(No Model.) 2 Sheets—Sheet 1.

G. HUMMEL.

WATT METER.

No. 570,019. Patented Oct. 27, 1896.

Fig. 1,

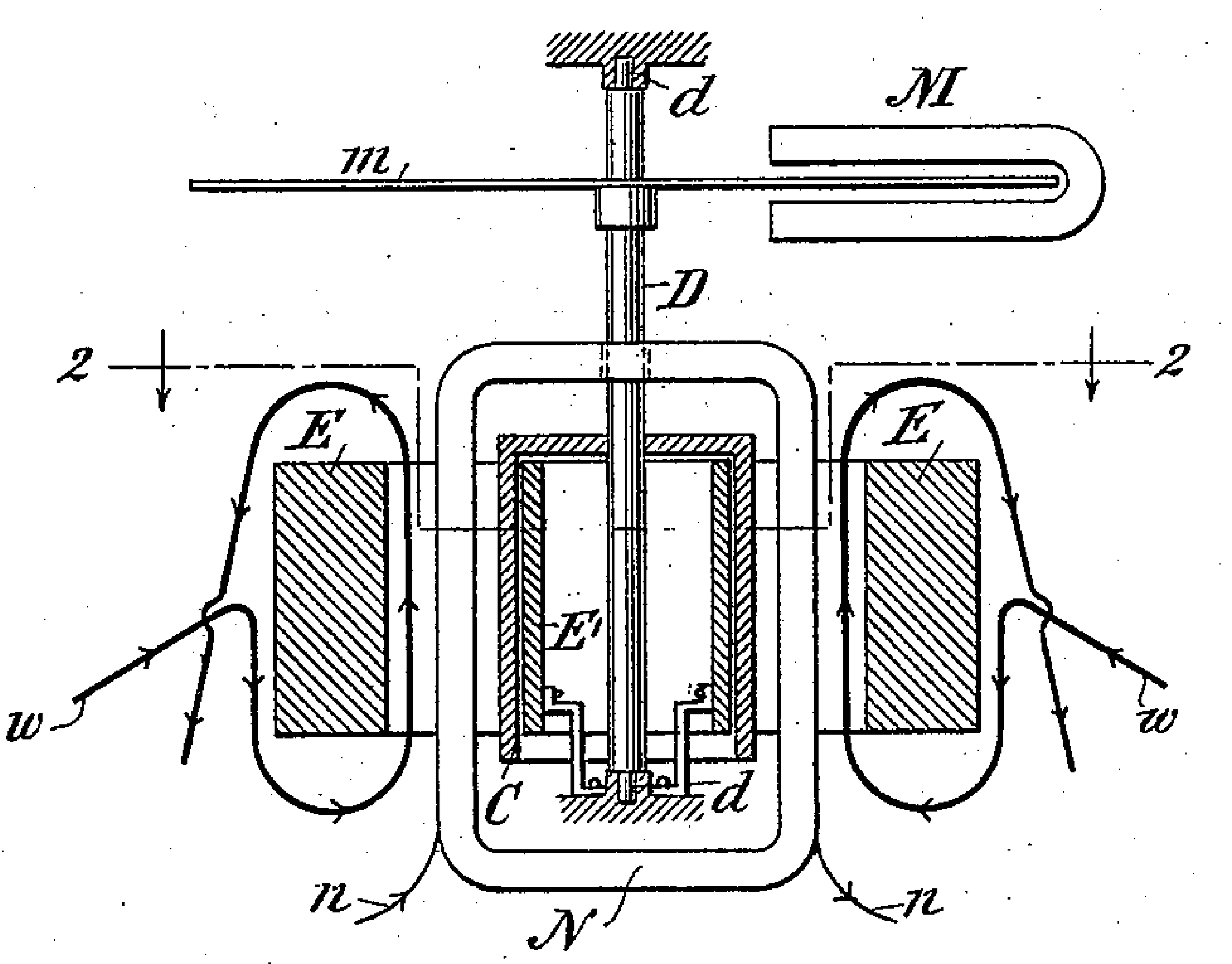
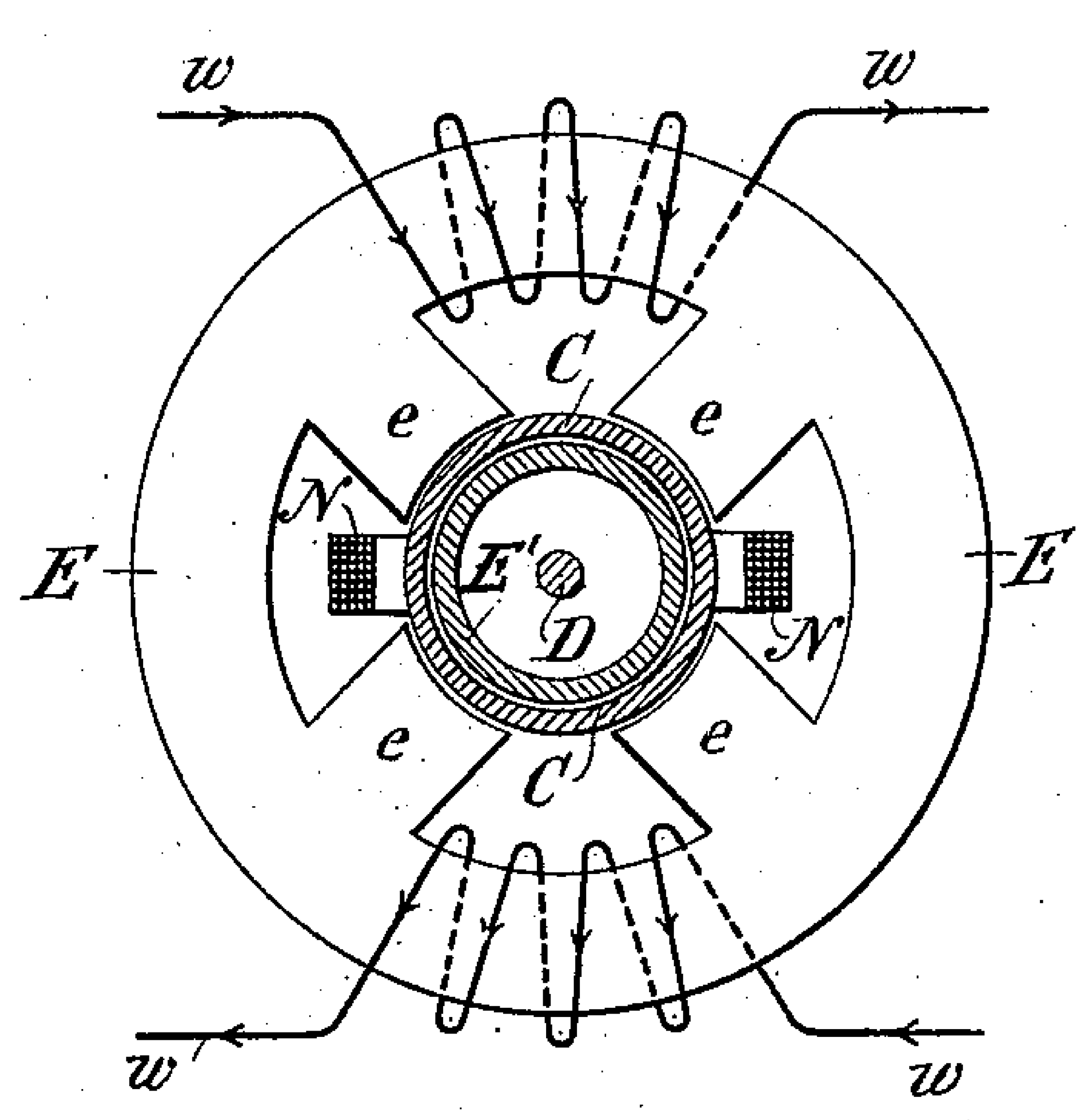


Fig. 2,



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

(No Model.) 2 Sheets—Sheet 2.

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Fig. 3,

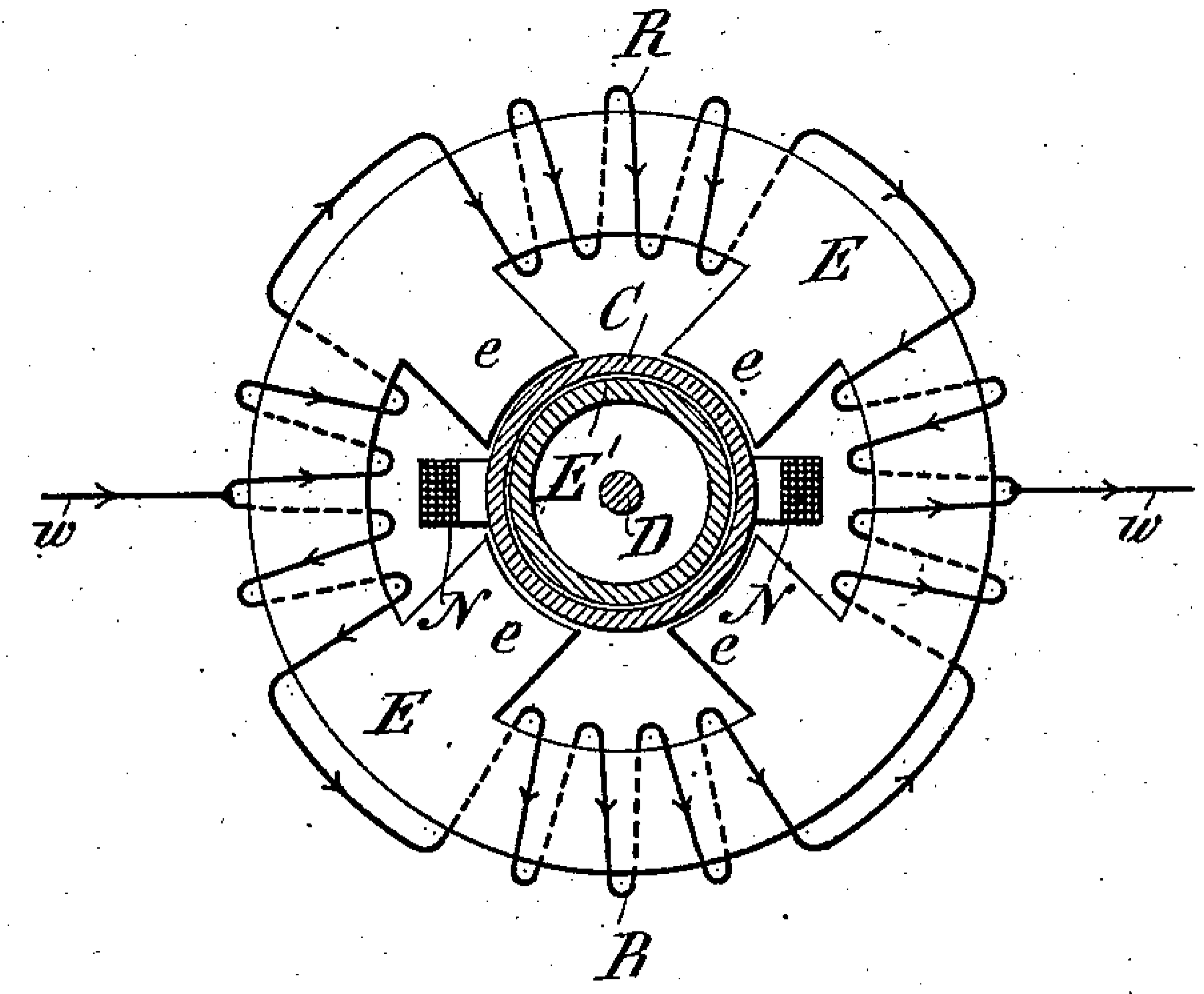
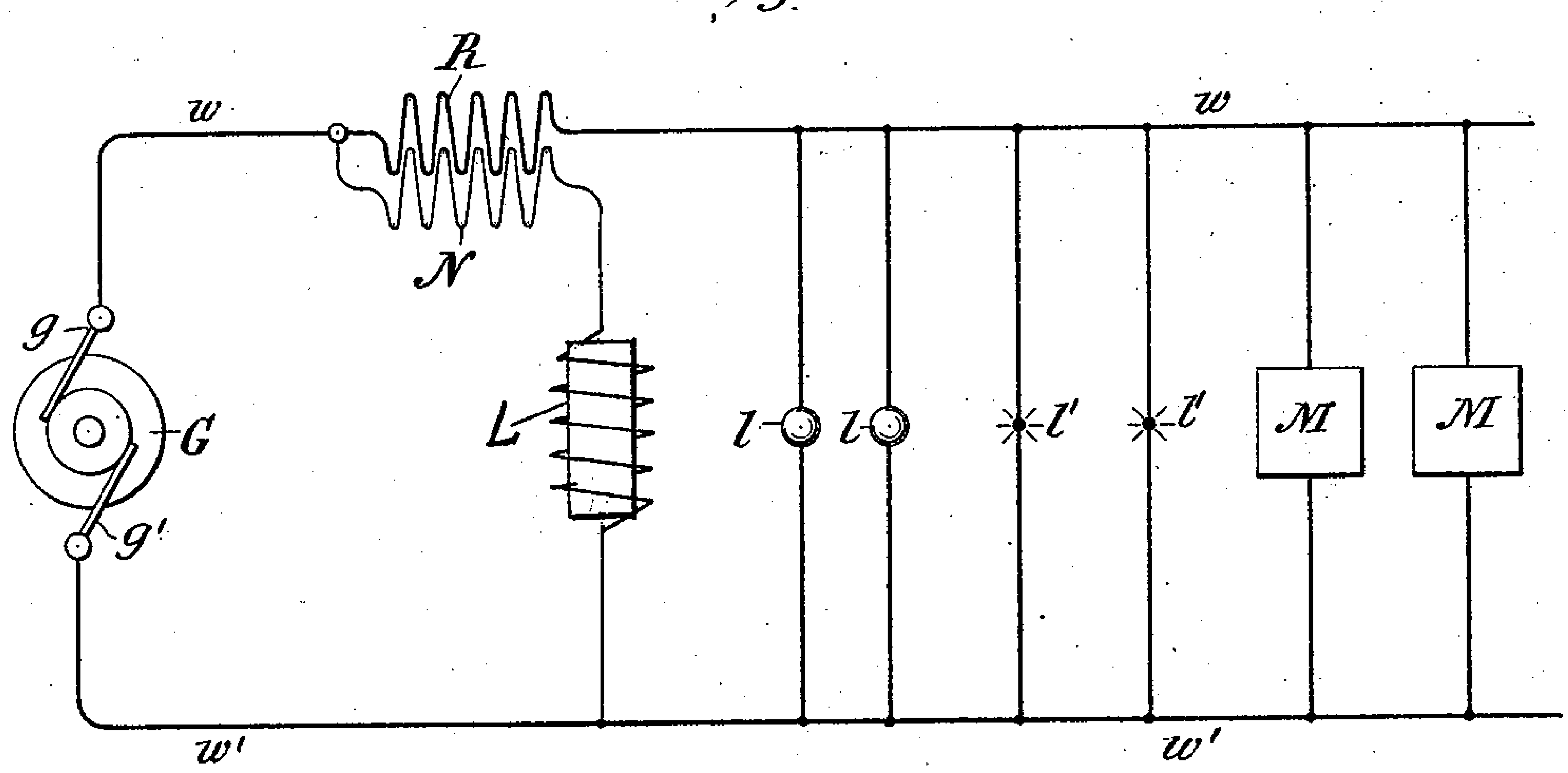


Fig. 4.



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UNITED STATES PATENT OFFICE.

GEORG HUMMEL, OF MUNICH, GERMANY.

WATTMETER

SPECIFICATION forming part of Letters Patent No. 570,019, dated October 27, 1896.

Application filed January 30, 1895. Serial No. 536,743. (No model.) Patented in Switzerland December 27, 1894, No. 9,812; in Italy February 14, 1895, XXIX, 38,094, LXXIV, 408; in France April 30, 1895, No. 244,481; in Hungary June 22, 1895, No. 3,074, and in Austria September 20, 1895, No. 45/3,422.

To all whom it may concern:

Be it known that I, GEORG HUMMEL, a subject of the King of Bavaria, residing at Munich, in the Kingdom of Bavaria, Germany, have made a new and useful Improvement in Wattmeters, of which the following is a specification.

My invention relates particularly to a novel form of electric motor intended especially for the driving of wattmeters or other apparatus designed to accurately measure alternating or pulsating currents of electricity; and to this end it consists in the mechanism hereinafter described, the novel features of which are particularly pointed out in the claims at the end of this specification.

The invention disclosed and claimed in the present application has been patented to me in the following-named coun'ries, to wit: Italy, Reg. Gen., Vol. XXIX, No. 38,094, Reg. Att., Vol. LXXIV, No. 408, dated February 14, 1895; Switzerland, No. 9,812, dated December 27, 1894; Hungary, No. 3,074, dated June 22, 1895; France, No. 244,481, dated April 30, 1895, and Austria, No. 45/3,422, dated September 20, 1895.

My invention will be fully understood by referring to the accompanying drawings, in which—

Figure 1 is a longitudinal sectional view of my improved meter-motor, showing the circuits in diagram; and Fig. 2 is a transverse sectional view of the same, taken on the broken line 2 2, Fig. 1, and as seen looking from the top toward the bottom of the drawing in the direction of the arrows upon that figure. Fig. 3 is a similar view to Fig. 2, illustrating the complete winding for a motor having a field-magnet with four pole-pieces; and Fig. 4 is a diagrammatic view illustrating an alternating or pulsating current electrical generator of well-known form and a pair of current-mains with my improved wattmeter-motor and a series of electrical translating devices connected in circuit therewith.

As far as I am aware, M. Ferraris was the first to call attention to the fact that the well-known motor invented by him can be used for the propulsion of electric meters. Furthermore, M. Blathy, for the same purpose, devised a motor in which two phases are utilized in separate magnetic circuits. While M. Blathy has thus utilized the principle referred to in the driving of an electric meter, no practical success, so far as I am aware, has been attained during the last decade in the application of Ferraris's principle in the construction of electric meters. The reasons for this are not difficult to ascertain. Ferraris's motor has, it is true, excellent theoretical characteristics, but is not really practically available for use in the manner named. I have directed my attention to the construction of a motor of essentially greater power, while having also other theoretical characteristics, and have arrived at the conviction that this end cannot be attained without the use of iron in the motor. By the use of iron, it is true, a different mode of operation is in effect created. The views of Ferraris are not strictly correct. Moreover, the unavoidable losses in effect as well as the changeableness of the permeability of iron at different demands exert an influence difficult to determine in advance. This influence is about comparable with that which the employment of iron would bring about in wattmeters. I have, nevertheless, discovered that in spite of these various influences the desired effect can be obtained if, in addition to the iron as a magnetic conductor common to both phases, a correspondingly long air interval for the magnetic path be used. In accordance with this principle of construction my improved meter-motor is constructed.

Referring now to the drawings in detail, the inducing as well the induced field is of iron E and E′, the inducing-field E being preferably of Gramme-ring multipolar form, having internally-projecting pole-pieces *e e*, four in number, as shown in Figs. 2 and 3. Between the inducing and induced fields is interposed an interval which consists in part of air and in part of copper, and thus possesses a resistance so considerable that the effect of the iron almost disappears. In contrast to the principles of construction of the latest forms of alternating-current motors the electric circuits of the armature in my invention consist of a relatively thick walled copper or diamagnetic cylinder or bell C, inside of which is located a stationary iron armature E′, and corresponding to its thickness the resistance of the magnetic circuit is increased. This copper cylinder or bell is attached to a vertically-disposed shaft D, journaled at *d d*, *m* being a retarding-disk and M a retarding-magnet of well-known form, the shaft D being geared to registering apparatus or other apparatus to be driven in any preferred manner. The copper cylinder or bell C, carried by the axis D, moves between the inducing-magnet system and the stationary iron armature E′. The winding of the motor consists of two parts: first, the field-conductor R, through which all of the current to be measured flows, this part of the winding being in the nature of a ring, as shown in Figs. 2 and 3, and connected to the main circuit *w w*, as shown in Fig. 4, and, second, a fine-wire shunt-winding N, which is preferably wound in one or more separate frames in order to avoid the expense of winding upon the rings. After it is thus wound in separate frames it is disposed between the separate field-poles *e e e e* and connected in the manner shown in Fig. 4, in which figure G represents an alternating-current dynamo and *g g′* the current-collecting brushes connected to current-mains *w w′*, *l l* being incandescent lamps, *l′ l′* arc-lamps, and M M alternating-current motors or other electrical translating devices connected in multiple between the current-mains.

L is an inductive resistance or condenser designed to shift the current phase of the shunt-circuit N as far as possible (about ninety degrees) toward that of the current in a resistance devoid of induction.

The theory of my improved apparatus is based upon the following considerations: The draft Z which the armature of a two-phase motor, with two phases ninety degrees apart, exerts is $Z=c_1\ i\ J\cos.\ \phi$, wherein i indicates the current strength of one circuit (say the shunt-circuit) and J the current strength of the other circuit, (say the main circuit.) c_1 is any desired constant; ϕ, the phase shift of the main current with respect to a current in a resistance entirely free from induction. It is apparent, therefore, that this draft will become the smaller the greater the phase shift of the main current. It will become *nil* if ϕ equals ninety degrees. The above equation properly interpreted corresponds to that of a wattmeter. In the latter, however, the phase of the shunt-current toward a current in a resistance free from induction is not shifted.

The work which the motor produces when the number of revolutions is equal to n and which corresponds to the draft Z is $A=Z\ n=c_1\ i\ J\cos.\ \phi\ n$. On the other hand, the work which is consumed in the copper disk becomes $A_2=c_2\ i^2\ w=\frac{c_2\ E^2}{w}$, wherein i indicates the current arising in the copper disk during rotation; E, the tension corresponding thereto; w, the resistance of the conductors in which this current passes. Now, as is appreciable, $w\ i^2=\frac{E^2}{w}=e_3\ n^2$. Since A_1 must equal A_2 in so far as losses in effect are not taken account of, now $c_1\ i\ J\cos.\ \phi\ n=c_3\ n^2$, or $c_1\ i\ J\cos.\ \phi=c_3\ n$.

It being presupposed that losses in effect do not come into consideration and that i is shifted ninety degrees toward a current in inductionless resistance, the number of revolutions of the present system is therefore exactly proportional to the electrical work $c_1\ i\ J\cos.\ \phi$ which is to be measured.

Although I have described my invention as applicable to watt and other electrical measuring meters, it is obvious that it might be used anywhere in the art where alternating-current motors are utilized.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. An alternating-current motor provided with a stationary field-magnet having pairs of internally-projecting field-magnet poles surrounded with field-magnet windings connected directly to a source of alternating-current supply, an additional field-magnet winding of higher resistance than the first field-magnet winding and located in shunt relation thereto, and an induction device located in said shunt for shifting the current phase in combination with a rotary part consisting of diamagnetic material such as copper and a fixed stationary part concentric with said rotary part, said stationary part being of magnetic material, and both of said parts being located wholly in the inductive field of all of the pole-pieces, whereby the inducing and induced effect is substantially the same.

2. A wattmeter-moter provided with two sets of windings for the fixed or stationary portion thereof, one set of said windings being disposed upon a field-magnet core having internally-projecting pole-pieces and the other upon an independent frame or support in combination with a cylindrical diamagnetic rotary part and a fixed or stationary cylindrical magnetic part, both of said parts being concentric with the curvature of the inner ends of the field-poles and located wholly in the magnetic influence thereof.

3. An alternating-current motor provided with a rotary part of diamagnetic material, in combination with two sets of field-magnet poles surrounding said rotary part, and a fixed or stationary concentric cylinder of magnetic material located within said rotary part, said concentric cylinder lying wholly in the magnetic field of all of said poles whereby the inducing and induced effect is substantially the same.

4. A wattmeter-motor having a propelling part in the nature of a diamagnetic cylinder,

a field-magnet or stationary part surrounding said cylinder and provided with energizing-coils connected in circuit with the current to be measured, and a stationary magnetic cylindrical part located within the diamagnetic cylinder and lying wholly within the magnetic field of all of the field-magnet poles, whereby the inducing and induced effect is substantially the same.

5. A wattmeter-motor having energizing-coils located in one branch of the circuit, the current of which is to be measured, a second energizing-coil located in multiple arc with the translating devices, said second coil being of higher resistance than the first-named coils; a rotary part consisting of a diamagnetic cylinder and a stationary cylindrical part of magnetic material located inside the rotary part, in combination with an induction device located in circuit with the second energizing-coil said cylindrical parts lying at all times wholly within the magnetic field, whereby the inducing and induced effect is approximately the same, substantially as described.

6. An alternating-current motor provided with a field-magnet core of cylindrical form having pairs of internally-projecting pole-pieces, and coils or windings connected in circuit with a current-main; additional field-magnet windings of a relatively greater number of coils and connected in multiple with translating devices between the current-mains, a cylindrical rotary part of diamagnetic material having its exterior surface in close proximity to the magnetic field of both sets of field-magnet poles, a fixed or stationary cylindrical magnetic part concentric with the diamagnetic armature, the arrangement being such that the inducing and the induced effect is substantially the same.

In testimony whereof I have hereunto subscribed my name this 27th day of December, 1894.

GEORG HUMMEL.

Witnesses:
EMIL HALZENBERGER,
H. KÜRTH.