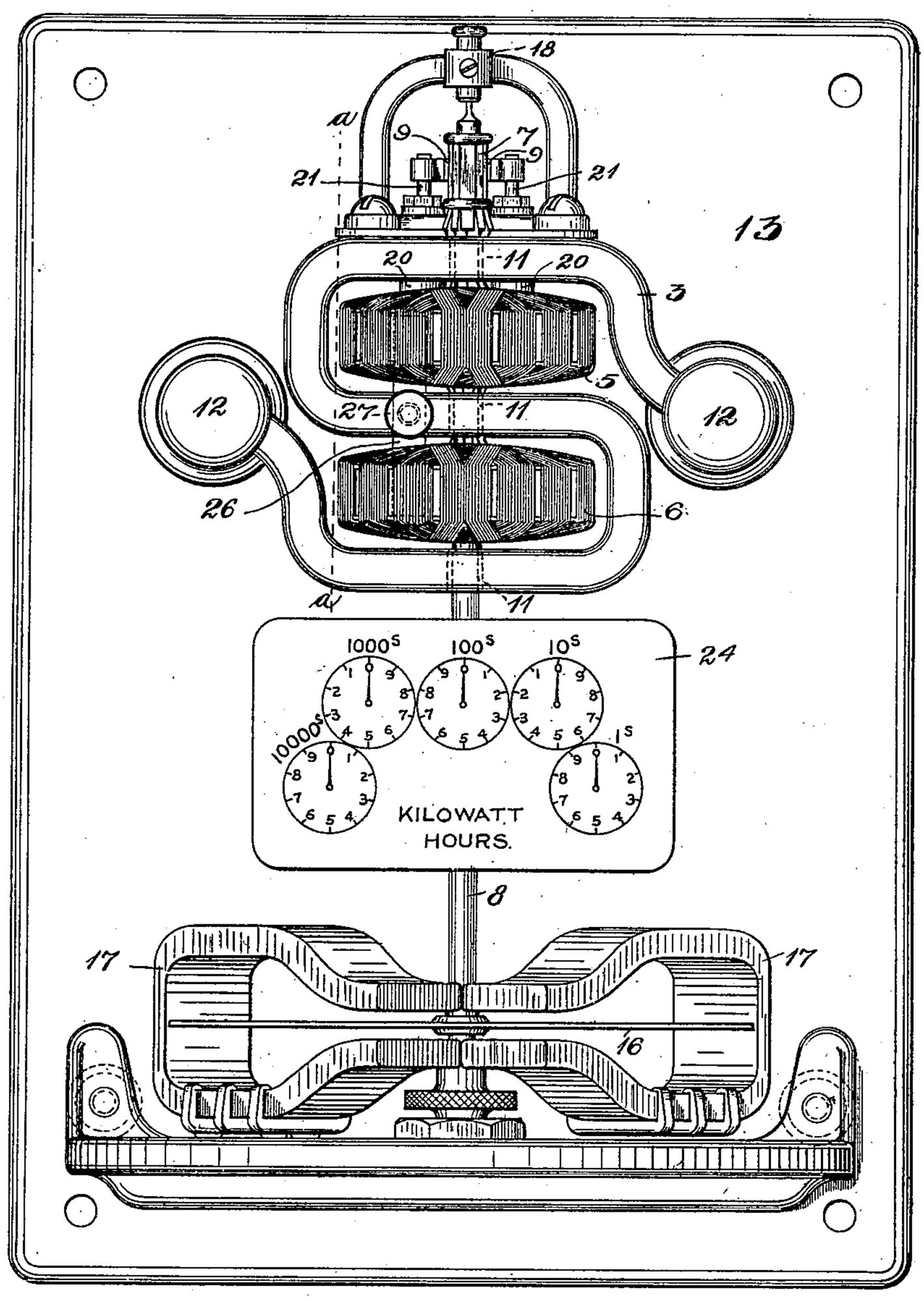

Fig. 1.

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Charles E. Smart.

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(No Model.) 4 Sheets—Sheet 2.

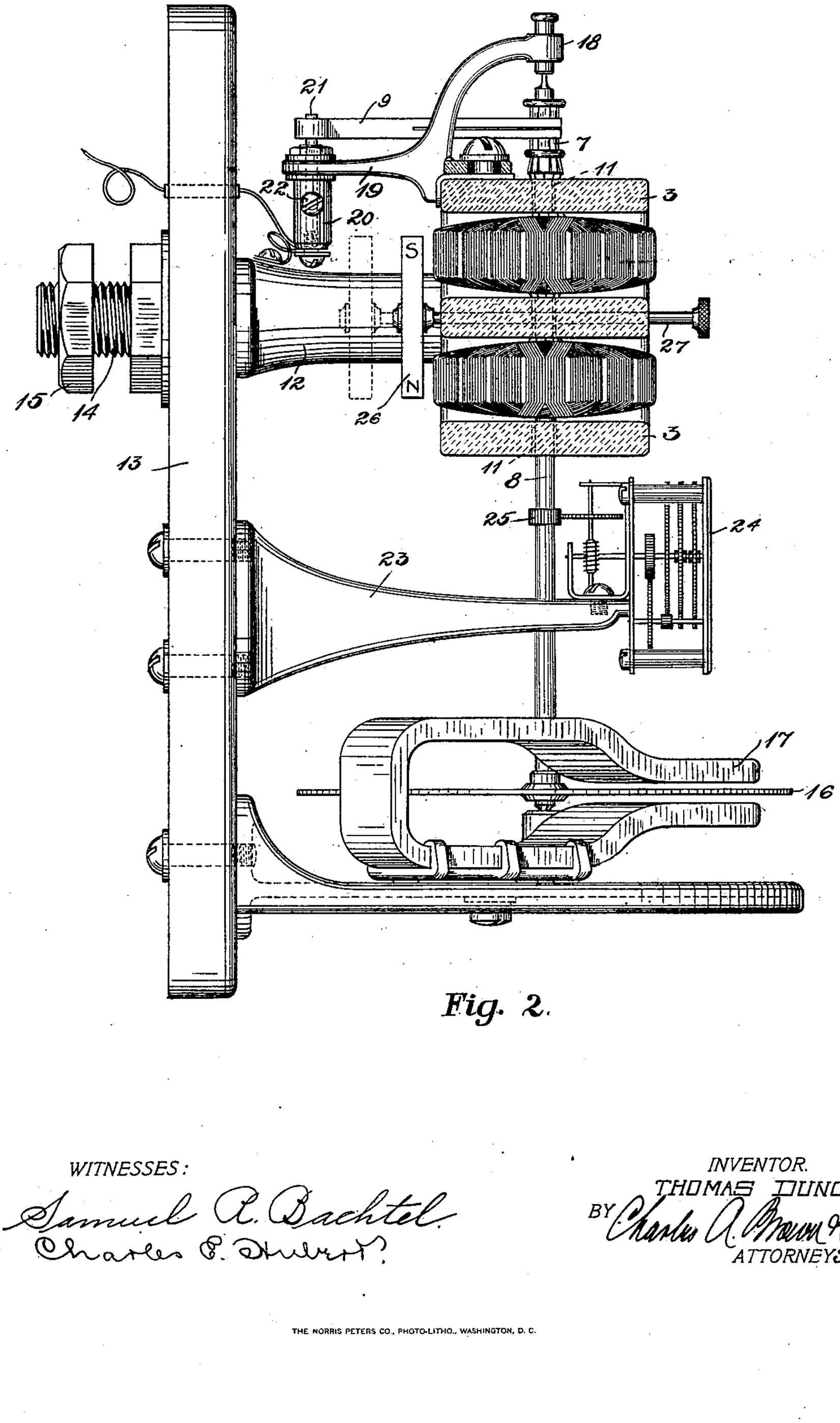

Fig. 2.

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(No Model.) 4 Sheets—Sheet 3.

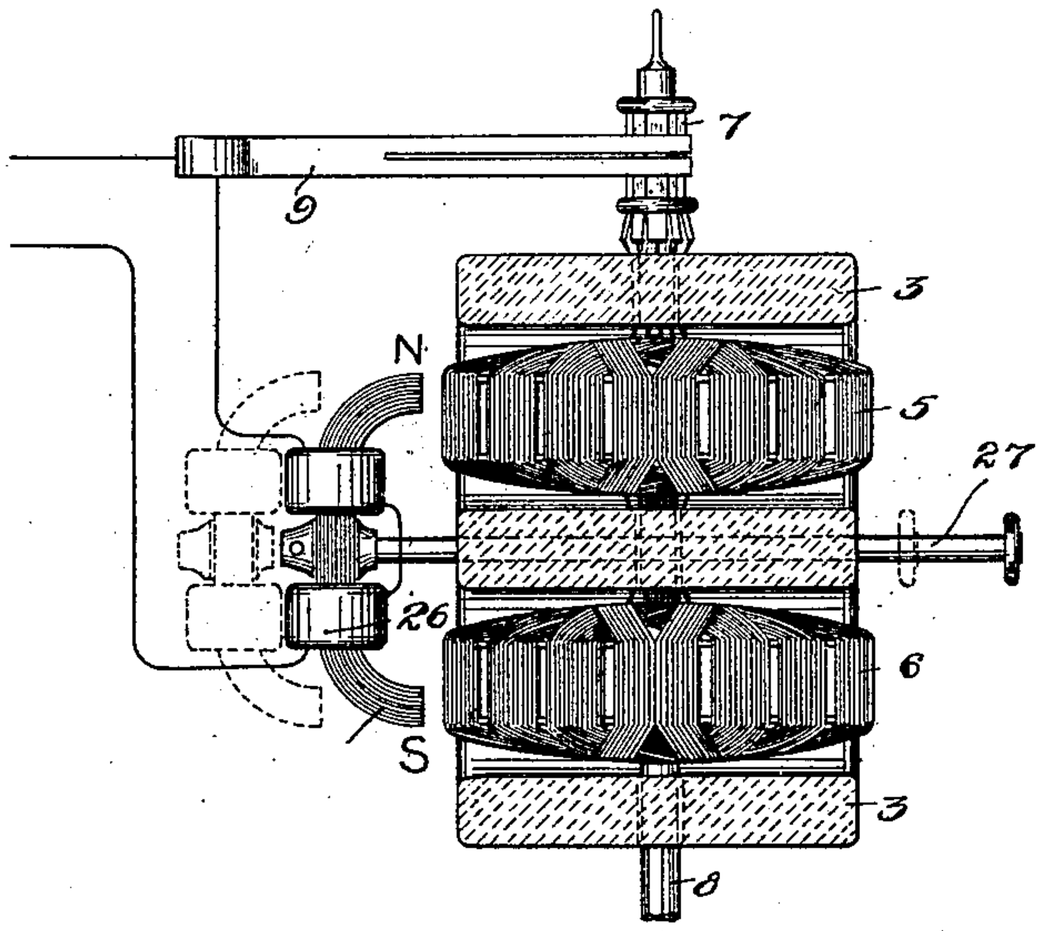

Fig. 3

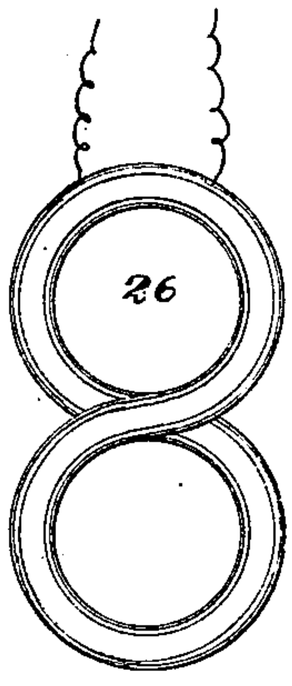

Fig. 4.

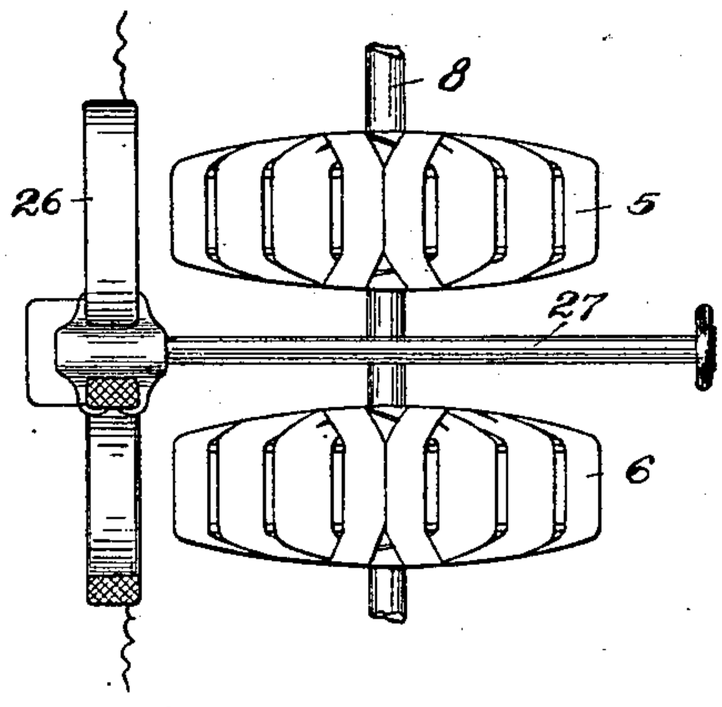

Fig. 5.

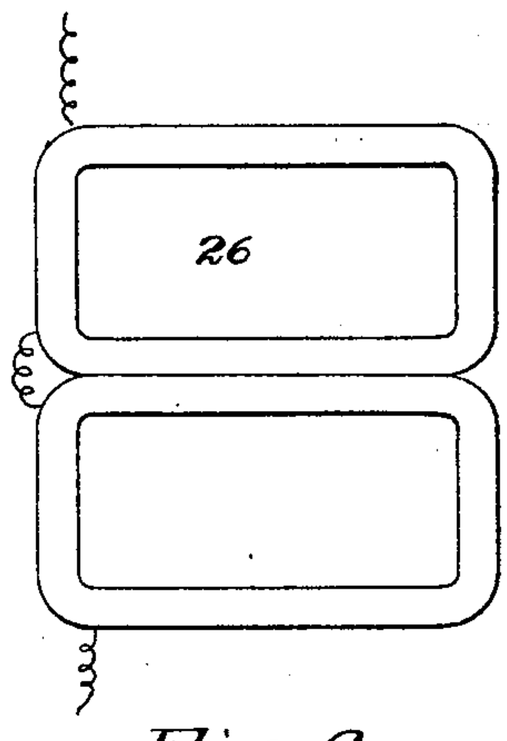

Fig. 6.

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No. 698,677. Patented Apr. 29, 1902.

T. DUNCAN.

ELECTRIC METER.

Application filed Jan. 2, 1900. Renewed Dec. 16, 1901.)

(No Model.) 4 Sheets—Sheet 4.

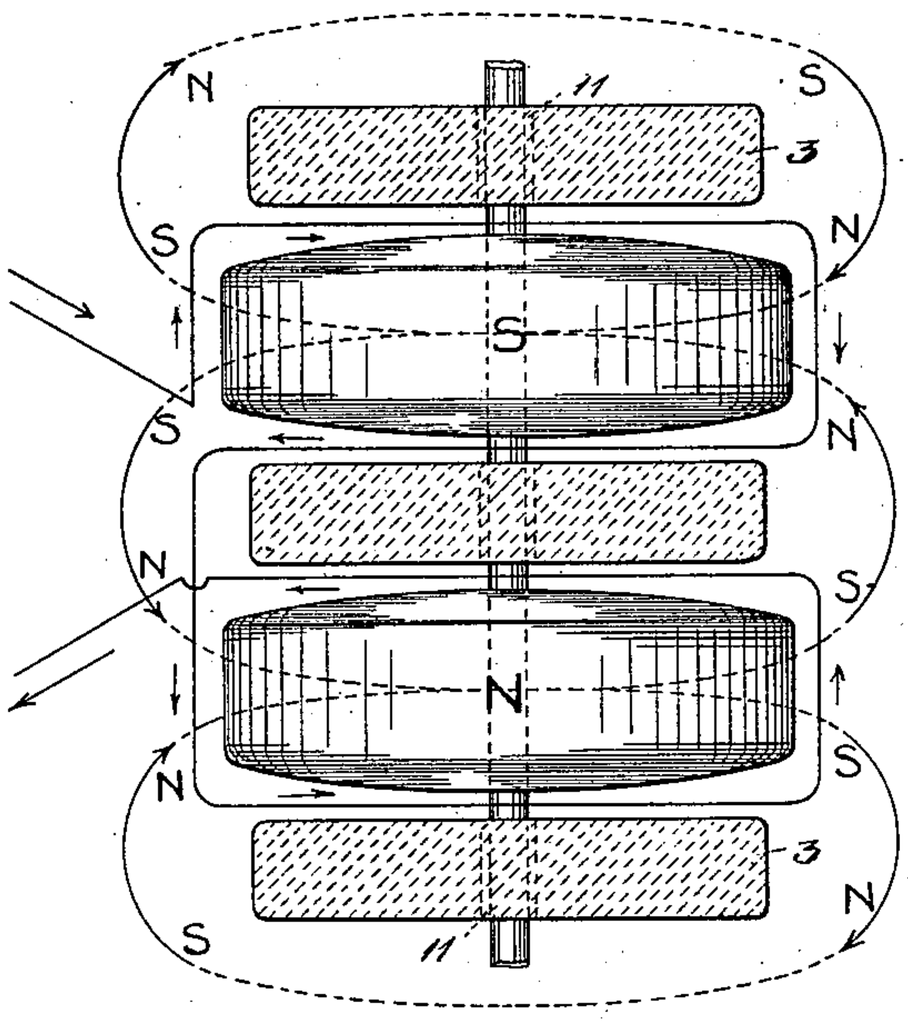

Fig. 7.

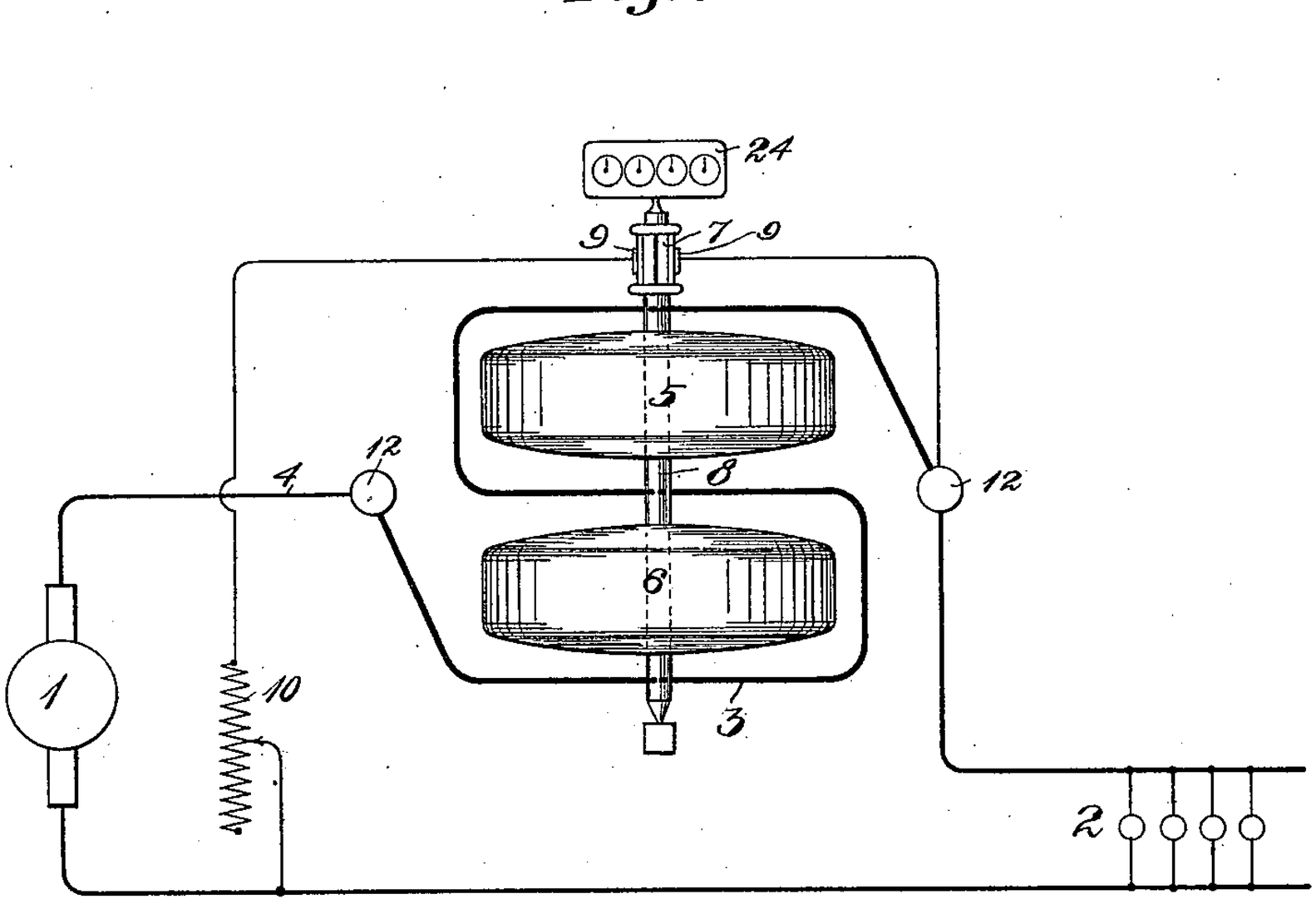

Fig. 8.

WITNESSES:
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UNITED STATES PATENT OFFICE.

THOMAS DUNCAN, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE SIEMENS & HALSKE ELECTRIC COMPANY OF AMERICA, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

ELECTRIC METER.

SPECIFICATION forming part of Letters Patent No. 698,677, dated April 29, 1902.

Application filed January 2, 1900. Renewed December 16, 1901. Serial No. 86,059. (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. 324,) 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 measured; second, the employment of a new and simple form of current-winding for producing effective torque; third, the provision of an improved device for furnishing starting torque which is adjustable to provide for variable compensation; fourth, 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; fifth, an improved construction of a meter wherein the commutator or collector and the brushes engaging the same are readily accessible.

In practicing certain features of my invention I preferably employ a heavy conductor which may be formed of cast copper in the shape of a letter **S**, the ends of this conductor being adapted for inclusion in circuit with a main transmission-conductor, the **S**-shaped conductor thereby constituting a field-winding. An armature preferably having two windings or sets of coils is provided, the windings being inclosed by the **S**-shaped field-conductor, the loops of the conductor each inclosing an armature-winding. The armature-windings are thus separated physically, the central portion of the **S**-shaped field-conductor intervening between the same. I preferably connect the armature-windings so that current will flow through the same in opposite directions. The current field-conductor is preferably provided with vertically-alined holes through which the armature-shaft is passed. In order that the commutator or collector may be accessible at all times to permit cleaning of the same and of the brushes engaging it, I preferably dispose the armature between the counting-train and the commutator. In the preferred embodiment of the invention the current field-conductor constitutes a support for the upper bearing of the armature-shaft. The torque-adjusting device that I employ in my present invention comprises a magnet which is placed with its poles in juxtaposition with the two windings of the armature where two windings are employed. In order to adapt this magnet for variable or reversible compensation, whereby a starting torque may be created where required or whereby tendency on the part of the armature to creep under no load, as when subject to vibration, may be counteracted, I mount the magnet to rotate about an axis extending transversely of the axis of rotation of the armature. Where this feature of the invention is employed with an armature having a double winding, the axis of rotation of the magnet is disposed between the windings of the armature, so that each winding may be coöperatively associated with a magnetic pole. I may employ either a permanent magnet or an electromagnet with or without a magnetic core. I also provide for an adjustment of the magnet toward or away from the armature to increase or decrease its effect thereon.

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. Fig. 3 is a sectional view of a portion of the apparatus on line *a a* of Fig. 1, circuit connections of the instruments being diagrammatically indicated. Fig. 4 is a detail view showing a coreless winding that may be employed as a part of the compensating device to coöperate with the armature. Fig. 5 is an elevation of the armature, showing another form of compensating device associated therewith. Fig. 6 is a view of another form of winding that may be employed in the compensating device. Fig. 7 is a diagrammatic view illustrating the circuit relations between the series or current winding and the armature-windings, the relative directions of current to 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. 8 is a diagrammatic view illustrating the circuit connections of the armature and field.

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

In Fig. 8 I have indicated a direct-current generator 1 of heavy current supplying translating devices 2. A series field winding or conductor 3 is included in circuit with one of the mains 4. The armature-windings 5 6 are inclosed by the convolutions of the **S**-shaped conductor. The armature-windings are preferably duplicates of each other, the connections thereof being such that current will flow through the 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 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. As shown most clearly in Figs. 1, 2, and 3, the **S**-shaped field-conductor is rigid, being preferably formed of cast copper. The vertically-alined holes 11 are provided in three parallel horizontal portions of the series conductor, through which the armature-shaft 8 is passed. Two metallic terminal posts 12 12 are provided for supporting a current-conductor 3 at its terminals, 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 armature-shaft 8 is provided at its lower end with a damping-disk 16, which coöperates with a pair of permanent magnets 17 to retard the rotation of the armature. The upper bearing 18 for the armature-shaft is preferably mounted upon the rigid conductor 3, being insulated therefrom. A rear extension 19 of the support for the bearing 18 is provided, this extension supporting posts 20, provided with vertical bores within which spindles 21 carrying the commutator-brushes may be vertically and rotatably adjusted, clamping-screws 22 being employed to secure the brushes in the positions to which they have been adjusted. In order that access may be readily had to the commutator and the commutator-brushes, I preferably provide a bracket 23, upon which the registering mechanism 24 may be mounted. This bracket is placed in such position that the registering-train is located below the armature, which is thus interposed between the registering-train and the commutator. I have shown a pinion 25 upon the shaft beneath the armature, which actuates the counting-train.

Referring to Figs. 1, 2, 3, 4, 5, and 6, I have shown a compensating magnet 26, which is preferably provided with means for effecting two adjustments thereof, one in a direction transverse to the armature-shaft, whereby the magnet may be moved from or toward the armature, and also a rotary adjustment whereby the magnet may be reversed to change the polarity of the poles presented to the armature. I do not wish to be limited, however, to the physical adjustment of the magnet for reversing the polarity thereof as it is presented to the armature.

I preferably provide the magnet with a stem 27, which passes through a bore in the field-conductor 3, the said stem being capable of longitudinal movement to move the compensating magnet toward or from the armature and rotary movement to effect the rotary adjustment of the magnet. As the current flows through the armature-coils in opposite directions, a single magnet will act effectively to produce the desired torques. The magnet will have one position of rotary adjustment to produce a starting torque to counteract friction, while in order to provide for a reversible compensation to prevent the armature from creeping under no load the magnet may be swung through a half-circle to present poles of opposite polarity to the armature-windings.

In Figs. 1 and 2 I have indicated permanent bar-magnets for effecting these results.

In Fig. 3 I have shown an electromagnet having a soft-iron core inclosed by a winding.

In Fig. 4 I have shown an **8**-shaped winding unprovided with a magnetic core.

In Fig. 5 have shown two circular coils mounted upon the stem 27.

In Fig. 6 I have shown two oblong coils that may form part of the compensating device.

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; but,

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

1. In a wattmeter, the combination with an S-shaped field-conductor, of an armature having windings inclosed by the convolutions of said conductor, and means for connecting said windings in bridge between the sides of the circuit in which the current is being measured, substantially as described.

2. In a meter, the combination with an S-shaped field-conductor, of an armature having windings inclosed by the convolutions of said conductor, the windings of the said armature being connected to have current flow through the same in opposite directions, substantially as described.

3. In a meter, the combination with an S-shaped field-conductor, of an armature having windings inclosed by the convolutions of said conductor, and a collecting device common to the windings of the armature, substantially as described.

4. In a meter, the combination with an S-shaped field-conductor, of an armature having windings inclosed by the convolutions of said conductor, and a commutator common to the windings of the armature, substantially as described.

5. In a meter, the combination with an S-shaped field-conductor, of an armature having windings inclosed by the convolutions of said conductor, the windings of the said armature being connected to have current flow through the same in opposite directions, and a collector common to the windings of the armature, substantially as described.

6. In a meter, the combination with an S-shaped field-conductor, of an armature having windings inclosed by the convolutions of said conductor, the windings of the said armature being connected to have current flow through the same in opposite directions, a commutator common to the windings of the armature, and commutator-brushes for connecting the armature in circuit, substantially as described.

7. In a wattmeter, the combination with a rigid S-shaped field-conductor, of an armature having two windings, each convolution of the field-conductor inclosing a winding, a commutator for the armature, and commutator-brushes for engaging the commutator and including the windings in bridge between the sides of a transmission-circuit, substantially as described.

8. In a wattmeter, the combination with a rigid S-shaped field-conductor, of an armature having two windings, each convolution of the field-conductor inclosing a winding, a commutator for the armature common to the armature-windings, and commutator-brushes for engaging the commutator and including the windings in bridge between the sides of a transmission-circuit, substantially as described.

9. In a wattmeter, the combination with a rigid S-shaped field-conductor, of an armature having two windings, each convolution of the field-conductor inclosing a winding, a commutator common to the windings of the armature and commutator-brushes engaging the commutator for including the armature between the sides of the transmission-circuit, said windings being arranged to have current flow through each in a direction opposite to that flowing in the other, substantially as described.

10. In a meter, the combination with an armature adapted to receive current from a distribution-circuit, of a magnetic corrective device, and means for adjusting the same toward or from the armature, substantially as described.

11. In a meter, the combination with the armature thereof, adapted to receive current from a distribution-circuit, of a magnetic corrective device coöperating with the armature, said corrective device being mounted to rotate about an axis transverse to the axis of rotation of the armature, substantially as described.

12. In a meter, the combination with the armature thereof, formed in two windings or sets of coils, of a single magnetic corrective device having two poles each opposed to a winding of the armature, and means for changing the polarity of the said corrective device with respect to the armature, substantially as described.

13. In a meter, the combination with the armature thereof, formed in two windings or sets of coils, of a single magnetic corrective device having two poles each opposed to a winding of the armature, said corrective device being rotatably mounted to change the polarity of the poles of the corrective device presented to the armature-windings, substantially as described.

14. In a meter, the combination with an armature adapted to receive current from a distribution-circuit and having two windings or sets of coils, of a single magnetic corrective device having two poles each opposed to a winding of the meter, substantially as described.

15. In a meter, the combination with an armature adapted to receive current from a dis-

tribution-circuit and having two windings or sets of coils, of a single magnetic corrective device having two poles each opposed to a winding of the meter, the said windings being connected to have current flow through each in a direction opposite to that flowing through the other, substantially as described.

16. In a meter, the combination with a rigid field-conductor, of an armature arranged within the influence of the field-conductor and suitable journals for the armature, one supported by the rigid conductor, substantially as described.

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

THOMAS DUNCAN.

Witnesses:
WILLIAM F. MEYER,
JAMES W. DALTON.