(No Model.)

2 Sheets—Sheet 1.

C. D. RAAB.

ELECTRIC METER.

No. 598,208.

Patented Feb. 1, 1898.

Fig. 1.

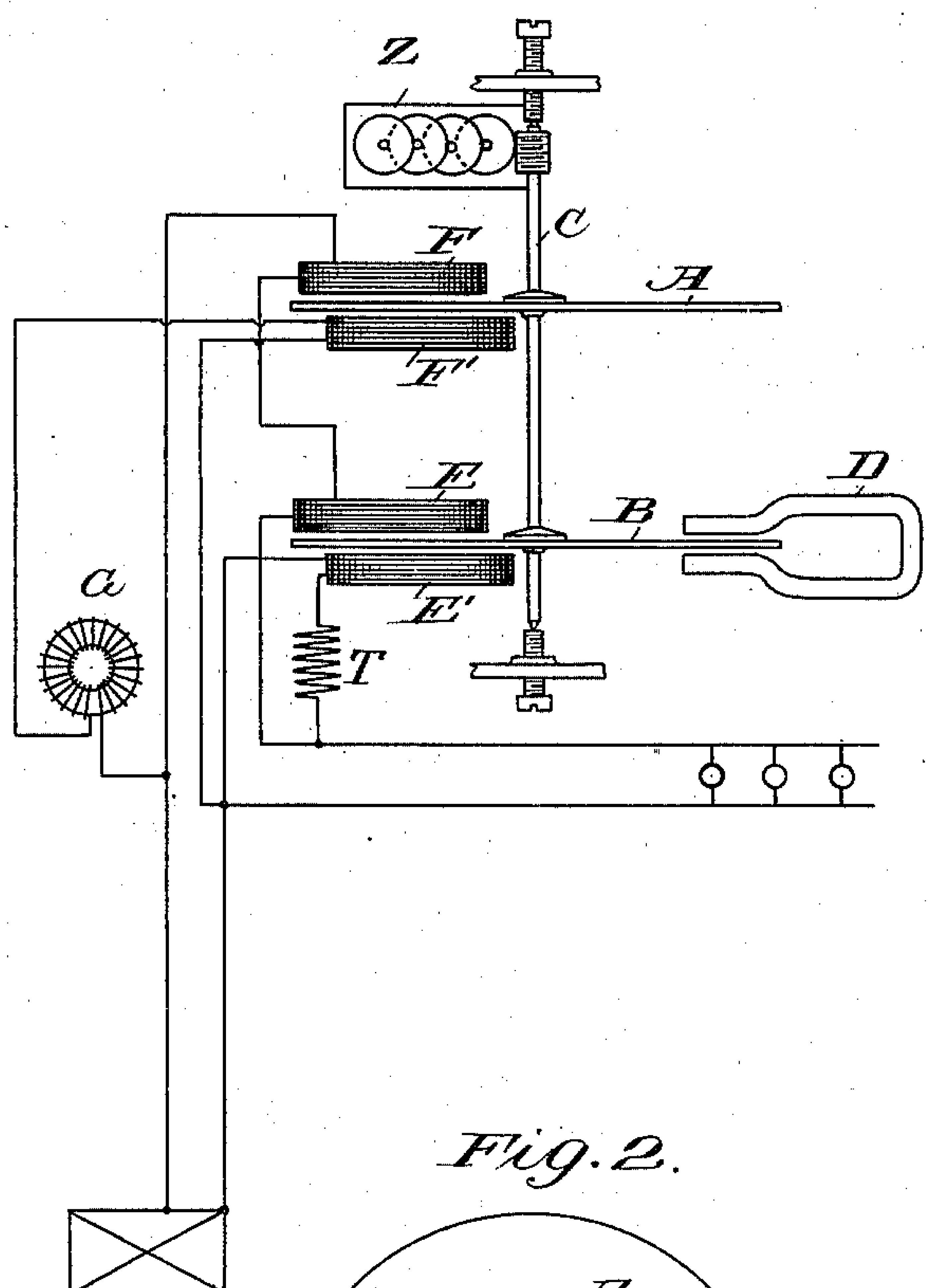


Fig. 3.

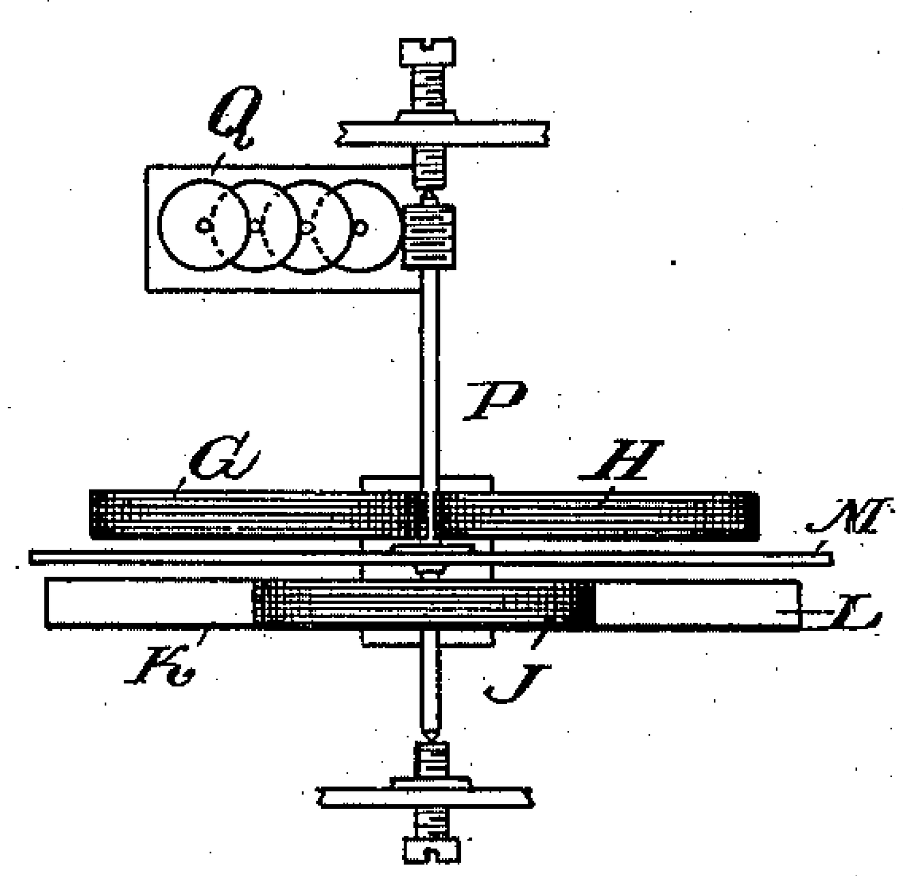


Fig. 2.

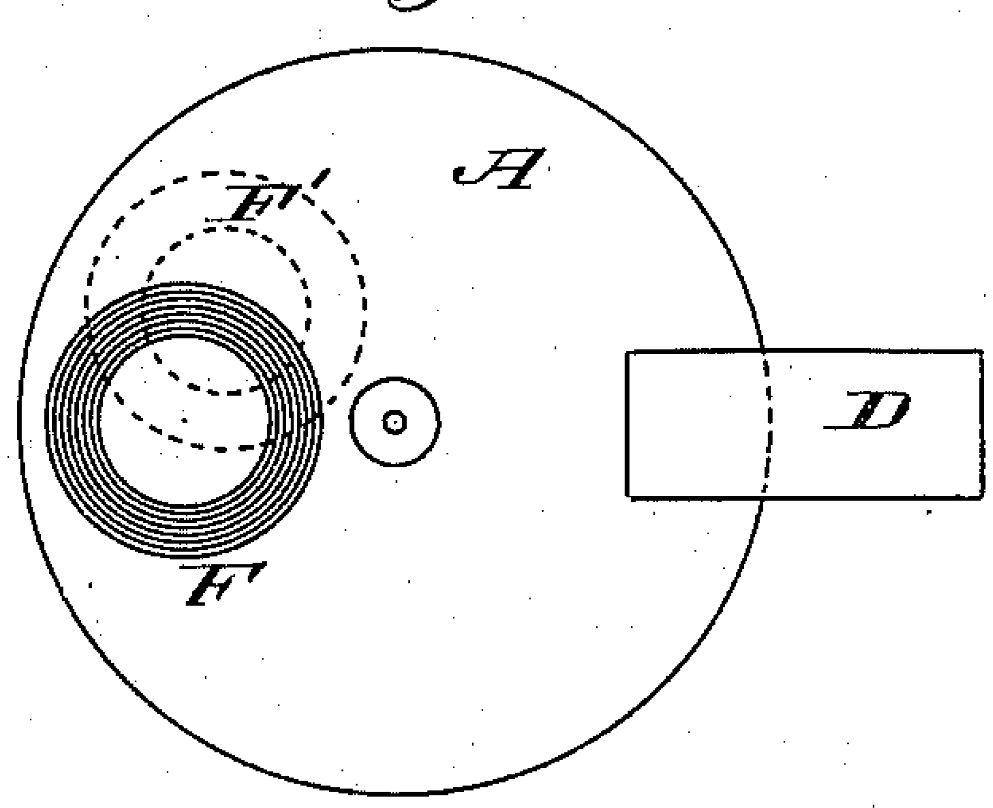
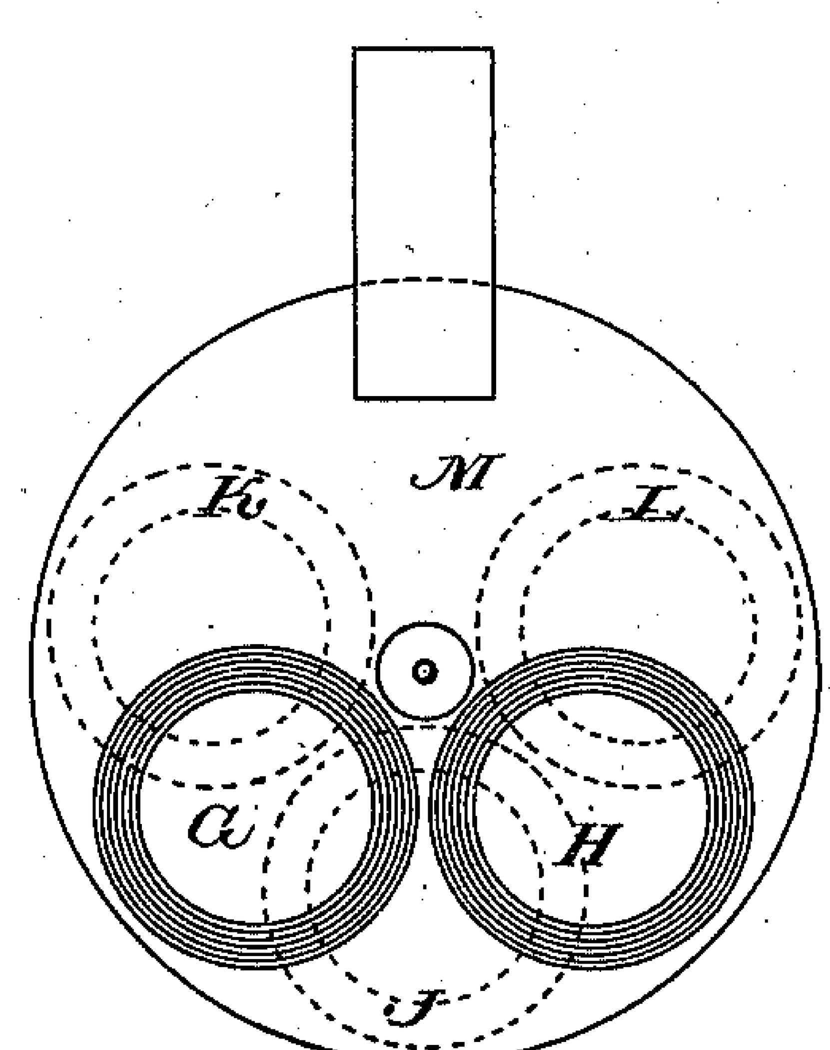


Fig. 4.



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(No Model.)

2 Sheets—Sheet 2.

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Fig. 5.

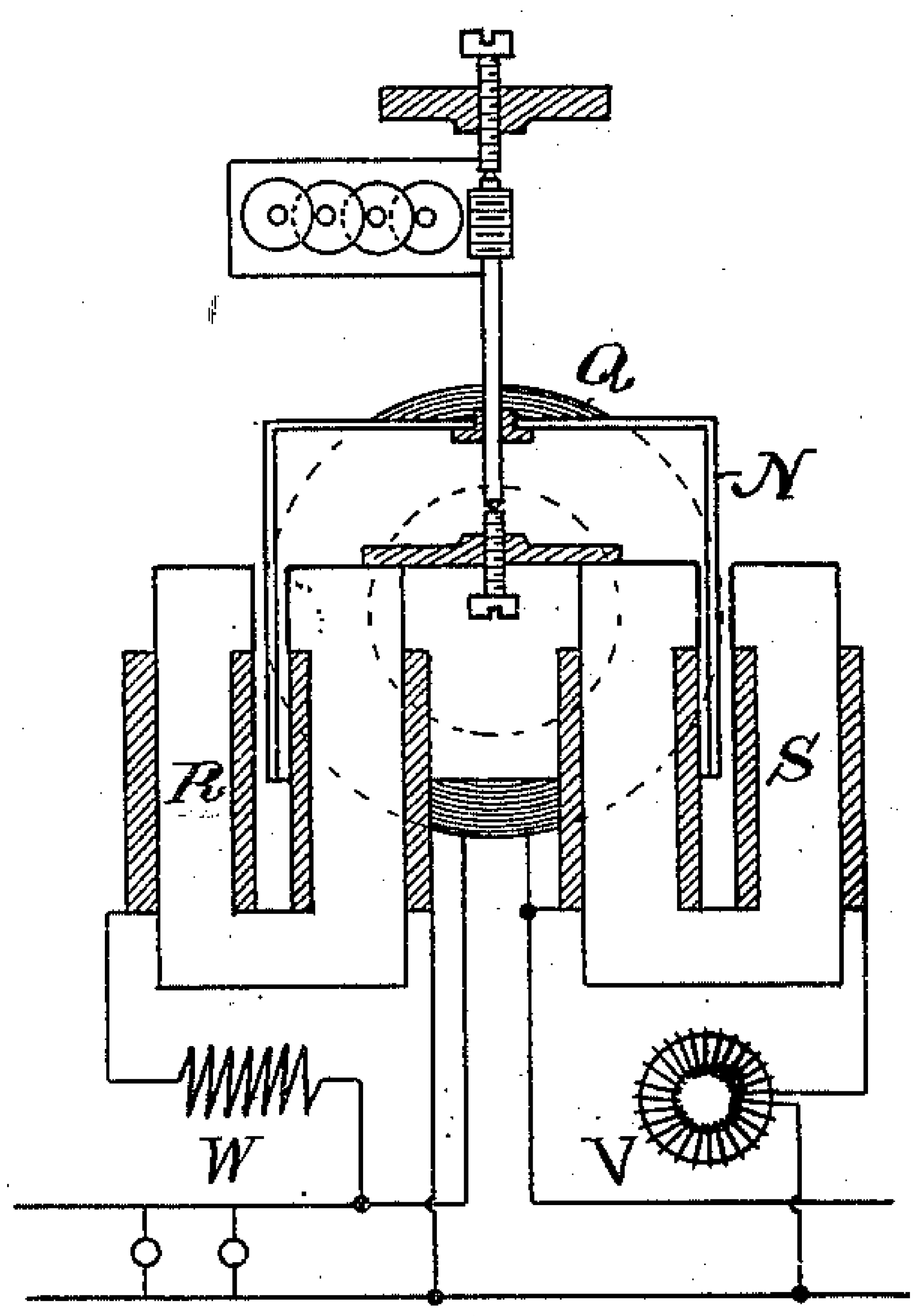


Fig. 7.

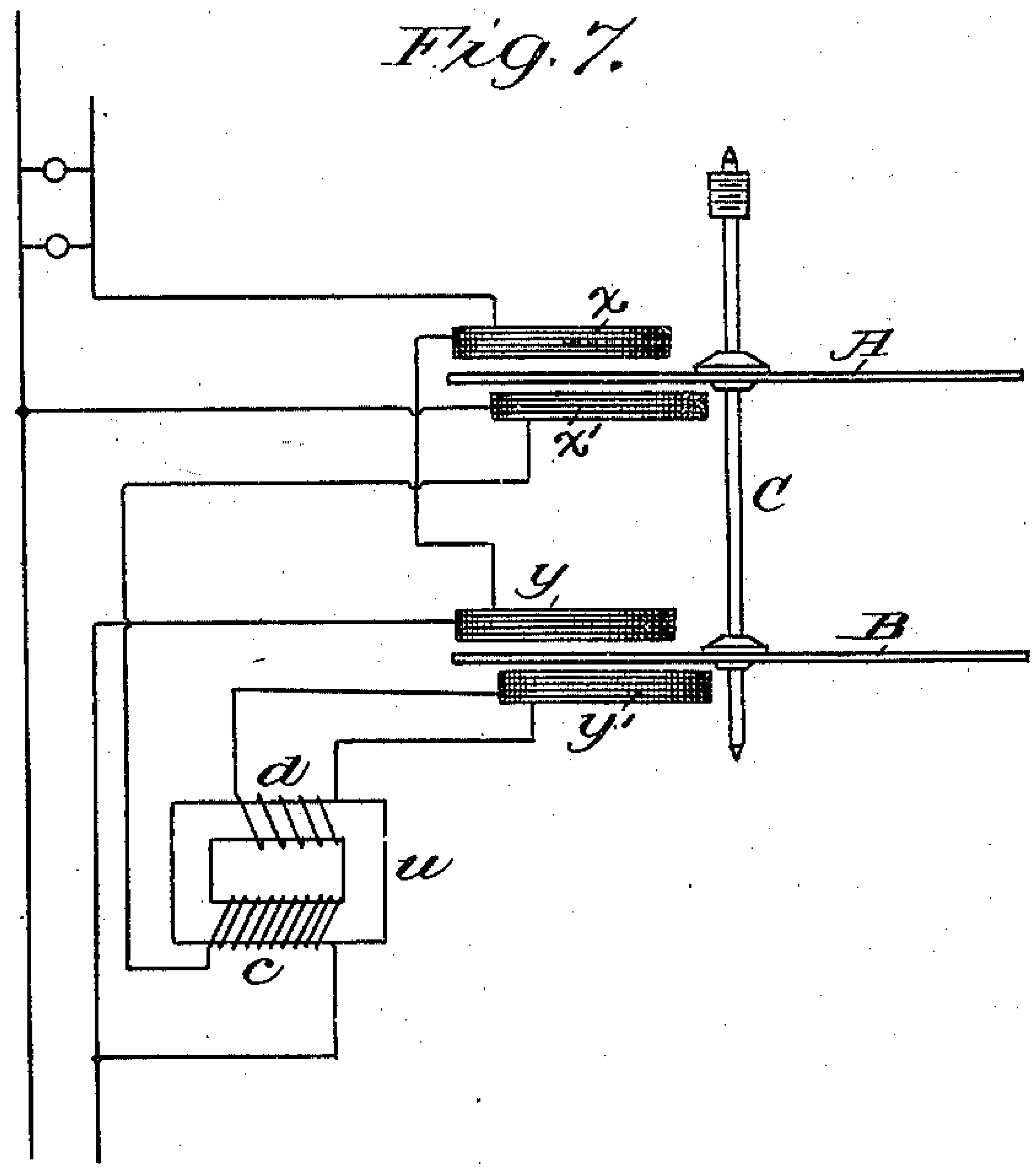
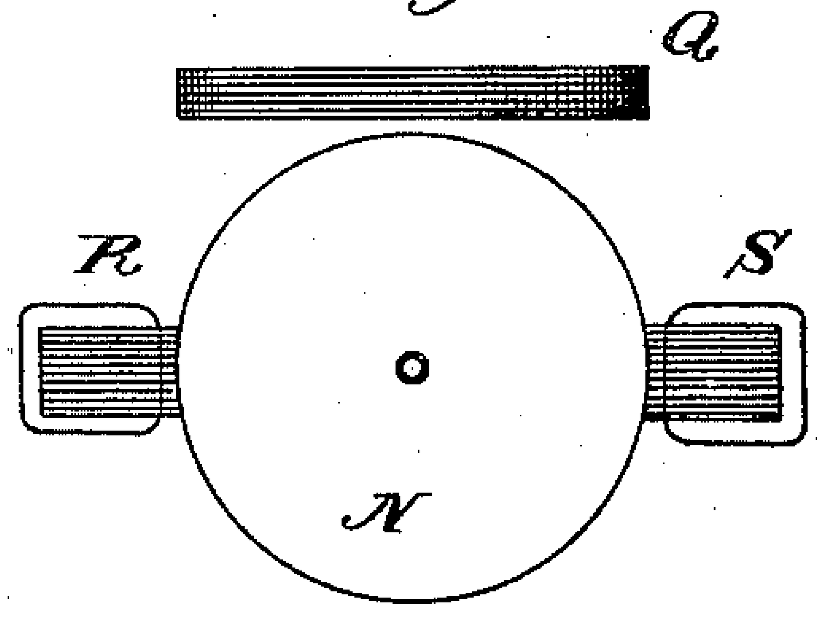


Fig. 6.



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UNITED STATES PATENT OFFICE.

CARL DANIEL RAAB, OF KAISERSLAUTERN, GERMANY.

ELECTRIC METER.

SPECIFICATION forming part of Letters Patent No. 598,208, dated February 1, 1898.

Application filed December 30, 1896. Serial No. 617,504. (No model.) Patented in Germany April 12, 1895, No. 84,676; in France December 11, 1895, No. 249,719, and in Austria June 26, 1896, No. 46/2,565.

To all whom it may concern:

Be it known that I, CARL DANIEL RAAB, a subject of the Emperor of Germany, residing at Kaiserslautern, in the Empire of Germany, have made a new and useful Invention in Alternating-Current-Motor Meters, (for which Letters Patent have been granted to me or with my knowledge and consent in the following-named countries: Germany, No. 84,676, dated April 12, 1895; Austria, volume 46, folio 2,565, dated June 26, 1896, and France, No. 249,719, dated December 11, 1895,) of which the following is a specification.

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

Figures 1 and 2 are respectively diagrammatic and plan views illustrating one form of the apparatus. Figs. 3 and 4 are similar views of a modified form. Figs. 5 and 6 are similar views of a third modified form. Fig. 7 is a diagrammatic view of a fourth modified form.

All alternating-current meters provided with an armature in the nature of a rotating metallic body moved by two magnetic fields with displaced phases, the one of which is produced by the current to be measured, the other by a shunt, have the disadvantage that the exactness of their indications are subject to extreme disturbances on account of such difference of phase. Such meters therefore could not be used hitherto for circuits having self-induction or capacity. This drawback would not exist if the phase of the shunt-current would differ by ninety degrees. Such a difference of phase, however, cannot be obtained by a choking-coil alone.

The object of the present invention is to remove this defect by the application of a second shunt without the necessity of displacing up to ninety degrees the phase of the above-named shunt-current.

An arrangement of this kind is shown in Figs. 1 and 2. Two copper disks A and B are attached to an axle C. On opposite sides of disk A are arranged two solenoids F and F′, and on opposite sides of disk B two similar ones E and E′. The solenoids F and E are located in the main circuit. The solenoids F′ and E′ are in the shunt, but each is placed in a primary circuit. An inductive resistance is interposed before coil F′ and a large non-inductive one before coil E′. Further, the pairs F F′ and E E′ of solenoids have different axial positions in order to cause their disks A and B to be put in motion. The damping is effected by a steel magnet D, and the number of revolutions may be read on a dial Z.

If the solenoids F and E are free of self-induction, F has against solenoid F′ a difference of phase of nearly ninety degrees on account of choking-coil G, whereas E against E′ possesses but a very slight difference of phase through the non-inductive resistance T. Thus axle C is only put in rotation by the disk A and the solenoids F and F′, and the second motor will remain inactive. If, however, the phase of the coils F and E is displaced by insertion of arc-lamps or electromotors, the difference of phase between the solenoids F and F′ becomes less and the motor consisting of the latter and disk A turns with less effect. On the other hand, the motor consisting of disk B and the solenoids E and E′ now becomes effective, their phases having grown different from one another. The larger the difference of phase in the main circuit the less effective the motor working disk A and the stronger the one belonging to disk B will become, and when at last through further increase of the self-induction the phase of the main current has reached that of solenoid F′ the performance of the motor-work wholly passes over to that one which belongs to disk B. In this case the proper removal of the influence of self-induction upon the number of revolutions is obtained by bringing the latter pro unit of time to the same amount which the meter possessed when exactly equally loaded with non-self-inductive main circuit. This is performed by regulating the energy of the motor belonging to disk B—for instance, through a suitable choice of the size of resistance T.

As to the quality of two magnetic fields which put a rotatory metallic body in motion, with phases displaced against one another, there are already various arrangements of motors, likewise to be employed for compensating the influence of the difference of phase.

The two motors of the meter in Figs. 1 and 2 represent themselves as such with solenoids free of iron, the axles of which are parallel to one another and vertical to the rotating surface of the moving body. Instead of this one might, for example, apply also the system of Ferraris, according to which the axles of the acting solenoids are crossed and stand vertical to that of the rotating body. Steel magnet D would, however, have to be removed in this case, as it would incorrectly influence the magnetic field of the main current, and the damping would accordingly have to be executed in some other way. Also such motors may be employed for the present purpose that contain in their shunt-field iron, which, besides, possesses the advantage of at the same time effecting the electrodynamic damping. Here also the shunt-field may be provided with iron, which is to have the slightest possible difference of phase against the non-inductive main current.

In the motor constructions of Figs. 1 and 2 it is possible to arrange the pairs F F′ and E E′ of solenoids in connection with a single armature-disk, as its effective force of lines limits itself almost only to those metallic parts which are opposite them in the direction of the axle. The solenoid arrangement may also still be simplified, inasmuch as a solenoid of the main current puts the armature-disk into rotation, on the one part with a non-inductive solenoid, on the other with one whose phase is displaced to about ninety degrees. Such an arrangement, in which accordingly the two motors are united into one, is shown by Figs. 3 and 4. M is a rotatory axled armature-disk, P a damping steel magnet, and Q a dial. G and H are main-current solenoids; J, K, and L shunt-solenoids, K and L of which are, by means of an interposed bifilar resistance, non-inductive, whereas the phase of J is displaced to about ninety degrees by a choke-coil. The inductive and the bifilar resistances are not visible on the drawings, they being already shown in Figs. 1 and 2.

Solenoid K can put armature M into rotation only by aid of coil G and solenoid L only by means of coil H, whereas coil J can act either with G or with H upon disk M. The energy of solenoid J at disposal is accordingly utilized with twice the effect of that of the non-inductive shunt, so that the Ω's resistance of J is the smallest possible, and there so arises in this circuit the strongest possible difference of phase, whereby the consumption of energy by coils K and L is considerably diminished.

Although the pairs K J and L J of the solenoids are situated beside each other, still each of them is exercising a slight torque upon disk M which two, however, are opposite one another. Solenoid K should have fewer windings than solenoid L in order that the torque produced by both L and J shall be larger than that of K and J, so that there is constantly existing in the direction of rotation of the meter, in the sense of the watch-hand, a resting torque just sufficient to compensate the tap friction of the axle.

Figs. 5 and 6 represent the already-mentioned motor construction with iron in the shunt, which is simplified, besides, in the same way as the arrangements of Figs. 3 and 4. The metallic rotating body in this case is a hollow cylinder N, which rotates between the pole ends of the electromagnets R and S. For purposes known a choke-coil V is interposed before the electromagnet S and a large non-inductive resistance W before the electromagnet R. A main-current solenoid Q is placed at an angle of ninety degrees against R and S, opposite cylinder N.

The electromagnets R and S and coil Q induce in the usual way electric currents in cylinder N, in which case Q, by aid of S, as well as that of R, is able to put the armature N into motion. The polarity of the fields of R and S is so chosen that they will work in connection with Q in the same turning direction.

For attaining the compensation of the fault caused by the difference of phase there served hitherto two primary shunt-fields, the one of which differed by about ninety degrees, the other being non-inductive. If the non-inductive field is replaced by a shunt-field with about one hundred and eighty degrees difference, the same effect is obtained. Such a magnetic field, for example, can be produced in the manner that the shunt having a field displaced about ninety degrees induces at the same time also the second shunt. This proceeding is shown in Fig. 7. Disks A and B and axle C are constructed as in Figs. 1 and 2. The solenoids X and Y are passed by the main current, and X′ and Y′ are placed in the shunt. Iron core U is at the same time inductive resistance and transformer. As an inductive resistance U serves, by means of its winding c, to displace the magnetic field of coil X′ about ninety degrees for purposes known. Part of the energy conducted to c is transformed in windings d and lead on to solenoid Y′, whereby the field of the matter is shifted against that of Y by about one hundred and eighty degrees. Thus the motor-work is performed by disk A so long as the circuit of current to be measured is free of self-induction. If the latter appears, coils Y and Y′ will possess less than a difference of phase amounting to one hundred and eighty degrees from one another and will, conjointly with disk B, replace the amount of work less performed by the first motor, and in case of highest difference of phase in X and Y the motor belonging to disk B will do the whole work.

By way of transforming the compensation of the fault caused by self-induction may also be executed through shifting the field of coil Y about three hundred and sixty degrees.

Just as is the case with the meter construction as shown in Fig. 7, also with regard to that in Figs. 3 and 4, the primary auxiliary shunt of coils K and L may be replaced by a secondary auxiliary shunt, which is generated through the circuit of coil I by means of transforming. The same also applies to the windings R and S of Figs. 5 and 6. All in all, the constructions above explained prove that the idea of rendering the type of meters named independent from difference of phase may be carried out after various methods, all of which are distinguished by the fact that in the principal structure the effects described remain as such, and if contained in both motors are united into one.

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

1. A motor-wattmeter for alternating currents provided with one or more metallic rotary armatures acted upon by two sets of magnetic fields having each a difference of current phase, one of said sets being produced by the main or direct current and the other by two shunt-currents, substantially as described.

2. A motor-wattmeter for alternating currents provided with one or more metallic rotary armatures and one or more inducing-coils therefor located in the main circuit, in combination with two additional inducing-coils located each in an independent shunt-circuit and having each a difference of current phase with relation to the first-named coil or coils, together with means connected with the shunt coil or coils for varying the inductive effects in accordance with the current utilized by the translating devices, substantially as described.

3. A motor-wattmeter for alternating currents having one or more rotary metallic armatures carried by a shaft geared to an indicating device, in combination with a number of inducing-coils having their axes in different planes, one set of said coils being located in the main circuit and the others in independent shunt-circuits, all of said coils being located in inductive proximity to said disk or disks, substantially as described.

4. A motor-wattmeter for alternating currents having a pair of metallic armatures secured to a shaft geared to an indicating device, in combination with two pairs of inducing-coils for said armatures, one of said pairs of coils being connected in the main circuit and each coil of the other pair in an independent shunt-circuit, substantially as described.

5. A motor-wattmeter for alternating currents having two rotary armatures provided each with inducing-coils of different phase, one pair of said coils being connected to the main circuit, and each coil of the other pair to an independent shunt-circuit in such manner that any variation in the current utilized by the translating devices shifts the load relatively upon the two armatures in such manner as to cause the indicator of the meter to indicate correctly the current actually used by said translating devices, substantially as described.

In witness whereof I have hereunto set my hand in presence of two witnesses.

CARL DANIEL RAAB.

Witnesses:
JAKOB BIERLEIN,
OSCAR BOCK.