(No Model.) 2 Sheets—Sheet 1.

F. TEAGUE.

ELECTRIC METER.

No. 496,371. Patented Apr. 25, 1893.

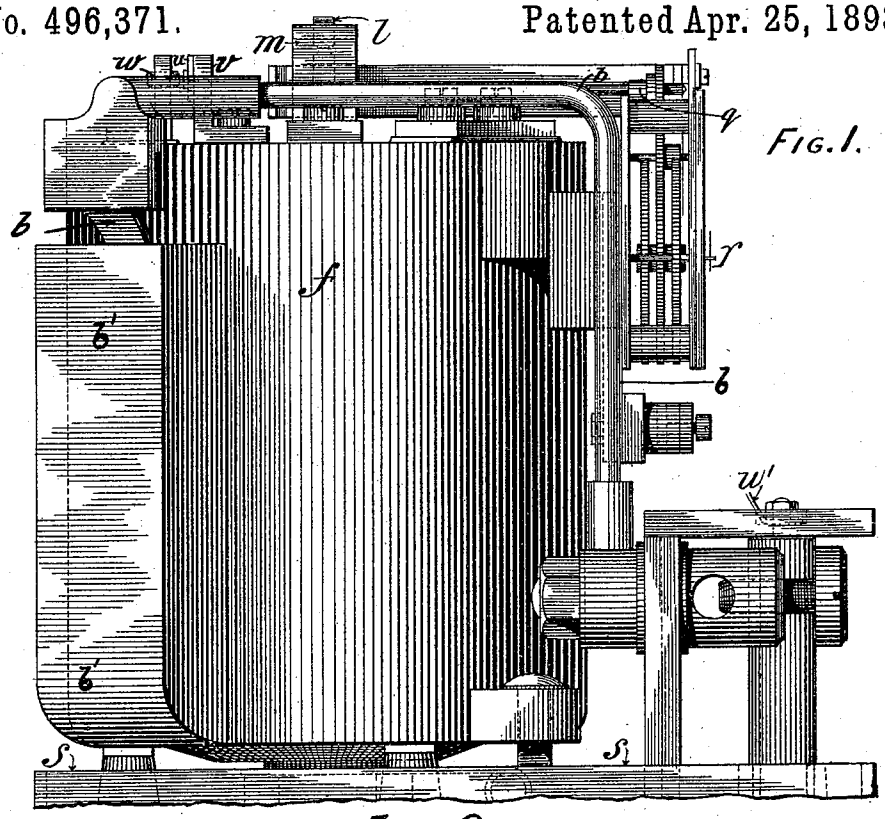
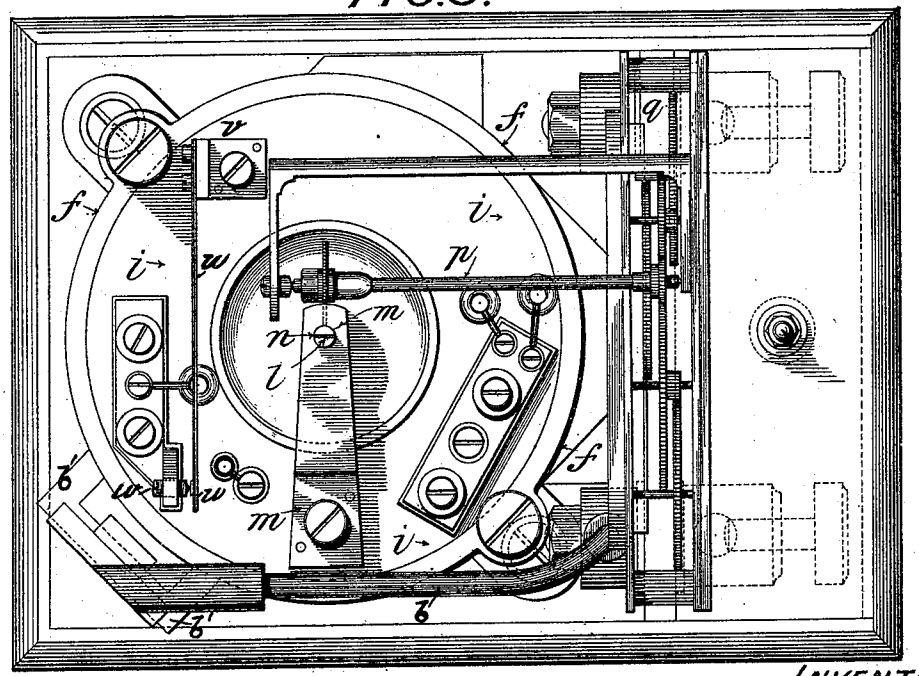


FIG. 1.

FIG. 3.



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(No Model.) 2 Sheets—Sheet 2.

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ELECTRIC METER.

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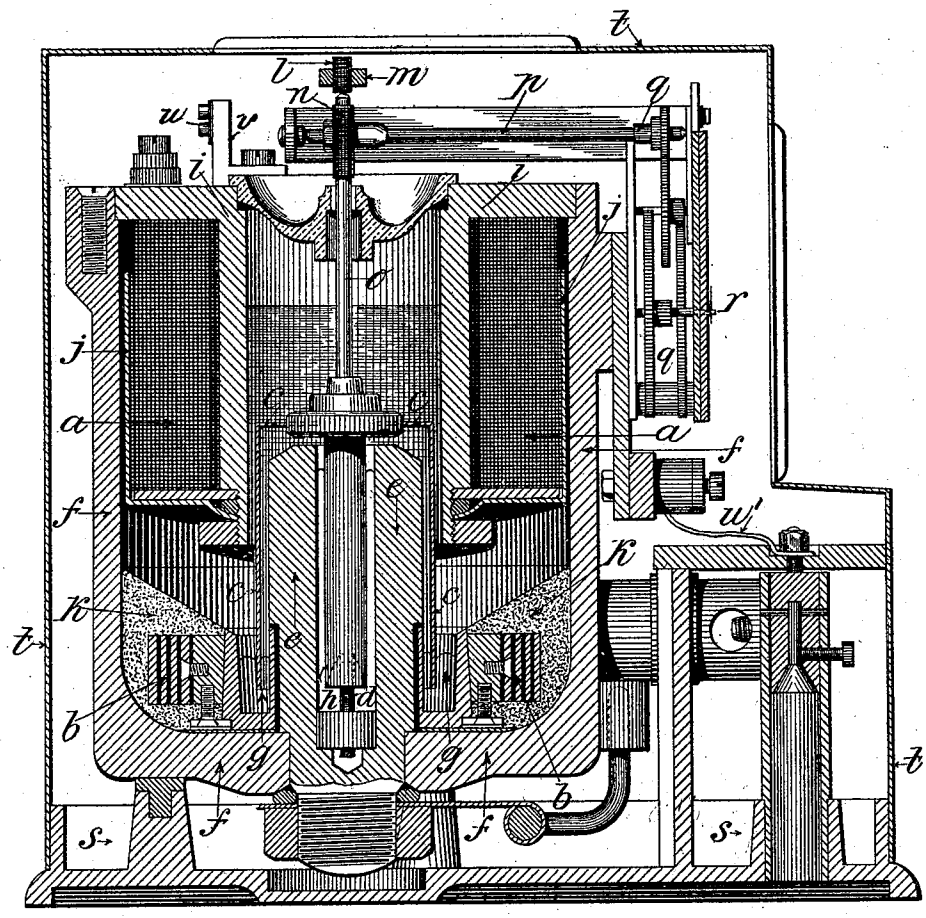
FIG. 2.



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UNITED STATES PATENT OFFICE.

FRANCIS TEAGUE, OF LONDON, ENGLAND, ASSIGNOR, BY MESNE ASSIGNMENTS, TO JOSEPH SINCLAIR FAIRFAX AND JASPER WETTER, OF SAME PLACE.

ELECTRIC METER.

SPECIFICATION forming part of Letters Patent No. 496,371, dated April 25, 1893.

Application filed February 2, 1892. Serial No. 420,048. (No model.) Patented in England November 5, 1891, No. 19,134; in France January 7, 1892, No. 218,533; in Belgium January 13, 1892, No. 97,921, and in Italy March 31, 1892, No. 31,212/209.

To all whom it may concern:

Be it known that I, FRANCIS TEAGUE, a subject of the Queen of England, residing at the Acme Electric Works, Ferdinand Street, Chalk Farm, London, England, have invented certain new and useful Improvements in Electricity Meters, (for which I have obtained British Letters Patent No. 19,134, dated November 5, 1891, and made application for No. 22,852, filed December 31, 1891, and obtained French Letters Patent No. 218,533, dated January 7, 1892; Belgian Letters Patent No. 97,921, dated January 13, 1892, and Italian Letters Patent No. 31,212/209, dated March 31, 1892,) of which the following is a specification.

My present invention comprises certain improvements in the construction and arrangement of meters to make them more efficient, less liable to get out of order, and to reduce the speed of the armature and its spindle. By this reduction of speed the number of wheels in the integrating gear is reduced, and the friction arising therefrom is eliminated, thus insuring greater accuracy in indicating varying amounts of electrical energy passing through the meter.

In the further description of this invention, reference is made to the accompanying drawings in which—

Figure 1 is an outer elevation, Fig. 2 is a vertical section, and Fig. 3 is a plan of my improved meter.

In my present invention I employ a compound winding for the electro magnet, composed of many turns of wire for the shunt winding *a*, and a few turns (about three to six) of thick wire for the series winding *b*. But unlike the compound winding I formerly employed, I now wind the series winding *b* in a reverse manner to the shunt winding *a*, so that when the current is passing through the coils the magnetic effect of the series winding *b* is different or opposite to the magnetic effect of the shunt winding *a*, thus neutralizing the latter to a very slight extent. This I call a differential compound winding, and when it is proportioned to suit the maximum amount of current to be passed through a meter, it compensates for the proportional difference in friction between high and low speeds, and so makes the speed proportionate to the current passing through the meter. The series winding *b* need not be wound upon the bobbin which carries the shunt winding *a*, as it may be placed upon any suitable part of the electro magnet—inside or out, if the form permits of the latter—provided it produces the differential effect above named.

The armature *c* is of copper or silver plated with nickel, and is supported by a jeweled step *d* within a central and tubular pole piece *e* which is mounted in the center of the bottom of a circular hollow magnet case *f*. At the bottom of the inside of the magnet case is an annular mercury trough *g* (surrounding the central pole piece *e*) in which the bottom edge of the armature *c* dips and makes an outer contact with the mercury therein. The inner mercury cup *h*, is formed by the tubular part of the central pole piece *e*, and it is deep enough to inclose nearly the whole of the stem of the armature *c*. The outer part of the circular magnet case *f* is higher than the top of the central pole piece *e*—and at some distance therefrom—and at its top is fitted with a flange or cover forming part of an annular pole piece *i*, which extends downward into the interior of the case *f*, and surrounds the central pole piece *e*, but leaving a truly concentric annular space between in which the armature rotates. The annular pole piece *i* forms the core of the shunt winding *a*, and a sheet metal guard *j* is secured at the bottom of the said annular pole piece *i* which extends upward close to the magnet case *f* and surrounds the conducting coil to shield it from liquid contact. At the bottom of the magnet case *f*, some cement *k* is run between it and the annular mercury trough *g* in funnel shaped form to direct mercury back to the trough, should any become displaced therefrom. The series coil *b*—in the form of a copper tape—is wound round and electrically connected with the annular mercury trough *g*, and is embedded within the cement *k*. The outer end of the

coil *b* rises from the inside of the case *f* through an external channel *b'* (shown in elevation in Fig. 1, and in plan in Fig. 3) to connect with the main circuit terminal.

The armature spindle *o*, passes through an orifice in a brass cap at the top of the magnet case, and is supported above by a jeweled pivotal bearing, the pivot *l* being adjustable in the bracket *m*, secured to the flange of the annular pole piece *i*. A worm or thread *n* is formed on the upper portion of the spindle *o* which engages with a worm wheel having the required number of teeth to drive by its axle *p*, the integrating train of wheels *q*, at the proper rate of speed, so as to indicate correctly by the index finger and dial *r* the amount of energy expended in the circuit. The circular magnet case *f* is mounted upon a suitable base *s* and inclosed by a cover *t* having glass dials therein for inspection; and a safety fuse *u'* is inserted in the shunt circuit, where its condition can be inspected through the glass dial.

An important part of the invention relates to the method of reducing the speed of the armature *c* and its spindle *o*, so as to reduce the number and friction of the wheels in the train *q* to a minimum. In my British specification No. 15,489, of 1889, for electric meters I stated that it was desirable to place a little paraffine on the mercury to prevent or retard oxidation, and I find that Borel and Paccaud proposed the same thing in 1885. I find also that Ferranti in 1888 and Perry in 1890 both proposed to use liquids for the purpose of partially floating the armature to reduce the weight and friction on the pivot bearing. But I carry this principle much further by totally immersing the armature *c* in a liquid, not only to reduce the weight and friction on the pivot, and to prevent oxidation to the mercury, but also to act as a fluid break to reduce the speed; and I even make one or more small holes in the armature to allow the liquid to fill up the whole of the space inside and outside the armature and to flow over and between the two mercury cups, which has not been done before. The sheet metal guard *j* is made high enough—as shown in the section—to inclose the coil *a* from contact with the liquid, which rises within the central space of the pole piece *i* to the small part of the spindle *o*, in order to reduce surface tension; while the inclosing brass cap at the top of *i* prevents the spilling of the liquid.

In applying liquids for the purposes stated above, I find that oils are objectionable owing to their liability to gum, and therefore I prefer to use glycerine instead. But as cold or heat affects the viscosity or fluidity of the liquid, and would vary the amount of mechanical resistance of the armature I arrange to keep the meter at a fairly uniform temperature by means of a resistance winding and a thermostat. The resistance winding consists of about six or eight layers of a suitable kind of wire, placed next to the core *i* (indicated in Fig. 2 by thick lines), one half of the layers being wound so that the current circulates in the opposite direction to the other half, to prevent induction, or change in the magnetism produced by the shunt winding *a*. In this resistance circuit is placed a controlling thermostat, consisting of a compound bar *u* made of a thin strip of copper and steel riveted together, and held firmly at one end by a terminal *v*. At the other end of a bar *u* is placed another terminal carrying an adjustable screw *w* which bears on the copper face of the bar *u* by a platinum point. When the temperature becomes too great in the resistance circuit the greater expansion of the copper strip over the steel causes the bar *u* to curl away from the screw *w* and so breaks the resistance circuit, but when the temperature falls, the bar *u* returns to its original position against the screw *w*, and the circuit is completed.

The effect of the liquid break or bath is such that in a meter adapted for thirty ampères (and passing that amount of current) at an electro motive force of one hundred volts, the armature has a speed of about fifteen revolutions per minute only. The same meter, passing five ampères has an armature speed of about two and one-half revolutions per minute. The armature will start with a current as low as one tenth of an ampère, and if the current is interrupted in an intermittent manner, the armature responds to every make and break of the circuit, and without apparent inertia.

What I claim, and desire to secure by United States patent, is—

1. An electric meter comprising a circular electro magnet with internal poles excited by an internal compound winding, a rotatable armature with two mercury contacts vertically supported and rotatable between the said internal poles, circuit connections and a train of wheels with index fingers driven from the said armature spindle, substantially as and for the purpose herein described.

2. In an electric meter, a circular electro magnet having internal poles excited by conducting coils placed inside, one of the said poles depending from the top and surrounding the other, which is centrally placed, and rises vertically from the bottom, substantially as and for the purpose herein described.

3. In an electric meter, a cylindrical electro magnet case with open top, and closed bottom, to form a receptacle for the actuating portion of the meter and combined with a liquid resistance bath contained therein, substantially as and for the purpose herein described.

4. In an electric meter, the combination of a cylindrical electro magnet case with a central pole piece extending upward from the bottom, and axially bored to form a mercury cup, and a depending annular pole piece surrounding the said central pole piece, substantially as herein described.

5. In an electric meter, the combination of

a cylindrical electro magnet case having a closed bottom with an annular pole piece and flange forming a cover to the said magnet case, substantially as herein described.

6. In an electric meter, the combination of a cylindrical electro magnet case with an annular pole piece and flange forming a cover, and a coil winding upon the said annular pole piece, substantially as and for the purpose herein described.

7. In an electric meter, the combination of a cylindrical magnet case with a closed bottom, a central pole piece extending upward therefrom, an annular mercury cup surrounding the said central pole piece, and an annular pole piece, substantially as described.

8. In an electric meter, the combination of a cylindrical magnet case with a closed bottom, a central pole piece extending upward therefrom and axially bored to form a mercury cup, an annular mercury cup surrounding the said central pole piece, and an annular pole piece substantially as described.

9. In an electric meter, the combination of a central pole piece with a surrounding annular mercury cup, a series winding thereon, and an inclosing cylindrical magnet case, substantially as herein described.

10. In an electric meter, the combination of a circular magnet case with a closed bottom, a mercury cup resting upon the said bottom, and a cement filling arranged in funnel form to drain into the said mercury cup, substantially as and for the purpose herein described.

11. In an electric meter, the combination of a circular magnet case with a closed bottom, a mercury cup resting upon the said bottom, a series conductor electrically connected to the said mercury cup, and a cement filling arranged in funnel form to drain into the said mercury cup, substantially as and for the purpose herein described.

12. In an electric meter, an electro magnet having a compound winding consisting of a series winding and a shunt winding arranged and operating so that the series winding slightly opposes the magnetic effect produced by the shunt winding, combined with an armature rotatable between the poles of the said magnet, and a liquid bath submerging the said armature, substantially as and for the purpose herein described.

13. In an electric meter, an electro magnet having a compound winding consisting of a series winding and a shunt winding, arranged and operating so that the series winding slightly opposes the magnetic effect produced by the shunt winding combined with a heating resistance winding, substantially as and for the purpose herein described.

14. In an electric meter, an electro magnet having a magnetically neutralized heating resistance winding, combined with an armature rotating in a liquid substantially as and for the purpose herein described.

15. In an electric meter, the combination of a movable armature an electro magnet having a heating resistance winding and a circuit controlling thermostat, substantially as and for the purpose herein described.

16. In an electric meter, the combination of a liquid bath to act directly upon the armature as a brake to retard the speed thereof, and a heating device, substantially as and for the purpose herein described.

17. In an electric meter, the combination of an armature, two mercury cups, and a liquid bath partially or wholly immersing the said armature and mercury cups, substantially as and for the purpose described.

18. In an electric meter, the combination of an armature, two mercury cups, a liquid bath partially or wholly immersing the said armature and mercury cups, and a heating resistance winding, substantially as and for the purpose herein described.

19. In an electric meter, the combination of an armature, two mercury cups, a liquid bath partially or wholly immersing the said armature and mercury cups, a heating resistance winding, and a circuit controlling thermostat, substantially as and for the purpose herein described.

20. In an electric meter, the combination of a compound wound electro magnet, an armature, two mercury cups, a liquid brake for retarding the speed of the said armature, a heating resistance winding, and a circuit controlling thermostat, substantially as and for the purpose herein described.

21. In an electric meter, the combination of an armature having mercury contacts with the pole pieces of an electro magnet, and a bath of glycerine in which the armature and the said mercury cups are immersed, substantially as and for the purpose herein described.

22. In an electric meter, the combination of a cylindrical electro magnet case having internal poles, one being annular in form, dependent from the top of the case and acting as a cover therefor, the other centrally placed at the bottom and projecting vertically therefrom into the space inclosed by the said annular pole and axially bored to form a mercury cup, a cylindrical armature pivoted within the said mercury cup to rotate within the annular space between the poles and having two mercury contacts, circuit connections therewith, a compound winding placed within the magnet case, and an integrating gear driven directly from the armature spindle, substantially as and for the purpose herein described.

23. In an electric meter, the combination of a cylindrical electro magnet case having internal poles one being annular in form dependent from the top of the case and acting as a cover and core, the other centrally placed at the bottom and projecting vertically therefrom into the space inclosed by the said annular pole and axially bored to form a mercury cup, a cylindrical armature pivoted within the said mercury cup to rotate within the annular space between the poles and having

two mercury contacts, circuit connections therewith, a liquid bath submerging the said armature and mercury contacts, and a differential compensating compound winding, substantially as and for the purpose herein described.

24. In an electric meter, the combination of a cylindrical electro magnet case having internal poles and a closed bottom, an annular mercury cup resting on the bottom, a funnel shaped filling surrounding the said annular mercury cup and draining into the same, and a central mercury cup, substantially as and for the purpose herein described.

25. In an electric meter, the combination of an electro magnet excited by a differential compensating compound winding, a perforated armature rotatable between the poles of the said magnet, mercury contacts for the said armature and circuit connections thereto, a fluid tight vessel surrounding the said poles, and a bath of glycerine within the said vessel submerging the said armature, substantially as and for the purpose herein described.

26. In an electric meter, the combination of an electro magnet excited by a differential compensating compound winding and having a truly annular space between its poles, an armature rotatable within the said annular space, two mercury contacts for the said armature and circuit connections thereto, substantially as and for the purpose herein described.

27. In an electric meter, the combination of a cylindrical electro magnet case having a closed bottom, a central pole piece axially bored to form a mercury cup, an annular mercury cup surrounding the said pole piece, a series winding wound around the annular cup, a channel in the case from the interior to the upper portion thereof for the passage of the series conductor, and a liquid bath submerging the said mercury cups, substantially as and for the purpose herein shown and described.

28. In an electric meter, a cylindrical electro magnet case having internal poles and a closed bottom, one of the said poles being annular in form and dependent from the top of the said case and forming a core for a shunt winding, substantially as herein shown and described.

29. In an electric meter, the combination of a cylindrical electro magnet case having a closed bottom and a dependent pole piece forming a cover, arranged and operating as a fluid receptacle, a pivoted armature rotatable within the said magnet case, an annular mercury cup resting on the bottom and circuit connections therewith, an internal winding, and a liquid bath submerging the said armature and mercury cup, substantially as and for the purpose herein described.

30. In an electric meter, the combination of a rotatable armature, mercury contacts therefor, a liquid bath or brake in which the armature is immersed, an electro magnet having an electric resistance heating circuit wound thereon in a magnetically neutralized manner, and a thermostat controlling the said resistance circuit, substantially in the manner and for the purpose herein described.

31. In an electric meter, the combination of a rotatable armature, mercury contacts therefor, a bath of viscous liquid in which the armature is immersed, a non-inductive electrical resistance winding for heating purposes, a compound metallic bar in circuit with the resistance winding and having an adjustable contact screw, substantially as and for the purpose herein described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

FRANCIS TEAGUE.

Witnesses:
C. E. BOTT,
E. C. BARKER.