No. 698,649. Patented Apr. 29, 1902.

# T. DUNCAN.

## ELECTRIC METER.

(Application filed July 10, 1899.)

(No Model.) 2 Sheets—Sheet 1.

*Fig. 1.*

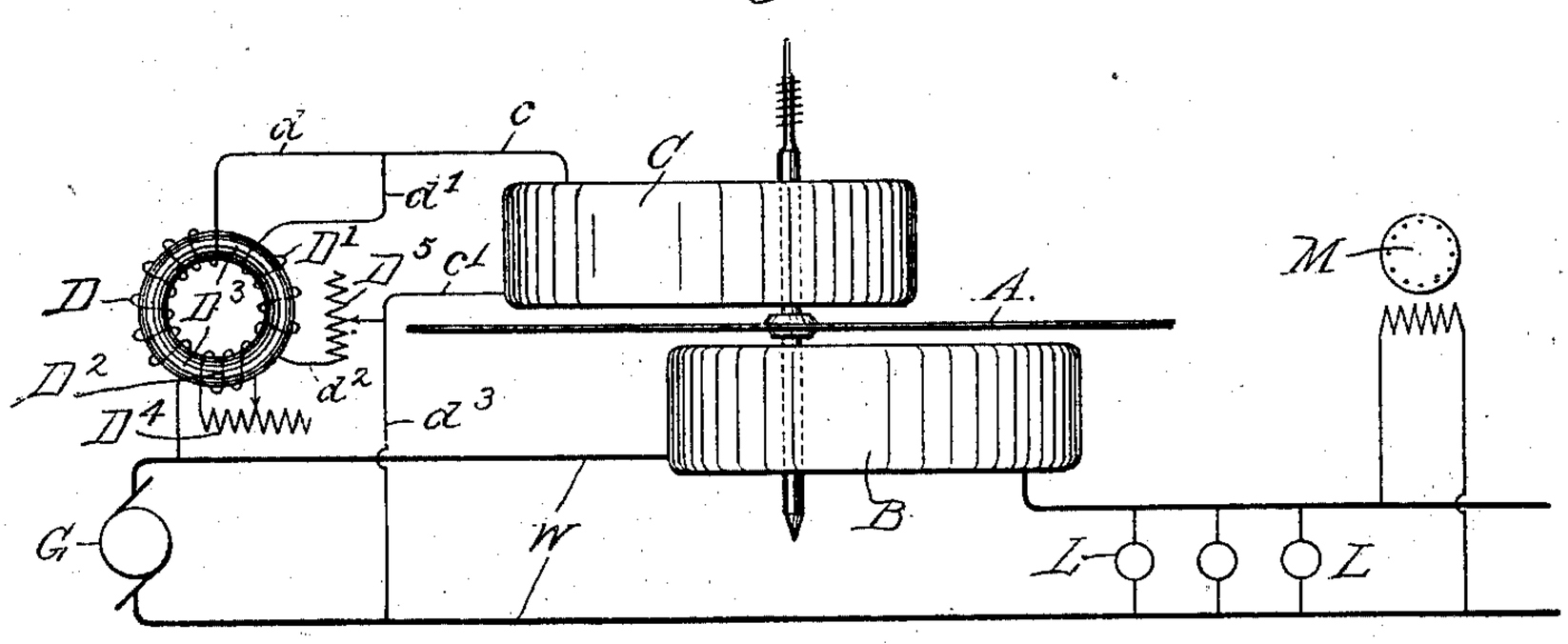



*Fig. 2.*

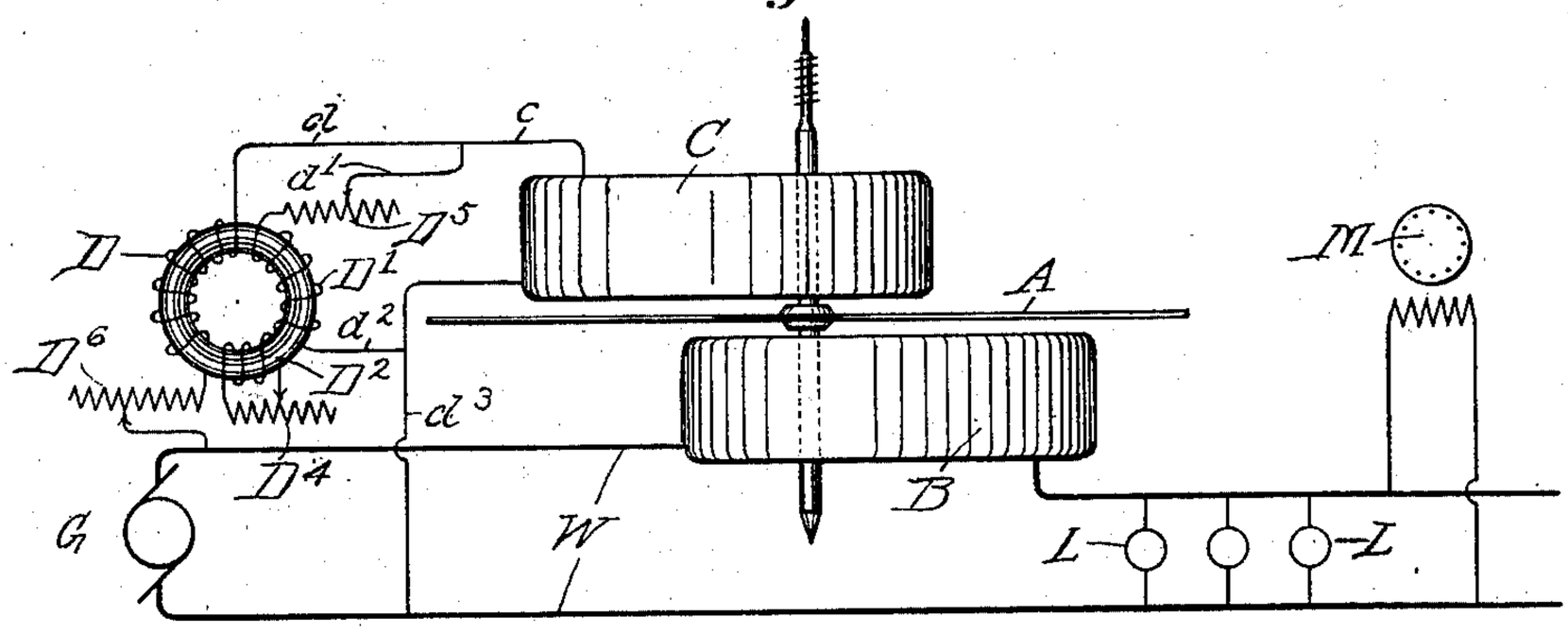
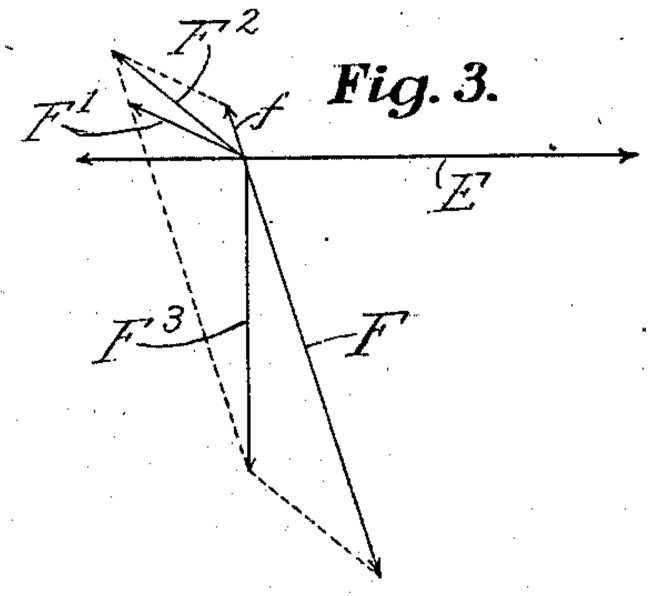



*Fig. 3.*




Witnesses

M. E. Marsh.
J. G. Merimbaum.

By his Attorneys

Inventor

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Carter & Brown.

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# T. DUNCAN.

## ELECTRIC METER.

(Application filed July 10, 1899.)

(No Model.) 2 Sheets—Sheet 2.

*Fig. 4.*

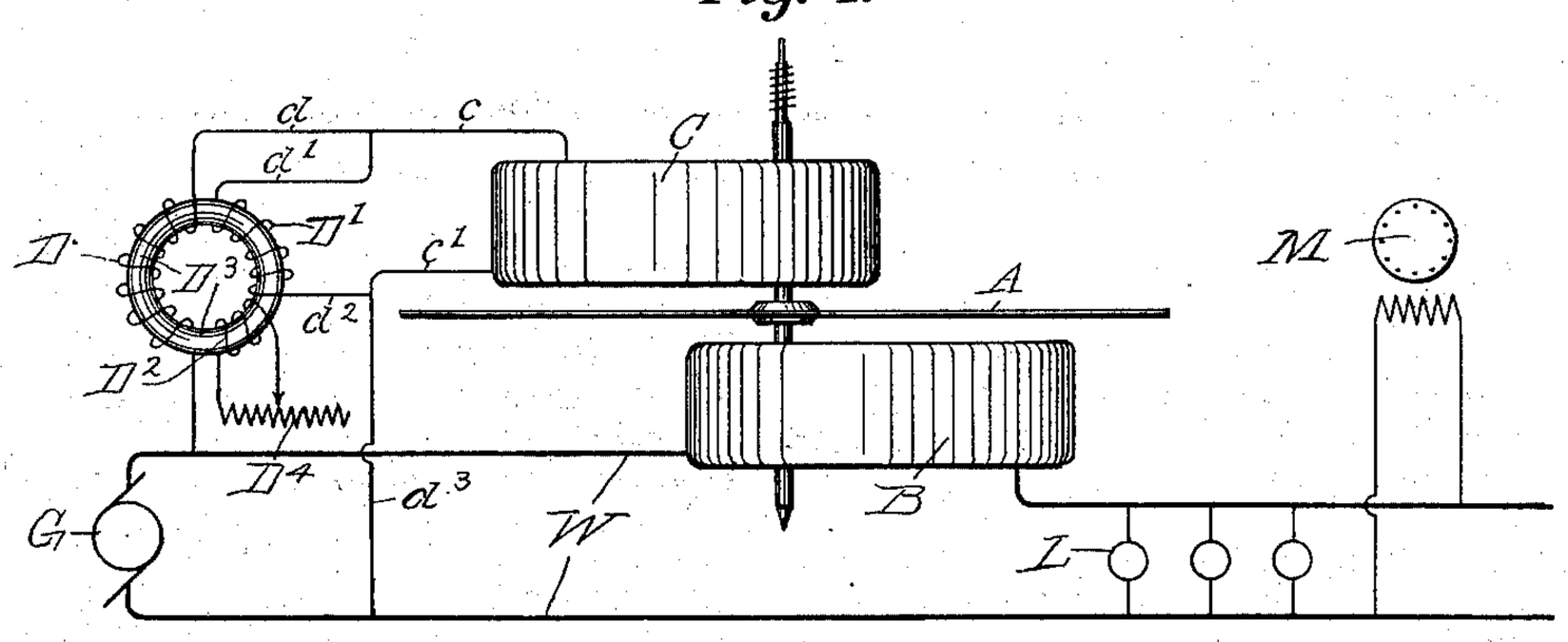
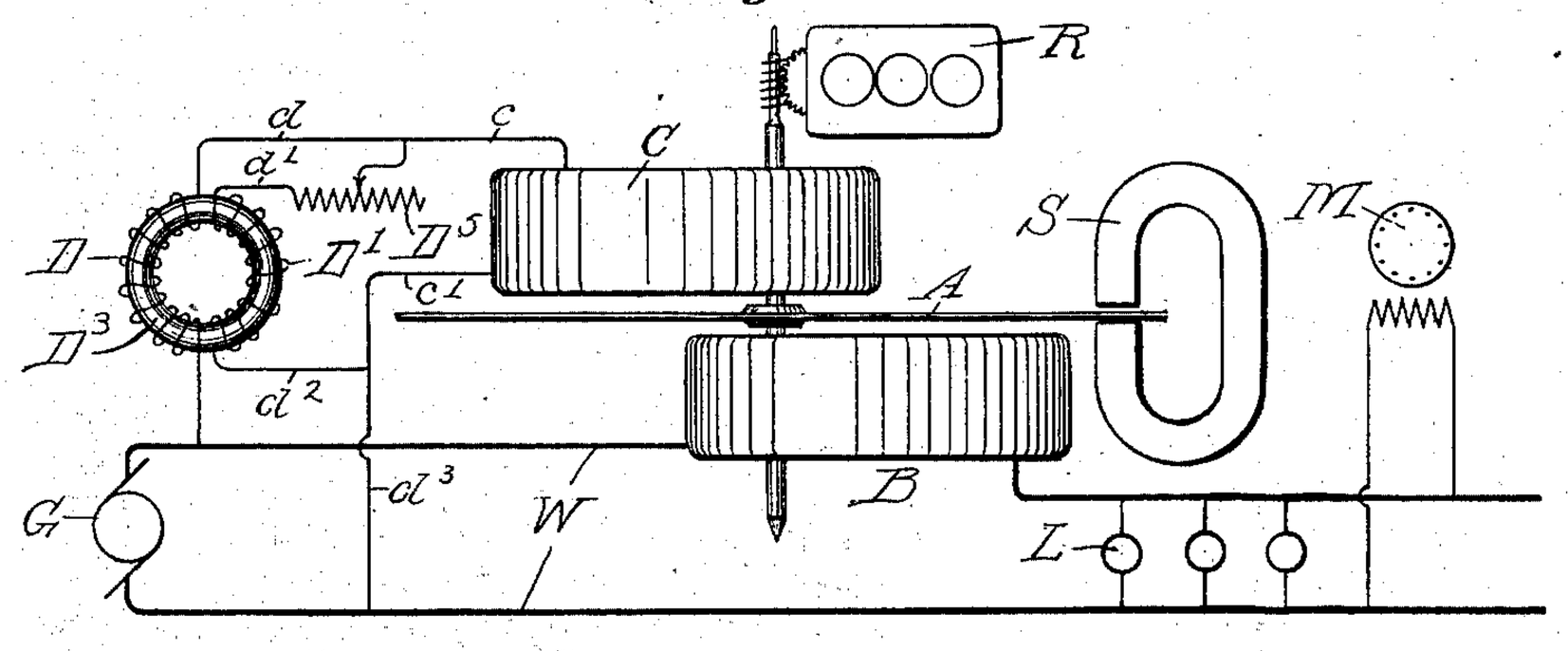



*Fig. 5.*




Witnesses
M. E. Marsh
J. G. Merinbaum

By his Attorneys
Thomas Duncan
Carter & Brame.

# 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. 698,649, dated April 29, 1902.

Application filed July 10, 1899. Serial No. 723,328. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS DUNCAN, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Electric Meters, (Case No. 52,) of which the following is a specification.

This invention relates to improvements in induction motor-meters for alternating-current work, and particularly to means for obtaining in such meters a magnetic field in quadrature with the electromotive force which it represents.

The invention consists in the matters hereinafter described, and particularly pointed out in the appended claims, and will be fully understood from the following detailed description of the constructions illustrated in the accompanying drawings, in which—

Figures 1, 2, 4, and 5 are partially diagrammatic views of meters embodying my invention. Fig. 3 is a vector diagram of the essential current effects.

In said drawings, A designates a rotary armature that is actuated in a familiar manner by the inductive influence of series and volt coils B and C, of which the former is connected in series in the work-circuit W and the latter in shunt across the line. An impedance-coil D is inserted in the shunt-circuit with the volt-coil to retard the current therein, and the armature is set in rotation by the resultant shifting field, due to this phase displacement. Additional lagging means are, however, necessary to obtain the full ninety-degree displacement necessary to accurate working under all conditions of service. In the present improvement such means consists of a secondary coil D′, placed in inductive relation to the impedance-coil D and connected with the terminals *c* and *c′* of the volt field-coil, so that the current induced therein by the shunt-current in the impedance-coil combines with the latter current in energizing said volt field-coil. This secondary current is displaced from the impressed electromotive force of the work-circuit by more than ninety degrees, and therefore in effect increases the lag of the primary shunt-current through the impedance-coil, their resultant action in the volt-coil being with proper proportioning that of a single current lagging by the ninety degrees desired. This effect of the secondary induced current will be somewhat diminished by the small shunt-current, which will traverse the secondary coil D′ through the leads *d*, *d′*, $d^2$, and $d^3$ in a direction opposite to said induced current; but the latter will still be great enough to accomplish the result required.

The essential current relations in the above respect are shown graphically in Fig. 3, in which the line E represents the electromotive force of the work-circuit, and F the main shunt-current, which, as before stated, is displaced somewhat less than ninety degrees in phase from the electromotive force by the impedance-coil D. F′ represents the induced current in the coil D′, and *f* the slight current or leakage, which is deflected through the coil D′ in opposition to said induced current. These two currents may be said to produce a resultant $F^2$, (obtained by completing the parallelogram on lines F′ and *f*,) as the effective current through said coil D′, and this resultant, combined with the primary shunt-current F, (obtained by completing the parallelogram on lines F and $F^2$,) gives a final resultant $F^3$ at ninety degrees with the electromotive force E as the effective current through the volt field-coil C, which produces the magnetic field acting on the armature A to represent the difference in potential between the main leads of the work-circuit.

An adjusting device for exactly regulating the phase retardation is shown in Figs. 1, 2, and 4 as provided in the form of a closed-circuit coil $D^2$, which is wound on the same magnetic core $D^3$ as the coils D and D′ and has an inserted adjustable resistance $D^4$. In Figs. 1 and 2 an additional adjusting means is provided in the form of an adjustable resistance $D^5$, connected in series with the coil D′, and in the latter figure a still further adjustment in the form of an adjustable resistance connected in series with the impedance-coil D is provided at $D^6$, while in Fig. 5 the adjustment $D^5$ is alone depended on. In all of said

views, G indicates the alternating-current generator, and L and M the lamps and motors constituting the load. Any suitable mechanism R is employed to register the revolutions of the armature, and a magnetic drag S will be applied in the usual manner to maintain the number of revolutions proportional to the torque exerted, such devices being indicated in Fig. 5, but omitted from the other views of the drawings for simplicity of illustration. These features, however, constitute in themselves no part of the present improvement and are mentioned merely for the purpose of enabling the complete installation to be fully understood.

I claim as my invention—

1. An electric meter provided with an armature, series and volt coils inductively actuating the armature, an impedance-coil connected in the shunt-circuit with the volt-coil, and a secondary coil placed in inductive relation to the impedance-coil and having its terminals connected with the terminals of the volt-coil, the said secondary coil being directly connected in multiple with the winding in circuit with the impedance-coil, substantially as described.

2. An electric meter provided with an armature, series and volt coils for inductively actuating the armature, an impedance-coil connected in the shunt-circuit with the volt-coil, a secondary coil placed in inductive relation to the impedance-coil and having its terminals connected with the terminals of the volt-coil, and a closed-circuit adjusting-coil placed in inductive relation to the impedance and secondary coils.

3. An electric meter provided with an armature, series and volt coils inductively actuating the armature, an impedance-coil connected in a shunt-circuit with a volt-coil, a secondary coil placed in inductive relation to the impedance-coil, and having its terminals connected with the terminals of the volt-coil, the secondary coil being connected directly in multiple with the volt-coil in circuit with the impedance-coil, substantially as described.

4. The combination with the work-circuit, of an electric meter provided with an armature A, an energizing-coil B connected in series in said work-circuit, an energizing-coil C connected in shunt across the line, an impedance-coil D inserted in said shunt-circuit, a secondary coil D′ placed in inductive relation to the impedance-coil D having its terminals connected with the terminals of the coil C, the secondary coil being directly connected in multiple with the energizing-coil in circuit with the impedance-coil, a measuring device R and a magnetic drag S, substantially as described.

5. An electric meter provided with an armature, two windings for effecting the operation of the armature, an impedance-coil connected in series with one of the windings, and a secondary coil placed in inductive relation to the impedance-coil and directly connected in multiple with the field-winding in series with the impedance-coil, substantially as described.

6. An electrical meter provided with an armature, series and volt windings for effecting the operation of the armature, an impedance-coil connected in series with the volt-winding and a secondary coil placed in inductive relation to the impedance-coil and having its terminals connected with the terminals of the volt-winding, the secondary coil being directly connected in multiple with the winding in series with the impedance-coil, substantially as described.

In testimony that I claim the foregoing as my invention I affix my signature, in presence of two subscribing witnesses, this 6th day of July, A. D. 1899.

THOMAS DUNCAN.

Witnesses:
WALTER H. ABBOTT,
DAVID F. STAKES.