(No Model.)

4 Sheets—Sheet 1.

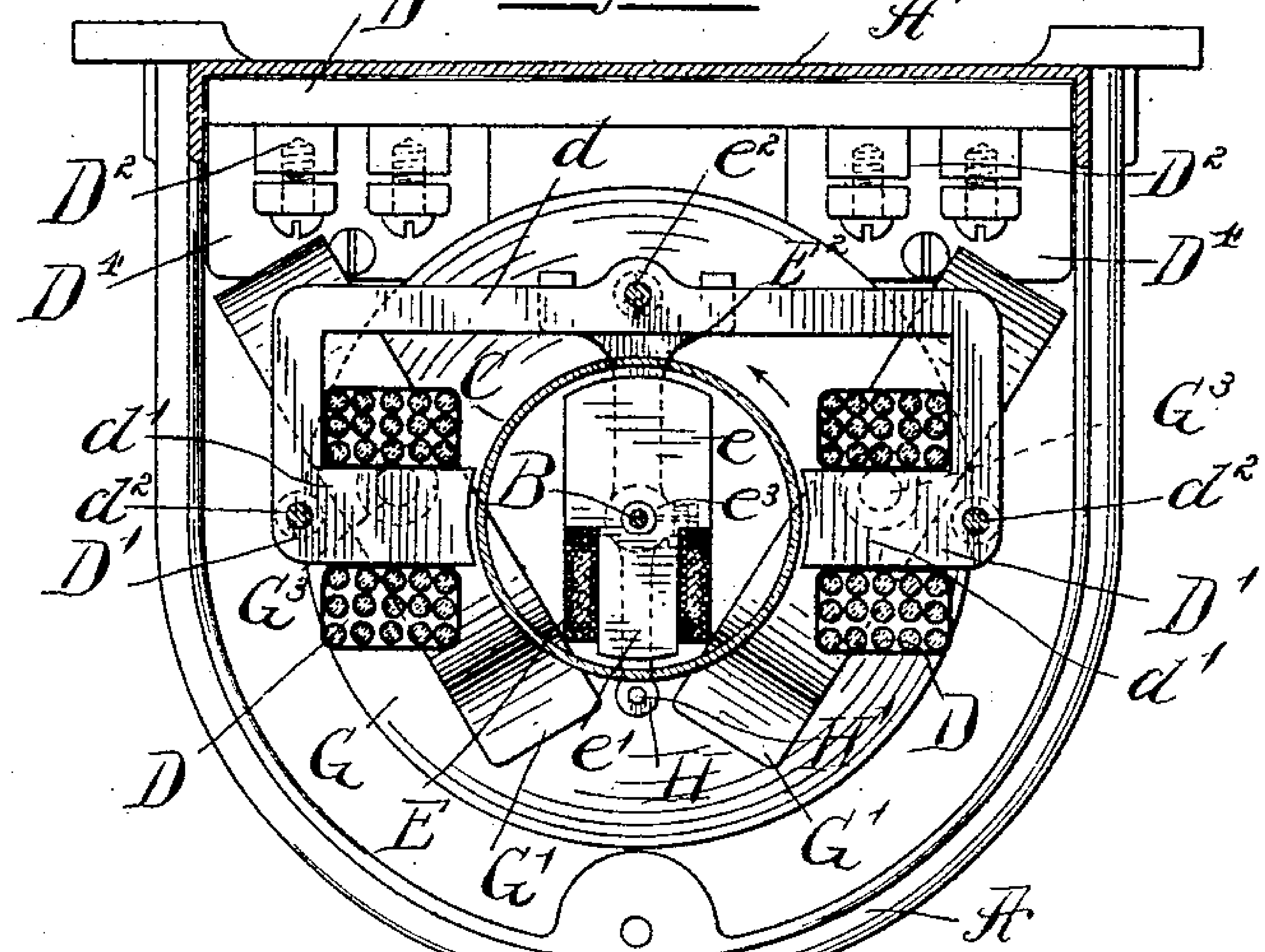
T. DUNCAN.

WATTMETER.

No. 573,078.

Patented Dec. 15, 1896.

Fig. 1.



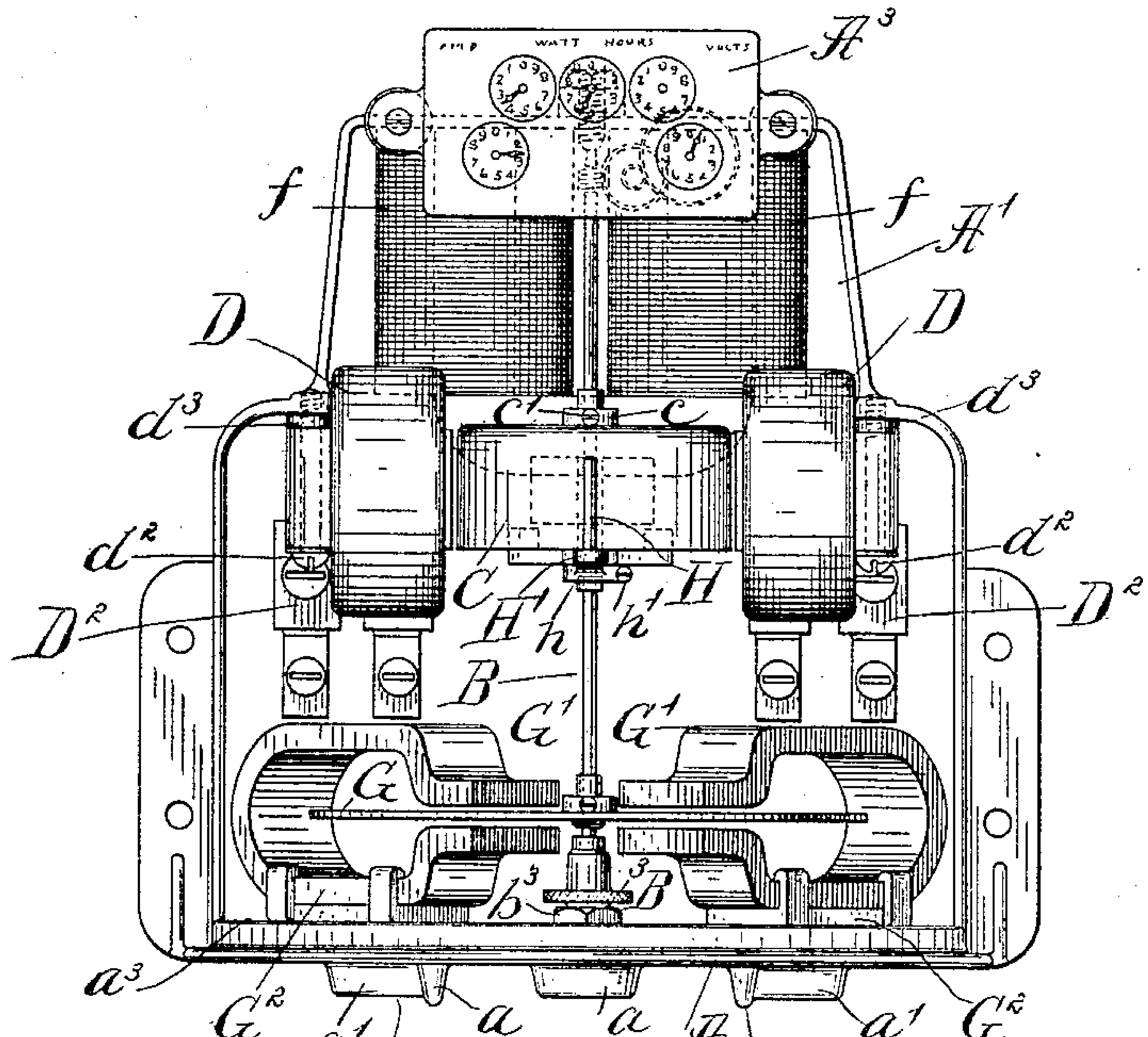


Fig. 2

Witnesses

Louis P. Abell

F. S. Hunting

Inventor

Thomas Duncan

By his Attorneys

Parkinson & Carter

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

(No Model.) 4 Sheets—Sheet 2

T. DUNCAN.

WATTMETER.

No. 573,078. Patented Dec. 15, 1896.

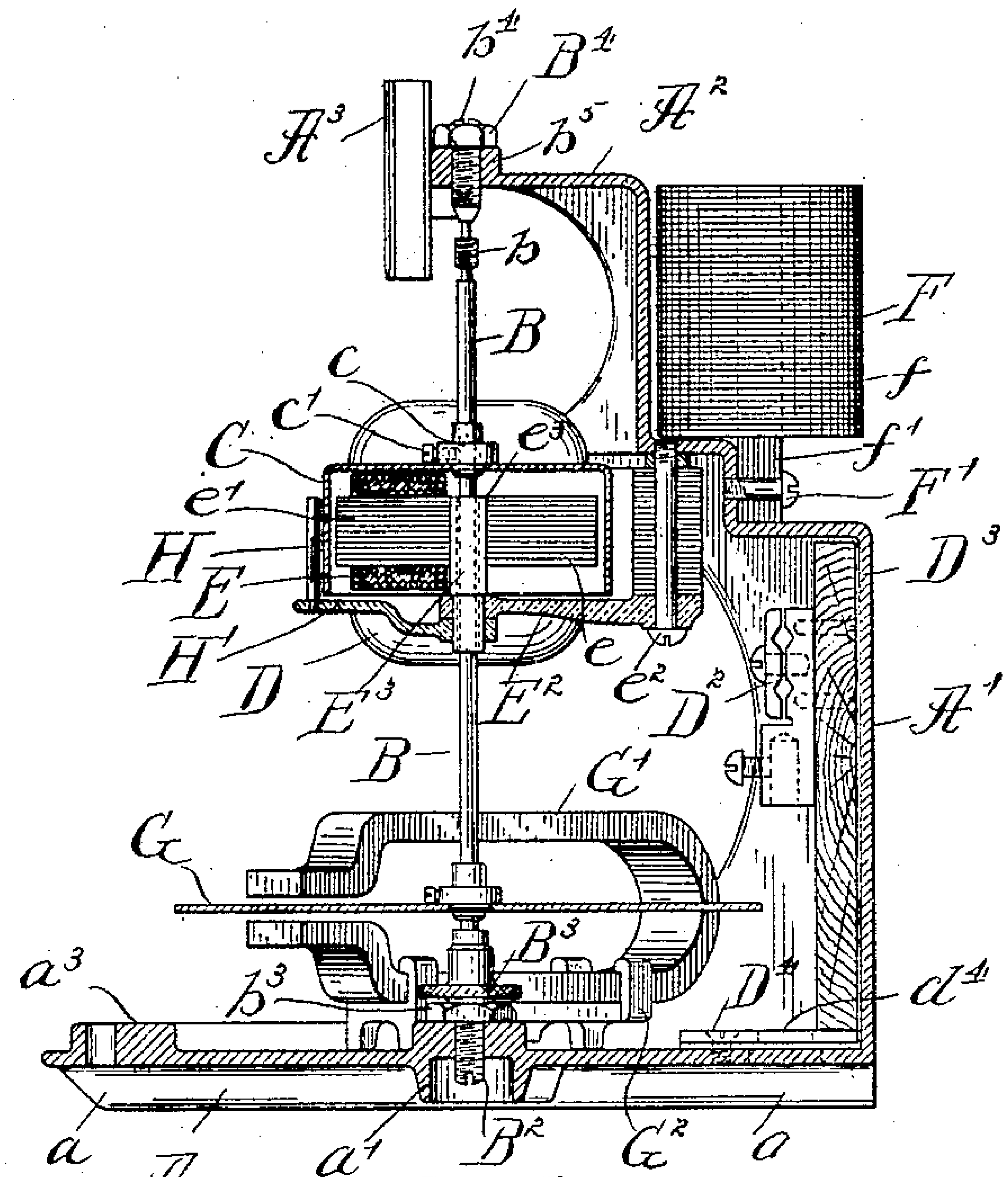


Fig. 3.

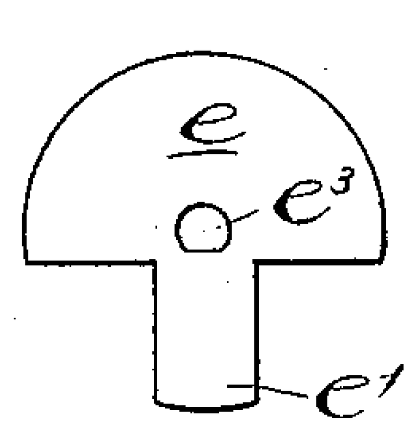


Fig. 4.

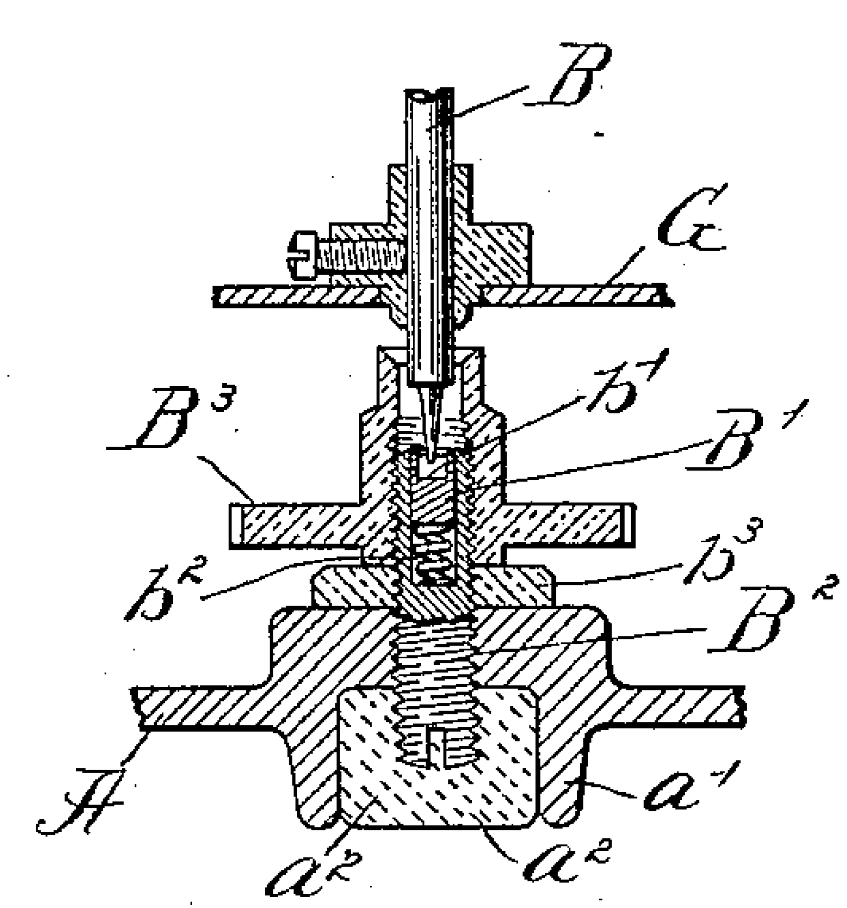


Fig. 5.

Witnesses
Louis J. Abell
F. S. Hunting

Inventor
Thomas Duncan
By his Attorneys
Parkinson & Carter

THE NORRIS PETERS CO. PHOTO-LITHO., WASHINGTON, D. C.

(No Model.)

4 Sheets—Sheet 3.

T. DUNCAN.

WATTMETER.

No. 573,078.

Patented Dec. 15, 1896.

Fig. 6.

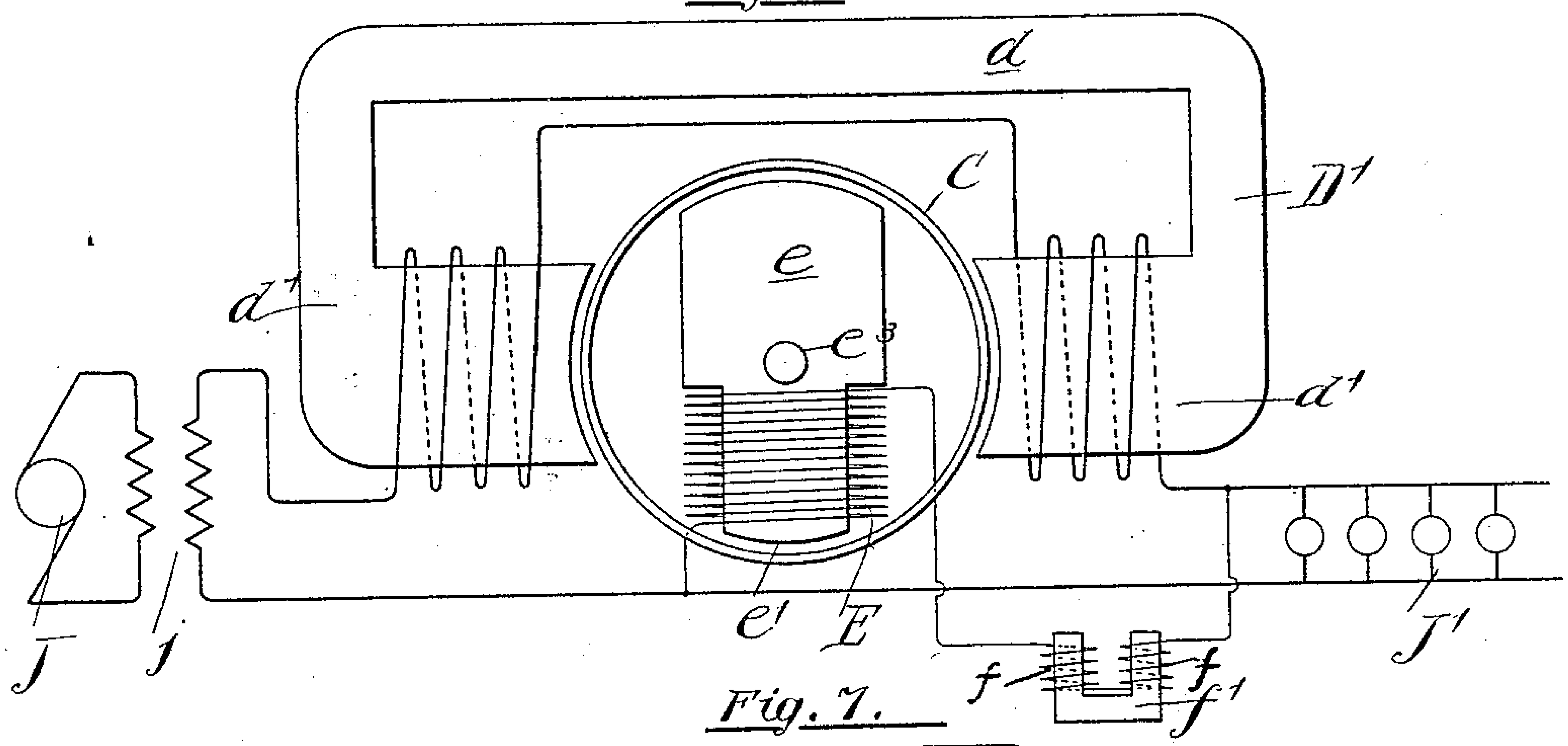
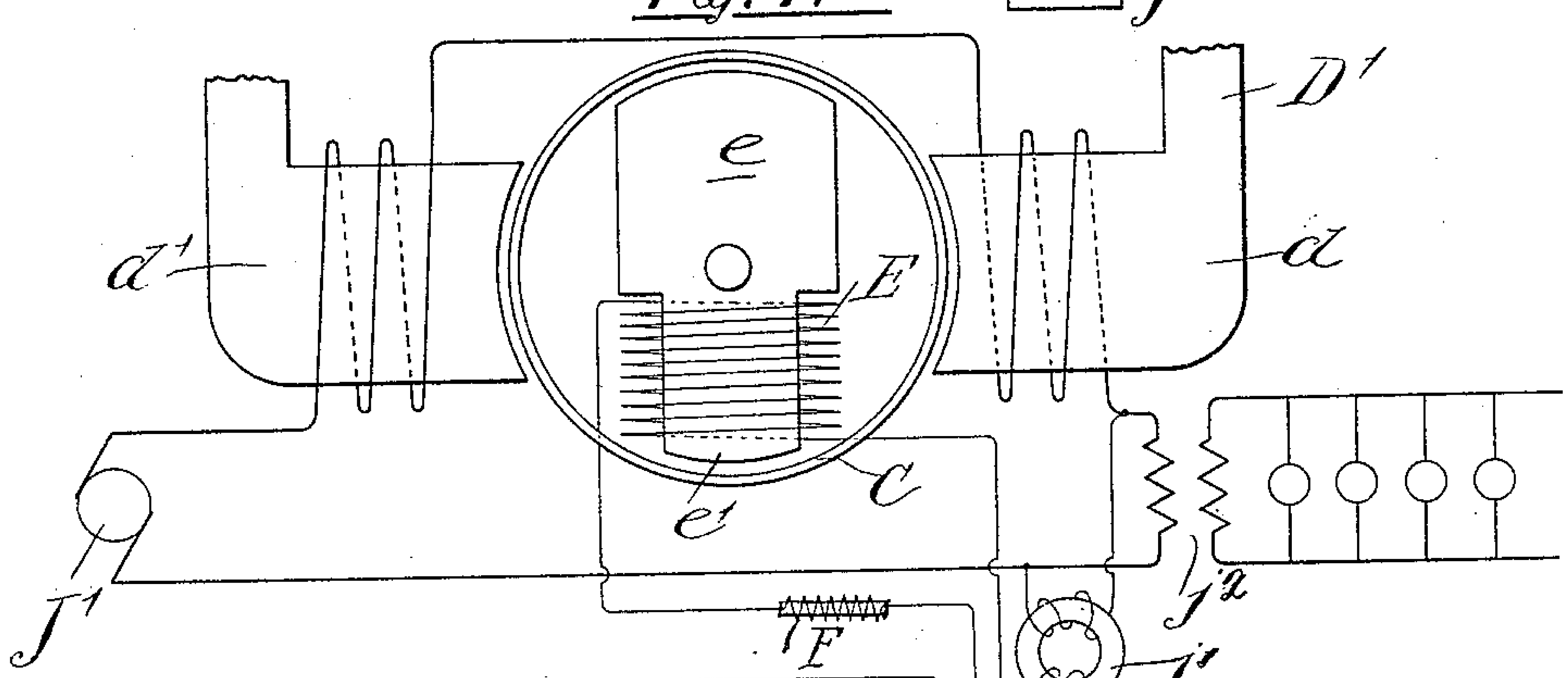


Fig. 7.



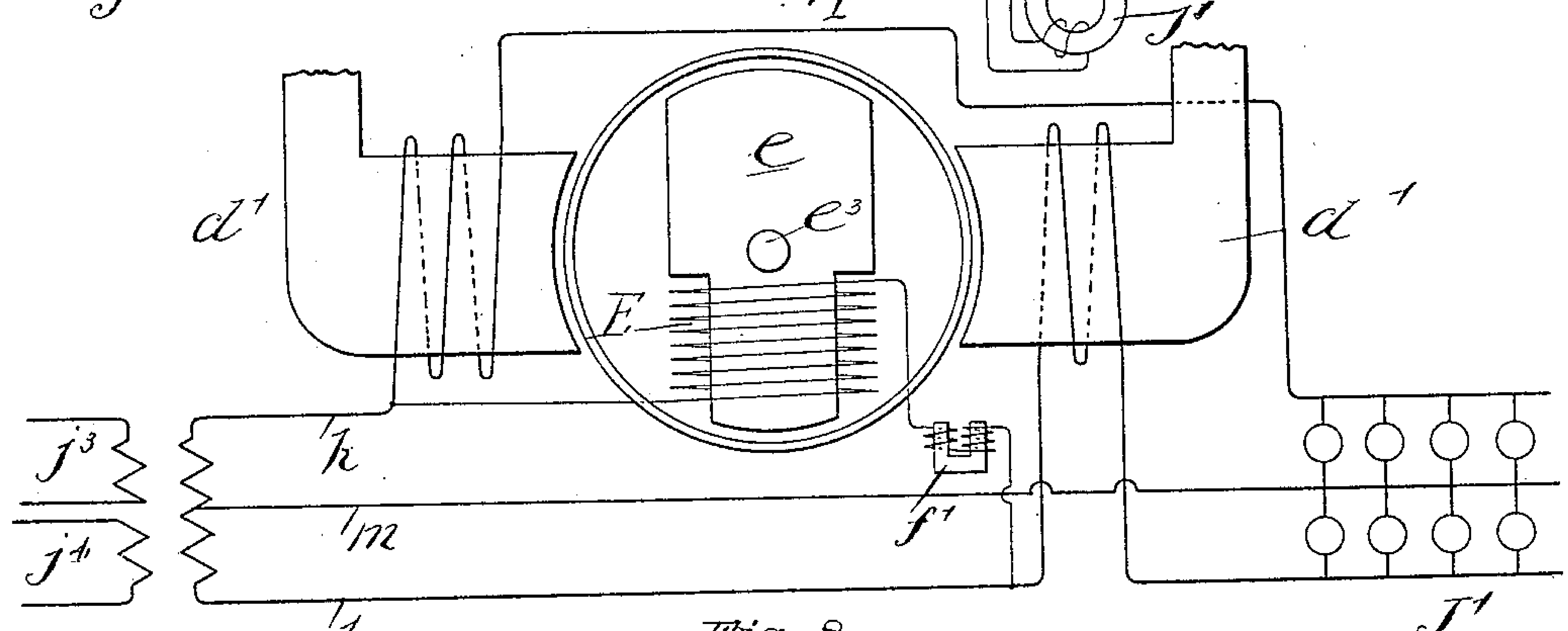


Fig. 8.

Witnesses

Louis J. Abell.

F. S. Hunting

Inventor

Thomas Duncan

By his Attorneys

Parkinson & Carter

THE NORRIS PETERS CO. PHOTO-LITHO., WASHINGTON, D. C.

(No Model.) 4 Sheets—Sheet 4.

T. DUNCAN.

WATTMETER.

No. 573,078. Patented Dec. 15, 1896.

Fig. 9.

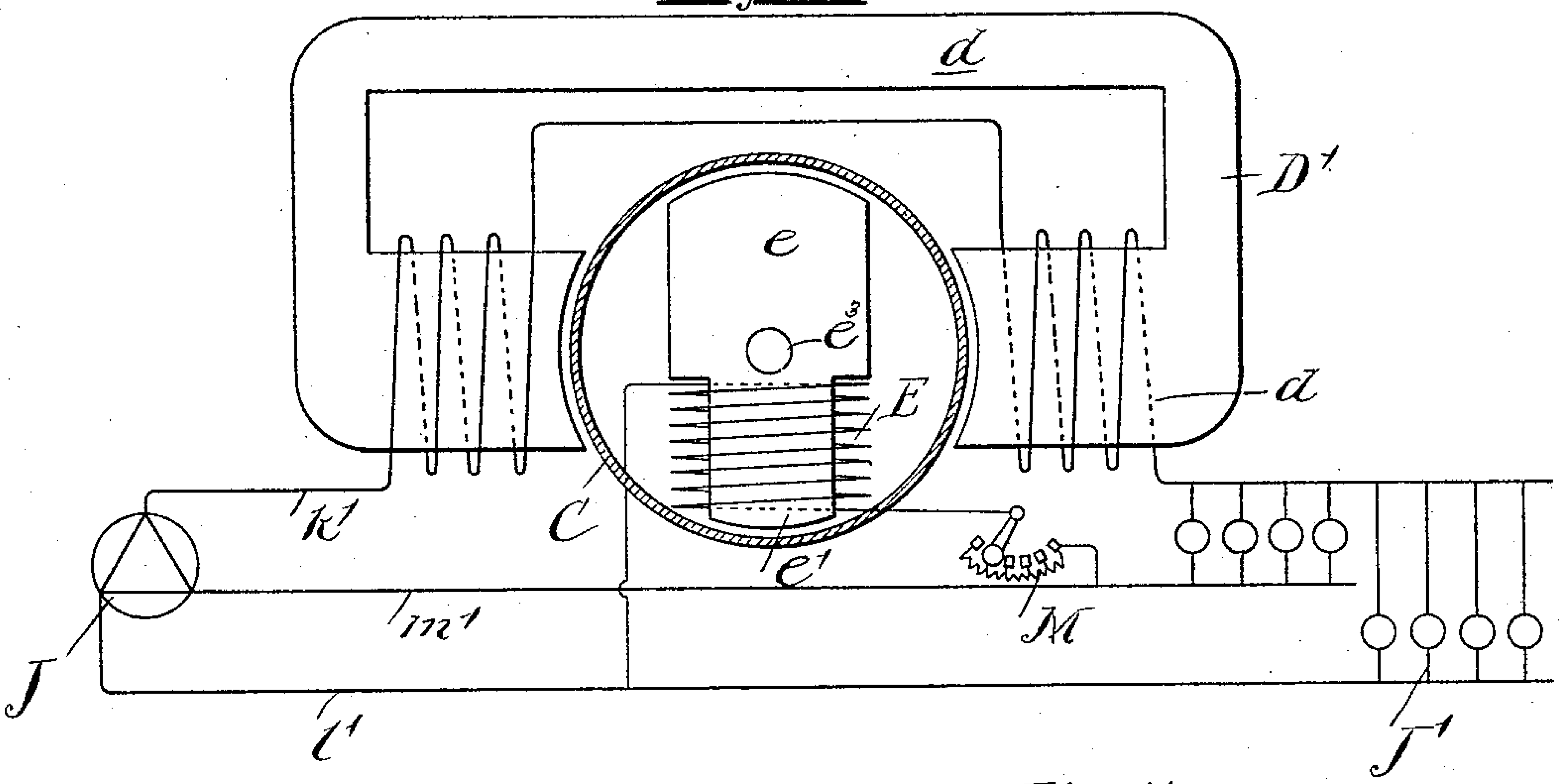


Fig. 10.

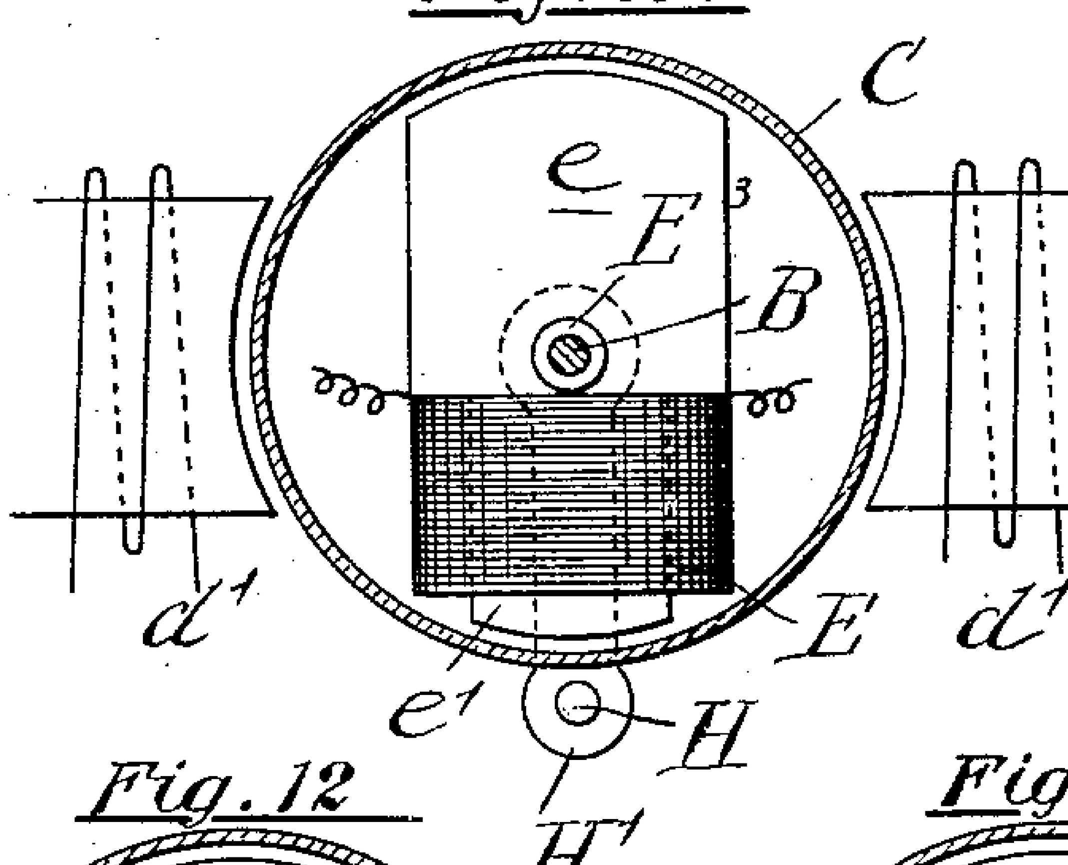


Fig. 11

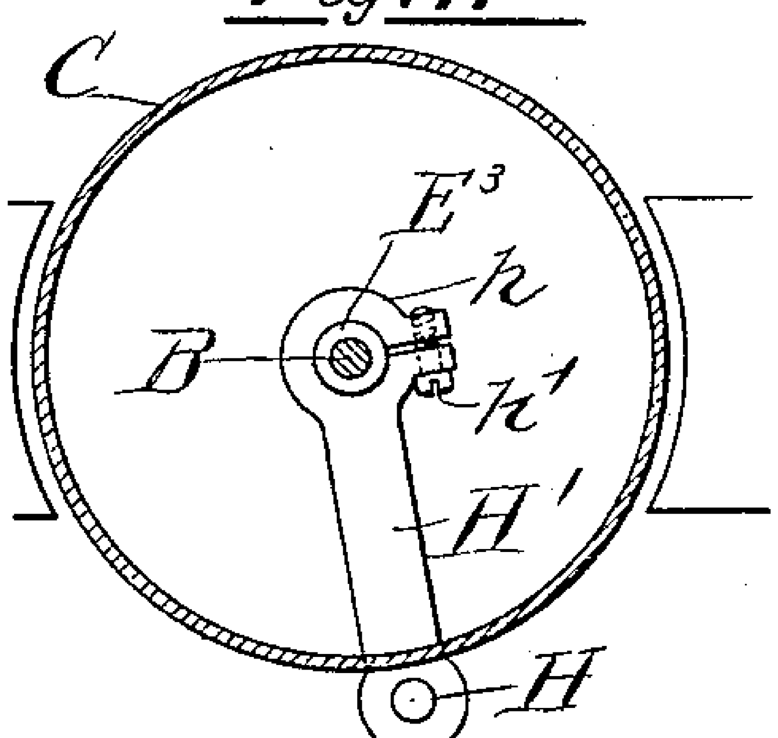


Fig. 12

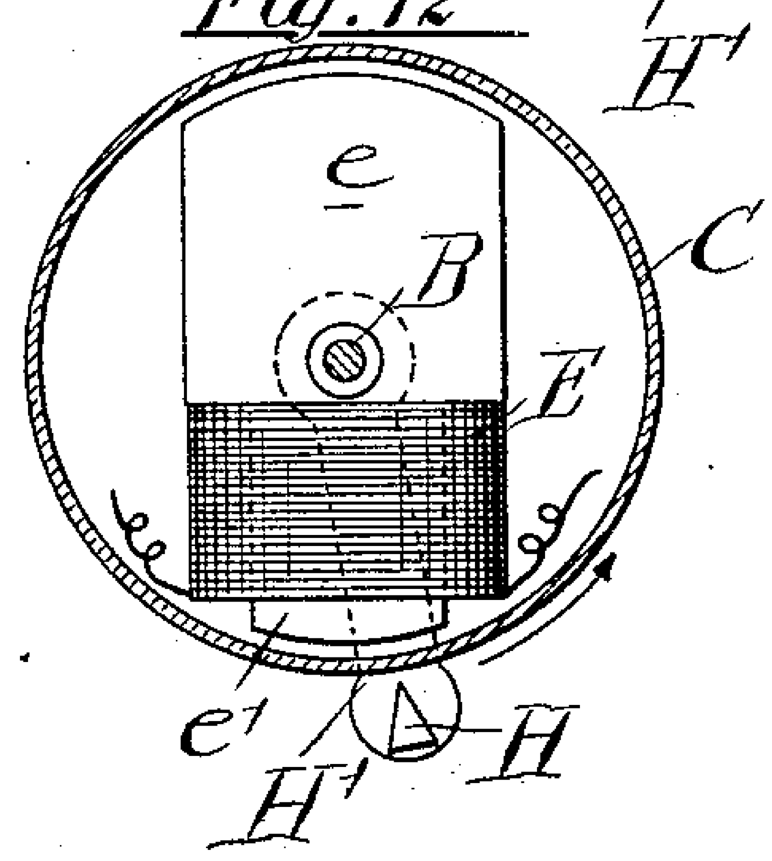


Fig. 13.

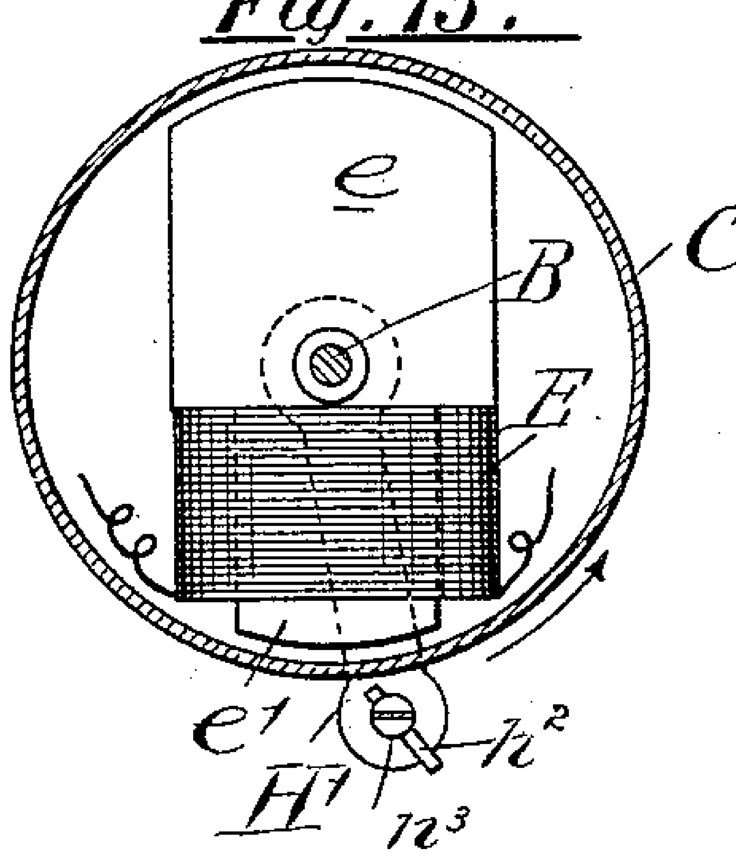
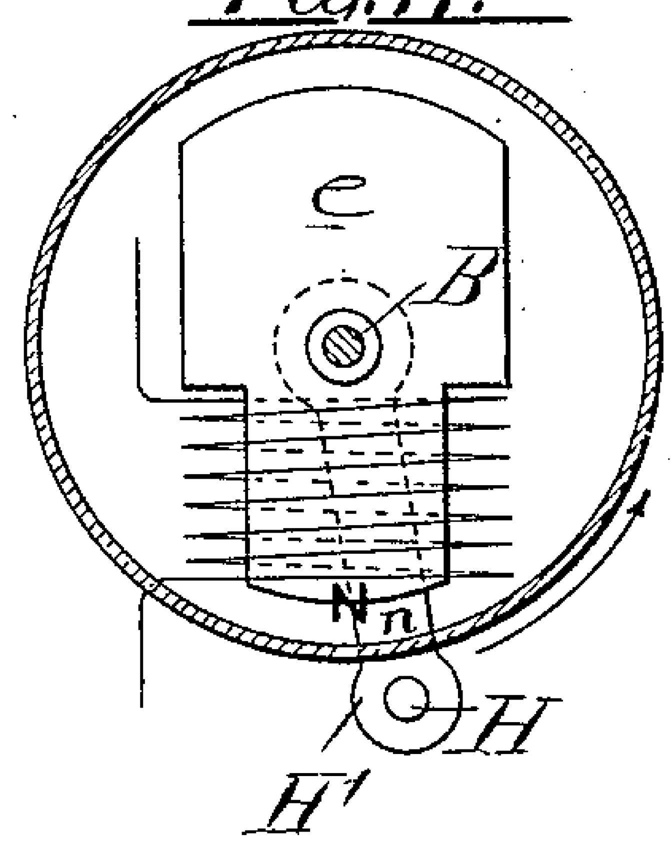


Fig. 14.



Witnesses
Louis p. Abell.
F. S. Hunting

Inventor
Thomas Duncan
By his Attorneys
Parkinson + Carter

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

THOMAS DUNCAN, OF FORT WAYNE, INDIANA.

WATTMETER.

SPECIFICATION forming part of Letters Patent No. 573,078, dated December 15, 1896.

Application filed April 29, 1896. Serial No. 589,511. (No model.)

To all whom it may concern:

Be it known that I, THOMAS DUNCAN, a citizen of the United States, residing at Fort Wayne, in the county of Allen and State of Indiana, have invented certain new and useful Improvements in Wattmeters, of which the following is a specification.

This invention relates to the construction and operation of integrating wattmeters for alternating electric currents, and pertains to that class known as "induction-motor" meters, which are ordinarily made to consist of a revoluble metallic body or armature actuated by the resulting field produced by two other magnetic fields differing in phase.

The most important factor sought in the construction of a wattmeter is accuracy, or that the rate of rotation shall at all times vary in exact ratio to the watt energy being used, and the record coincide with a straight line.

A further desirable object is the evolution of a meter that shall not be susceptible to, or perceptibly affected by, changes in the rate of alternations and that shall be accurate within wide ranges of electromotive force.

To these ends the present invention is primarily addressed; and it consists, among other things, in combining with a closed-circuit armature a field due to and varying with the current in amperes flowing in the series coils, an asynphased field representing the electromotive force in volts and varying directly as the pressure, and means for inducing an independent torque between said voltage field and armature, in combining with an armature, series coils, and shunt-coil means for causing the shunt-coil to act independently upon the armature to induce a starting torque, and in various other novel features and details, as hereinafter pointed out and claimed.

In the drawings, Figure 1 is a plan view, in horizontal section, through the field and shunt or volt coils and their cores and the armature of a meter embodying my invention. Fig. 2 is a front elevation of said meter; Fig. 3, a side elevation in vertical central section; Fig. 4, a detail of a modified or alternative form of the shunt or volt coil core-punching; Fig. 5, an enlarged detail in sectional elevation, embracing the lower part of the spindle, its adjustable step or bearing, and accessory devices. Figs. 6, 7, 8, and 9 are diagrams illustrating different methods of connecting in various circuits and systems of distribution; and Figs. 10 to 14 show different arrangements of the armature, volt-coil, and the armature-diverter for inducing the independent starting torque and overcoming the friction on very small loads with large meters.

Referring to the drawings, A represents the base of the meter box or frame, reinforced by ribs a underneath and formed with inverted cups or sockets a', surrounding each bolt or screw hole, for the reception of a filling of wax or other sealing material a^2 to prevent tampering, and with a boss or leveling-table a^3 at its front edge, planed off at right angles to the axis of the spindle, so as to determine the true verticality of the latter by the use of a small spirit-level.

A' is the back of the frame rising from this base, and A^2 an overhanging bracket supporting at its outer end the registering-train A^3, inclosed in a suitable casing. Between the base A and the bracket A^2 is mounted the vertical spindle B, engaging and driving, by means of the worm b and intermeshing worm-wheel, the registering-train. The foot of this spindle is stepped in a jewel, sapphire, for instance, b', set into a movable block B', resting upon a spring b^2, which takes up shocks and prevents breaking of the jewel if the meter is roughly used, both block and spring being inclosed in and guided by a cylindrical socket in the upper end of the screw-threaded jewel-post B^2, which is threaded through the base for adjustment and held firmly in any given adjustment by means of the jam-nut b^3, as shown, its head being sealed by wax, as above suggested. Upon the jewel-post is a lifting-nut B^3, adapted to be turned up against some projecting part carried on the spindle to lift the latter off of the jewel and jam it against the overhead bearing to prevent rotation when the meter is not being used or is in transit from one place to another. The top of the spindle is held in position by the screw-bearing b^4, threaded through the overhung bracket and tightened up by the jam-nut b^4, which bears against a boss b^5 from said bracket.

C is the armature, consisting of a drum or cylinder of aluminium or other suitable metal, forming a closed circuit, and secured to the spindle by means of a hub c and set-screw c', so as to be adjustable lengthwise thereof, if desired, to vary the torque by moving it into or out of the field. At opposite sides of this armature are placed the field-coils D, connected in the main circuit in series or in multiple, depending upon the amount of current and the size of wire with which they are wound, so that the current supplying the lamps or other translating devices traverses them. These coils embrace a laminated field-core D′ of iron and of essentially the form shown, that is to say, having an elongated yoke d and inturned poles d', upon which latter the coils are wound at opposite ends of a diameter through the armature and around an axis represented by such diameter extended. This form of core possesses several advantageous features. It reduces the magnetic resistance of the field of the coils to the lowest possible amount, whereby the coils themselves may be made to consist of very few turns and yet produce a dense field of magnetism. This at the same time keeps down the C^2 R loss in said coils on account of the length of wire being small. It also prevents the flux from diffusing and leaking from the coils and producing an irregular torque, but keeps it concentrated at the poles in an effective manner.

To further increase the efficiency of the field-magnet, the insetting poles or cores proper, d', are enlarged to present an area greater than that of the connecting-yoke between them, and advisably to about twice the area of the yoke, or in about the proportion shown in the drawings. This will allow an amount of iron in the yoke always below magnetic saturation even when on full load. A less amount may cause an increase in reluctance and detract from the efficiency, and a greater amount has also been experimentally demonstrated to reduce the beneficial results, the form and proportions above indicated always producing the very best, to wit, a speed varying in exact ratio to the power or watts. This is probably due to the lines of force being more evenly diffused by the enlarged poles. The punchings building up this laminated core are held together, and the core and coils supported upon the meter-frame, by screw-bolts d^2, taking into lugs d^3, insetting from said frame at the proper height. The coils are connected with the outside current through the binding-posts D^2, fastened upon the insulating board or support D^3 at the back of the meter-box. To further guard against contact with the frame of the meter, insulating-pieces D^4, provided with holes d^4, are employed, through which the inleading wires pass to make contact with the binding-posts.

The shunt or volt coil E is also provided with a laminated iron core, upon one end only of which the coil is wound. If wound upon both ends, the proportion of speed to load is very wavy and poor, due, presumably, to the following: A test being made with a coil on both ends the speed fell off considerably as the load increased instead of keeping on in a straight line, on account, probably, of the lines of force from the field-coils passing through the volt-core and developing a counter electromotive force or pressure in the volt-coil, thereby causing it to reduce its field as the load increased around the series coils. This detrimental effect is largely diminished by winding the coil upon one end of the core only, even when the core is the same size from end to end, but upon enlarging the unwound end, as shown in the drawings, it entirely disappears, the effect of enlarging this end being to cause the lines which previously leaked through the volt-core to pass straight through from one pole of the field-magnet to the other. In the more eligible form of this improvement, therefore, the laminated volt or shunt core E has one end e enlarged, and upon the other reduced end e' the shunt-coil is wound. In this enlarged end core the punchings may have the outline shown in Figs. 1 and 10 or that detailed in Fig. 4, which latter answers well. It follows that any intermediate form will attain the object sought in approximately the highest degree, and in fact almost any form in which the free end or pole of the core or punching is larger than the end forming the core proper to the exciting or volt coil will give beneficial results over and in addition to those attained by the use of a uniform core also wound at one end only. This form of core enables the production of a strong field of force with a minimum number of turns; it gives the greatest self-induction, to wit, with straight cores, and it is a form which enables the meter to give a straight-line characteristic, due to its allowing the current in the shunt-coil to vary as the voltage. This shunt-coil and core are advisably mounted with their axis at right angles or perpendicular to the axis of the field-coils, or about so, and preferably within the armature, with the unwound or enlarged end toward the yoke of the core of the field-magnet and between the poles thereof and intersecting their magnetic axis. For this purpose a supporting-arm E^2 is secured to the back of the meter-box or frame by means of a screw-bolt e^2, which passes through the yoke of the field-core and serves thereby as an additional means to bind the punchings of the latter together and hold it firmly in position. To the front end of said supporting-arm is soldered an upright tube or sleeve E^3, projecting both above and beneath the arm and loosely embracing the meter-spindle. The punchings, suitably apertured at e^3, are driven onto the upper reach or limb of the sleeve, which projects within the armature to a tight fit, and to insure their proper positioning one side of the sleeve may be flattened and the aperture through the punchings correspondingly outlined, as in

Fig. 4, so that the edges of the superposed punchings may come flush with each other as the core is built up.

In order to produce rotation of the armature, a difference of phase must be established between the series field-coils and the volt-coil. In the present construction, and unless a multiphase current is to be measured, the volt-coil or shunt-coil is caused to lag behind the series coils, and for this purpose an inductive resistance or impedance F is employed in series with said volt-coil of such nature that it will permit a flow of current varying with the electromotive force. This resistance preferably consists of two coils *f*, wound upon the parallel extension of a **U**-shaped core *f'*, of laminated iron, and it is conveniently fastened to the frame of the meter at the back, as in Fig. 3, by means of the screw-bolt F', passing through the yoke of the core, with the coils supported upon the upwardly-projecting limbs of said core.

Inductance-coils for lagging the currents in the shunt-circuits of meters have been used previous to this, but they have been of a form which partook either of a closed magnetic circuit or one having a very small air-gap. Such forms are unsuited to the present purpose, since they will not permit a flow of current to traverse them which will vary with the electromotive force, in which case the field produced by the volt-coil would not respond in a constant ratio to the changes in the electromotive force of the circuit. The **U**-shaped form, however, accomplishes the desired result. It has already been mentioned that the volt-coil also possesses this quality, (of permitting a flow of current varying with the electromotive force,) and since it is connected up in series with the described resistance-coil it follows that the field representing the electromotive force in volts and acting upon the armature must vary directly as the pressure. We have, then, the field due to and varying with the current or amperes flowing in the series field-coils and the field due to the current flowing in the shunt or volt coil and varying with the electromotive force of the circuit, both acting upon the aluminium armature and producing a torque equal to the power or watts. Each of these fields, taken by itself, produces an oscillating magnetic field, the lines of which are at right angles to the face of the coil. The two fields when taken together and being out of step or having asynchronous phases produce a resultant field which revolves or shifts around a vertical axis. The surface of the aluminium cylinder or armature is therefore being continuously cut or threaded by lines of force as they sweep round. Currents are induced in the aluminium which, by Lenz's law, are in such directions as to resist motion, and since the cylinder is freely suspended its endeavor to resist motion of the field results in its being set in motion itself.

In order to prevent acceleration and to keep the speed of the armature proportional to the energy to be measured, a load or drag must be applied, and one that will vary directly as the speed. To accomplish this, it is common practice to employ a metallic disk driven between the poles or one or more permanent magnets, which induce eddy currents in the disk and exert a damping or braking force, which varies directly as the speed, so that the resulting speed upon any load will be equal to the watts. Herein the disk G is shown as secured upon the meter-spindle immediately above the lifting-nut B^3, so that the latter when turned up engages with its hub and raises the spindle. The permanent magnets G' are made adjustable in order to obtain the proper rate of rotation by shifting their poles, being for this purpose mounted as to their lower limbs in clamps G^2, each of which is held in adjusted position against the base by a screw-bolt G^3, entering one of the cups *a* and having its head sealed with wax, so that by loosening the bolt the poles of the magnet may be set in or out with reference to the axis of the disk.

In the construction of meters in general it is common to employ a separate or auxiliary winding on the series coils to overcome the friction and inertia of starting, particularly in the case of large meters. As to this the present improvement consists in establishing a condition wherein the volt or shunt coil acts independently upon the armature in causing it to rotate in the same direction as that due to the resultant of the series and shunt coils collectively. This result is obtained by placing in front of the shunt-coil and on the other side of the shell of the armature-cylinder a magnetizable pin or piece of iron wire H, hereinafter termed the "diverter," whereby the lines of force established by the coil pass through the cylinder to reach the pin and in so doing develop eddy currents in said cylinder. These currents, on account of their self-induction, will lag behind the currents in the volt-coil, and will therefore present to the pole or core of said coil a like sign of polarity, as shown in Fig. 14 at N and *n*, causing the cylinder to be moved or repelled around in the direction of the arrow, since a magnetic repulsion will exist between the poles of the same sign. This repulsion can be increased by adjusting the diverter in the direction of rotation. For this purpose it may be supported upon a bracket-arm H', adjustably secured upon the lower reach or limb of the sleeve E^3, which supports the volt core and coil by means of a split collar *h* and binding-screw *h'* or other suitable means, so that by swinging the arm the diverter may be displaced laterally, and when the proper balancing effect has been secured may be held in fixed position by tightening up the screw.

To illustrate, Fig. 10 shows the diverter in line with the volt-coil, so that there is no tendency to repel the armature to either side, but only in a line coincident with their axes, which are the same. Therefore no torque will be exerted and no motion or lateral repulsion takes place. In Fig. 11 the volt-coil is removed from within the armature to expose the means for adjusting the diverter. In Figs. 12 and 14 the diverter has been moved to the right to induce rotation of the cylinder in the direction indicated by the arrow, and as the angle is increased the repulsive force inducing rotation is also increased.

In Fig. 12 the diverter-pin is shown as three-sided, so that in addition to, or independently of, adjusting the bracket-arm the pin itself may be moved, that is, the sharp edge toward the cylinder may be slightly turned one way or the other and effect a change in the rotation, and in Fig. 13 a horizontally-adjustable pin h^2 is set in the vertical pin H for fine adjustments, the set-screw n^3 allowing a longitudinal movement, the vertical pin a swinging or pivotal movement, and the bracket-arm a lateral adjustment. This device can be used to advantage in supplying a want that it is impossible to meet in other meters now upon the market, that is to say, the ability to change the starting torque in a few seconds without having to take the meter from its place of installation and without having to change any windings or resistances simply by altering the position of the diverter, or, in other words, adjusting its position to the right or to the left. It is quite common with all meters that after they have been in operation for some time they become sluggish or slow upon small loads, owing, probably, to the accumulation of dust upon the moving parts or the oil becoming thick, when they have to be removed and cleaned. This is avoided by the present construction.

Since the tendency to rotation due to the diverter derives its energy solely from the shunt-field, it is obviously at its maximum when the load is first turned on and when it is most needed to overcome the inertia of the parts and the frictional resistance, which under light loads is a material factor of inaccuracy. As the load increases, however, the increasing current in the series coils operates with increasing effect upon the resultant field, which actuates the armature and diminishes or neutralizes this independent torque due to the diverter. Therefore the device, automatically, as it were, produces a starting torque when most needed and gradually loses it as there is less need for it. This conduces to a speed that is in exact ratio to the watts, or, in other words, to the essentially regular or straight line characteristic of the present meter.

The meter herein described may be used in single-phase or two-phase alternating currents and with primary or secondary circuits. In Fig. 6 it is represented as measuring the energy of single-phase currents. The currents supplied by the generator J are transformed for utility at j, from whence they pass through the field-coils in series and around the field-core to the lamps or other translating devices J′. The volt or shunt coil is excited by being placed in multiple upon the leads, as shown, and also connected in series with the inductance-coil and its U-shaped core. In Fig. 7 the meter is connected into the primary circuit of the alternating-current dynamo or generator J and measures the total output. The shunt-coil in this case is excited by a small transformer j', which reduces the primary electromotive force to a much lower or suitable pressure, so that it can be used with safety. An inductance-coil is also connected in series with this secondary circuit and shunt-coil to produce the necessary lag between the series coil energized by the primary circuit and the shunt-coil energized by its secondary circuit. The primary current is used to supply the transformer j^2 with its lamps in a secondary circuit. In Fig. 8 the meter is adapted to operate on the three-wire system of distribution. This consists of the two transformer-primaries j^3 j^4 and their secondaries k, l, and m, the line or circuit m representing the two inside terminals of the two transformers, or what is termed the "neutral" or "third" wire. The outer wires k and l are connected around the two poles of the field-cores, respectively, and thence to the lamps, and the volt or shunt circuit is connected across the two outside lines, which represent the sum of the electromotive forces of the two transformers, and in series with the inductance-coil.

To use this meter in integrating the energy on two-phase circuits of distribution, it may be connected up, as shown diagrammatically in Fig. 9, wherein the series coils are connected in the common return-circuit k' and the volt-coil across the two lines l' and m' with a non-inductive resistance M in series with it, since this combination does not require an impedance-coil to produce a lag, the necessary displacement of phase being maintained by the generator.

I do not intend to limit myself herein, in its relations to other features of my invention, to the use of a shunt-core wound upon one end only, or to a shunt-core enlarged at one end and wound at the other, or to the position and arrangement of the shunt coil and core, nor, similarly, to a field-core provided with enlarged poles, or to the particular form of the field-core, nor, likewise, to the specific form of inductive resistance described; neither do I limit myself to the specific means set forth for producing the independent starting torque in conjunction with the shunt-coil, nor to the use of an imperforate armature; but

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

1. The combination with the armature, of a field due to and varying with the current in amperes flowing in the series coil, an asynphased field representing the electromotive force in volts and varying directly as the pressure, and means for inducing an inde-

pendent torque between said voltage field and the armature.

2. The combination with the armature, of a field due to and varying with the current in amperes flowing in the series coil, an asynphased field representing the electromotive force in volts and varying directly as the pressure, and means for diverting the flux of the latter field to induce an independent torque on the armature.

3. The combination with the cylindrical armature, of field coils and core inducing a field varying with the current in amperes, a shunt or volt coil and core inducing a field varying with the electromotive force in volts, and a magnetizable diverter located opposite said shunt-coil and on the other side of the armature-shell.

4. The combination with the cylinder armature, of field-coils and core inducing a field varying with the current in amperes, a shunt coil and core inducing a field varying with the electromotive force in volts, a paramagnetic diverter located opposite said shunt or volt coil and on the other side of the armature-shell, and means for adjusting said diverter.

5. The combination with the cylindrical armature, of field coils and core inducing a field varying with the current in amperes, a shunt coil and core axially at right angles to the axis of the field-coils and inducing a field varying with the electromotive force in volts, and a magnetizable diverter located opposite said shunt-coil and on the other side of the armature-shell.

6. The combination with the cylindrical armature, of field coils and core inducing a field varying with the current in amperes, a shunt coil and core axially at right angles to the axis of the field-coils and inducing a field varying with the electromotive force in volts, a magnetizable diverter located opposite said shunt or volt coil and on the other side of the armature-shell, and means for adjusting said diverter relatively to the axis of said shunt-coil.

7. The combination with the cylindrical armature, of field coils and core external thereto and inducing a field varying with the current in amperes, a shunt coil and core inclosed within the armature and inducing a field varying with the electromotive force in volts, and a magnetizable diverter located opposite the volt-coil externally to the armature.

8. The combination with the cylindrical armature, of field coils and core external thereto and inducing a field varying with the current in amperes, a shunt coil and core inclosed within the armature and inducing a field varying with the electromotive force in volts, a magnetizable diverter located opposite the volt or shunt coil, externally to the armature, and means for the adjustment of the proximate face of said diverter laterally in relation to the magnetic axis of said volt-coil.

9. The combination with the armature, and with a field-magnet, of a shunt-core and a shunt-coil wound upon one end of said core.

10. The combination with the armature, and a field-magnet, of a shunt-core arranged with one end intersecting the axis of the field-magnet, and a shunt-coil wound upon the opposite end only of said core.

11. The combination with the armature, and with a field-magnet, of a shunt-core enlarged at one end, and a shunt-coil wound upon the smaller end thereof.

12. The combination with the armature, and with a field-magnet, of a shunt-core enlarged at one end and arranged with said enlarged end intersecting the axis of said field-magnet, and a shunt-coil wound upon the reduced end only of said shunt-core.

13. The combination with the armature of a field-core having an elongated yoke and insetting poles, field-coils wound upon said poles, a shunt-core, and a shunt-coil wound upon said shunt-core.

14. The combination with the armature of a field-core having an elongated yoke and insetting poles, field-coils wound upon said poles, a shunt-core, and a shunt-coil wound upon one end only of said shunt-core.

15. The combination with the armature, of a field-core having an elongated yoke and insetting poles at opposite ends of a diameter through the armature, field-coils wound upon said poles, a shunt-core enlarged at one end, and a shunt-coil wound upon the smaller end of said shunt-core.

16. The combination with the armature, of a field-core having an elongated yoke and insetting poles at opposite ends of a diameter through the armature, field-coils wound upon said poles, a shunt-core enlarged at one end and arranged with said enlarged end between the poles of the field-core, and a shunt-coil wound upon the smaller end of said shunt-core.

17. The combination with the armature, of a field-core having an elongated yoke and insetting enlarged poles at opposite ends of a diameter through the armature, field-coils wound upon the enlarged poles, a shunt-core, and a shunt-coil wound upon one end only of said shunt-core.

18. The combination with the armature, of a field-core having an elongated yoke and insetting enlarged poles at opposite ends of a diameter through the armature, field-coils wound upon the enlarged poles, a shunt-core enlarged at one end, and a shunt-coil wound upon the smaller end of said shunt-core.

19. The combination with the armature, of a field-core having an elongated yoke and insetting enlarged poles at opposite ends of a diameter through the armature, field-coils wound upon the enlarged poles, a shunt-core enlarged at one end and axially at right angles to the axis of the field-core, and a shunt-coil wound upon the smaller end of said shunt-core.

20. The combination with the armature, of a field-core having an elongated yoke and insetting enlarged poles at opposite ends of a

diameter through the armature and external thereto, field-coils wound upon said enlarged poles, a shunt-core enlarged at one end and located within the armature with its enlarged end between the poles of the field-core, and a shunt-coil wound upon the smaller end of said shunt-core.

21. The combination with the armature, of a field-core having an elongated yoke and insetting enlarged poles at opposite ends of a diameter through the armature and external thereto, field-coils wound upon said enlarged poles, a shunt-core enlarged at one end and located within the armature axially at right angles to the axis of the field-coils, and a shunt-coil wound upon the smaller end of said core.

22. The combination with the armature, and with the field-coils, of the shunt-coil with its iron core, reduced at the end upon which the coil is wound, and an inductive resistance in the shunt-circuit, adapted to permit a flow of current varying with the electromotive force.

23. The combination with the armature, and with the field-magnet, of a shunt-core inclosed within said armature, a shunt-coil wound upon one end only of said core, and an inductive resistance in the shunt-circuit adapted to permit a flow of current varying with the electromotive force.

24. The combination with the armature, and with the field-core having enlarged inturned poles and field-coils wound upon said poles, of the shunt-core enlarged at one end, the shunt-coil wound upon the smaller end of said core, and the inductance-coil with its laminated U-shaped core, connected in series in the shunt-circuit.

25. The combination with the armature, and shunt core and coil, of a magnetizable diverter pivotally adjustable with reference to the axis of said core and coil, and means whereby said diverter may be adjusted bodily and laterally.

26. The combination with the armature, and shunt core and coil, of a magnetizable diverter adjustable in and out with reference to the periphery of said armature.

27. The combination with the armature, and shunt core and coil, of a magnetizable diverter adjustable in and out with reference to the periphery of said armature, and means for its lateral adjustment along said periphery.

28. The combination with the armature, and shunt coil and core, of a magnetizable diverter adjustable pivotally and also in and out with reference to the periphery of the armature, and means for its bodily and lateral adjustment along said periphery.

29. The combination with the meter-spindle, of the cylindrical armature carried thereby, the fixed sleeve encircling said spindle within the armature and supported from the meter-frame, the iron core-punchings built upon said sleeve to form a shunt-core, and the shunt-coil wound upon said punchings.

30. The combination with the meter-spindle, of the cylindrical armature carried thereby, the fixed sleeve encircling said spindle and supported from the meter-frame, the core-punchings built upon the upper line of said sleeve within the armature, the shunt-coil wound upon the core thus formed, the adjustable arm supported upon the lower line of said sleeve, and the magnetizable diverter carried at the outer end of said arm.

31. The combination with the field and shunt coils, of a closed-circuit armature and means for its adjustment into or out of the field.

In testimony that I claim the foregoing as my invention I affix my signature, in presence of two witnesses, this 21st day of April, A. D. 1896.

THOMAS DUNCAN.

Witnesses:
HENRY W. CARTER,
JOHN E. DALTON.