(No Model.)

4 Sheets—Sheet 1.

C. ERBEN.

ELECTRIC METER.

No. 573,082. Patented Dec. 15, 1896.

Fig. 1.

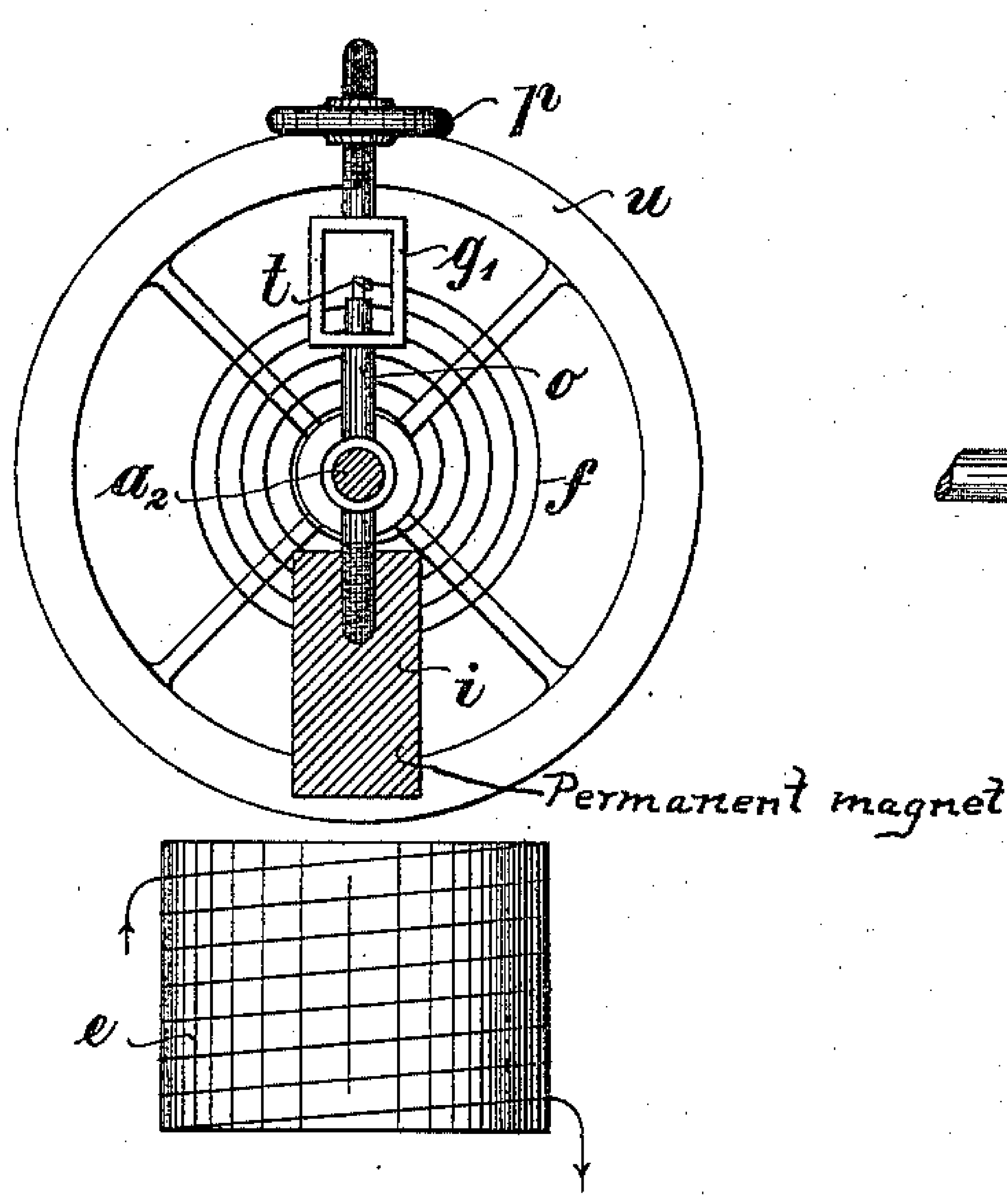
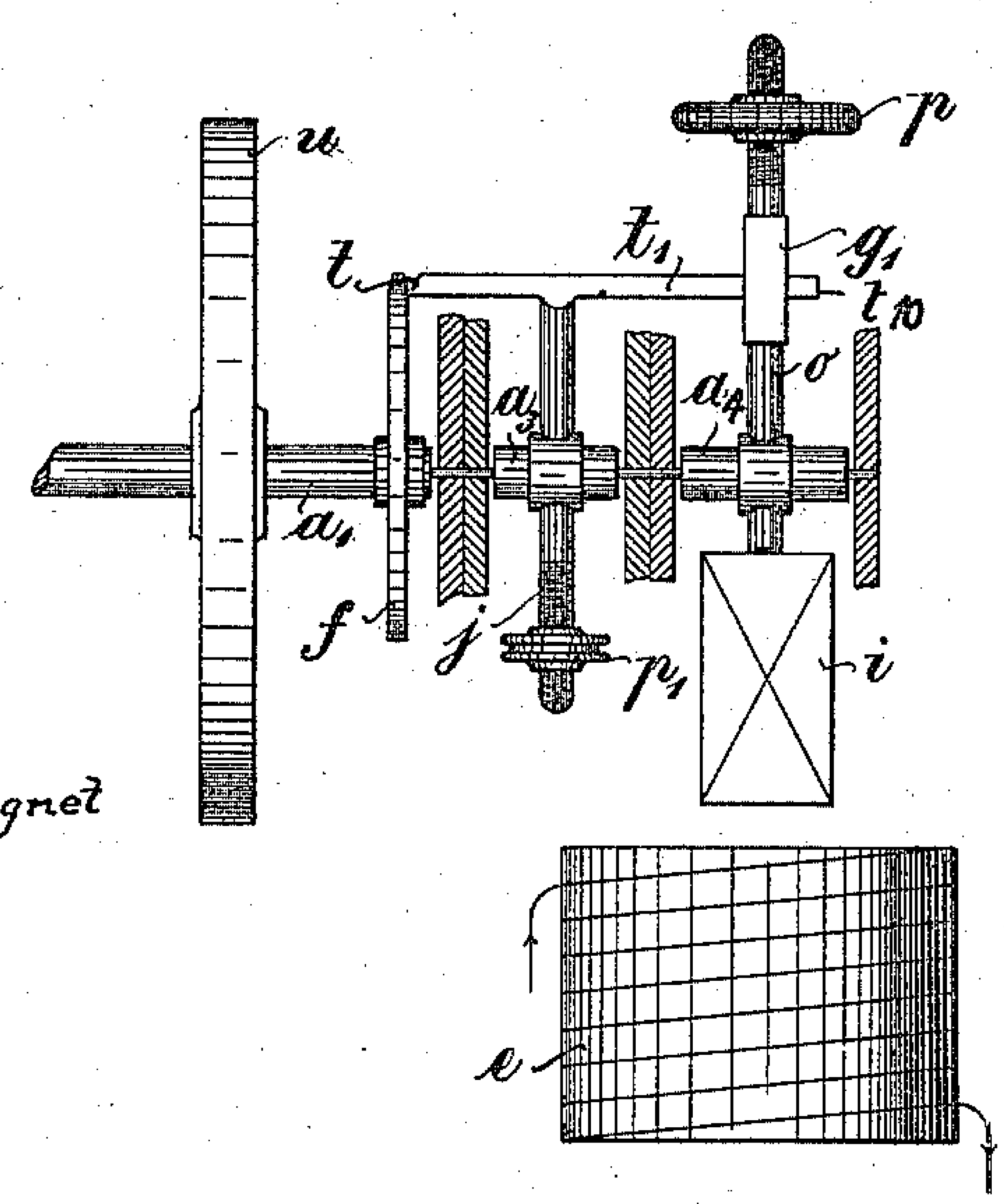


Fig. 2.



Witnesses.

Inventor.

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(No Model.)

4 Sheets—Sheet 2.

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Fig. 3.

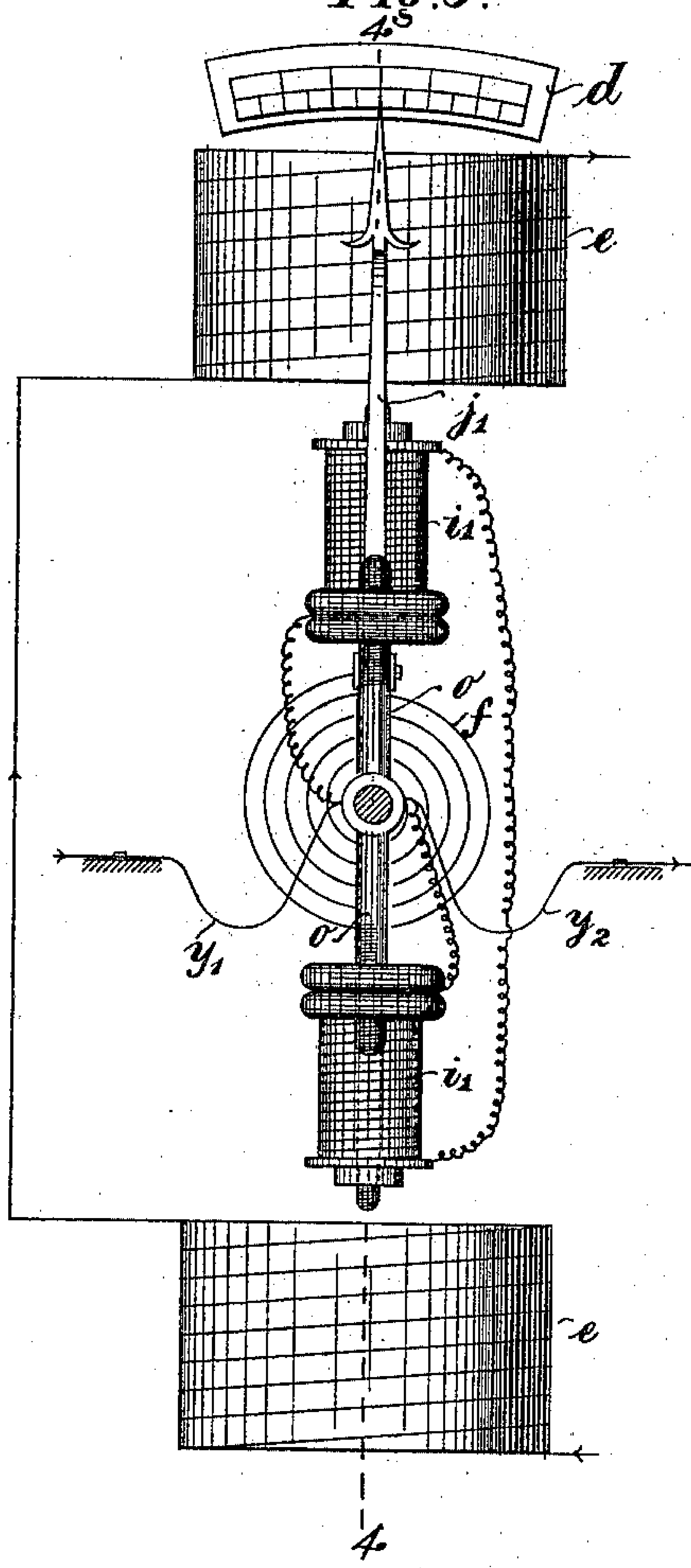


Fig. 4.

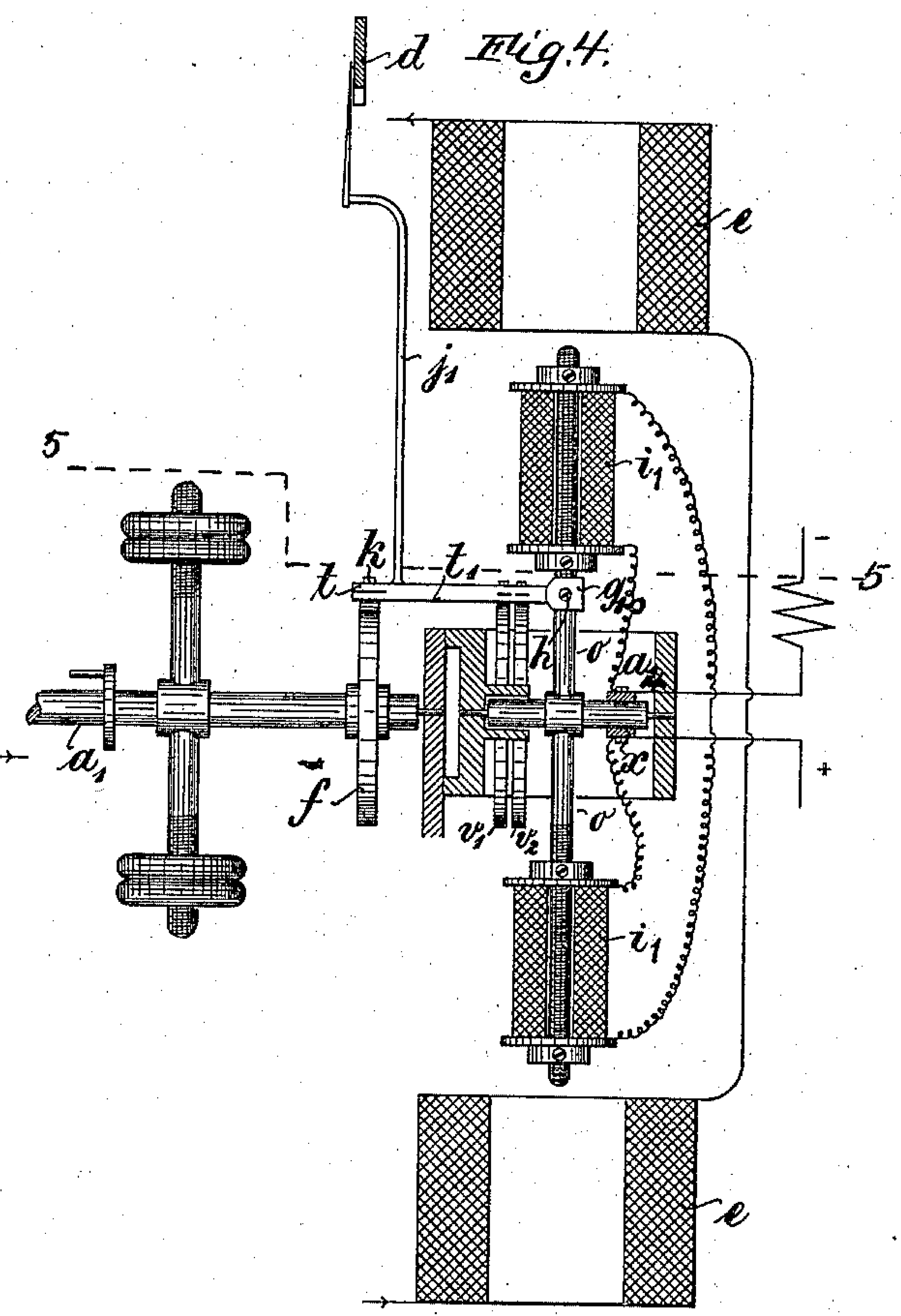
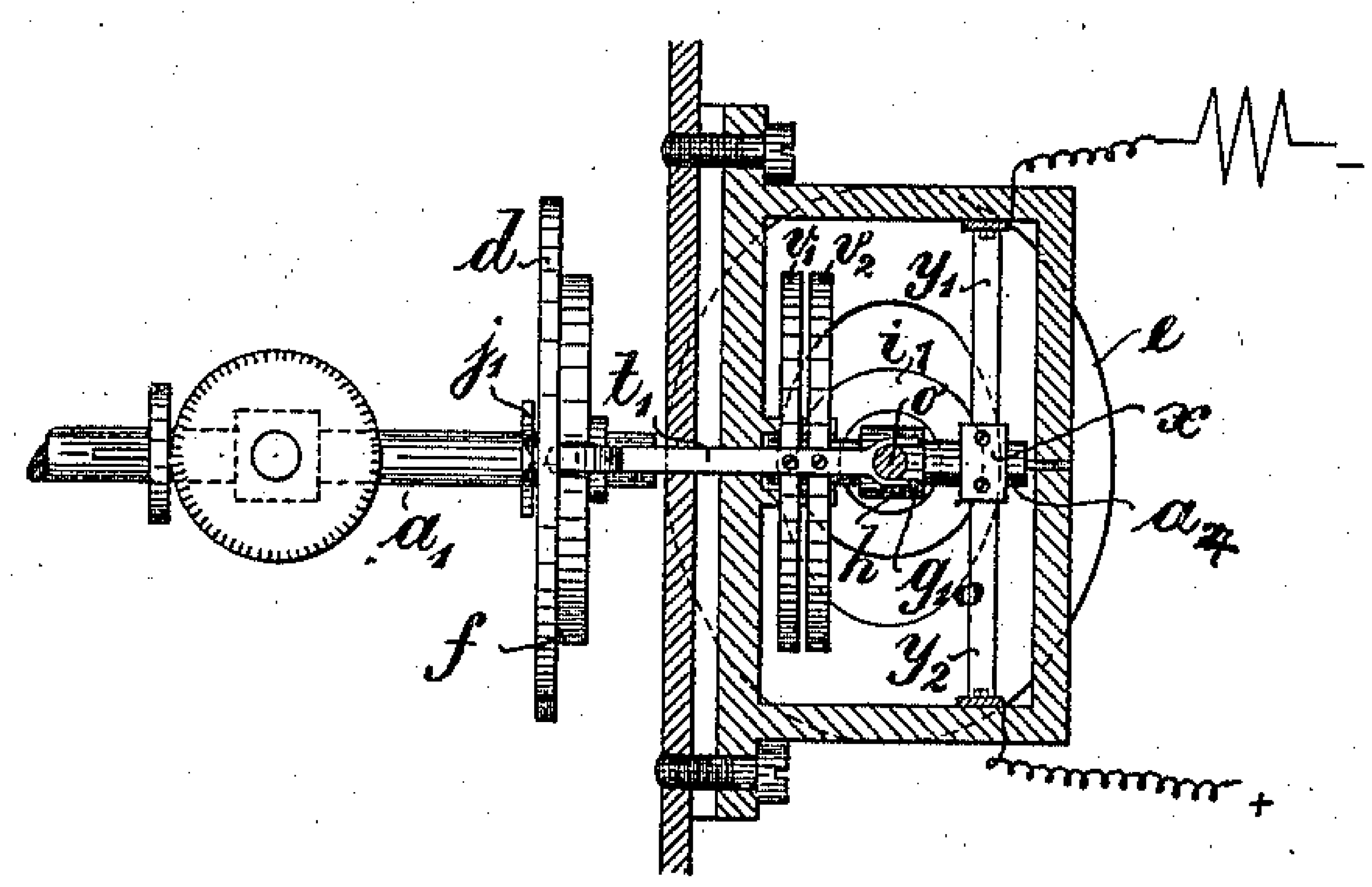


Fig. 5.



Witnesses.

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Fig. 8.

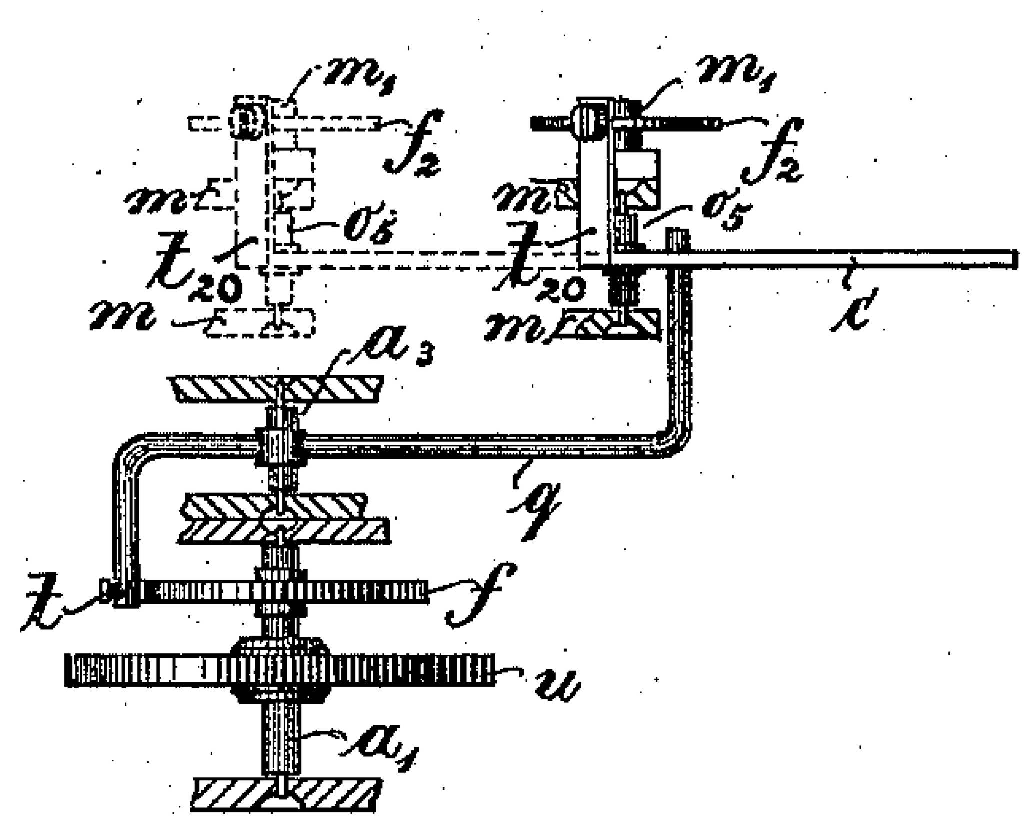
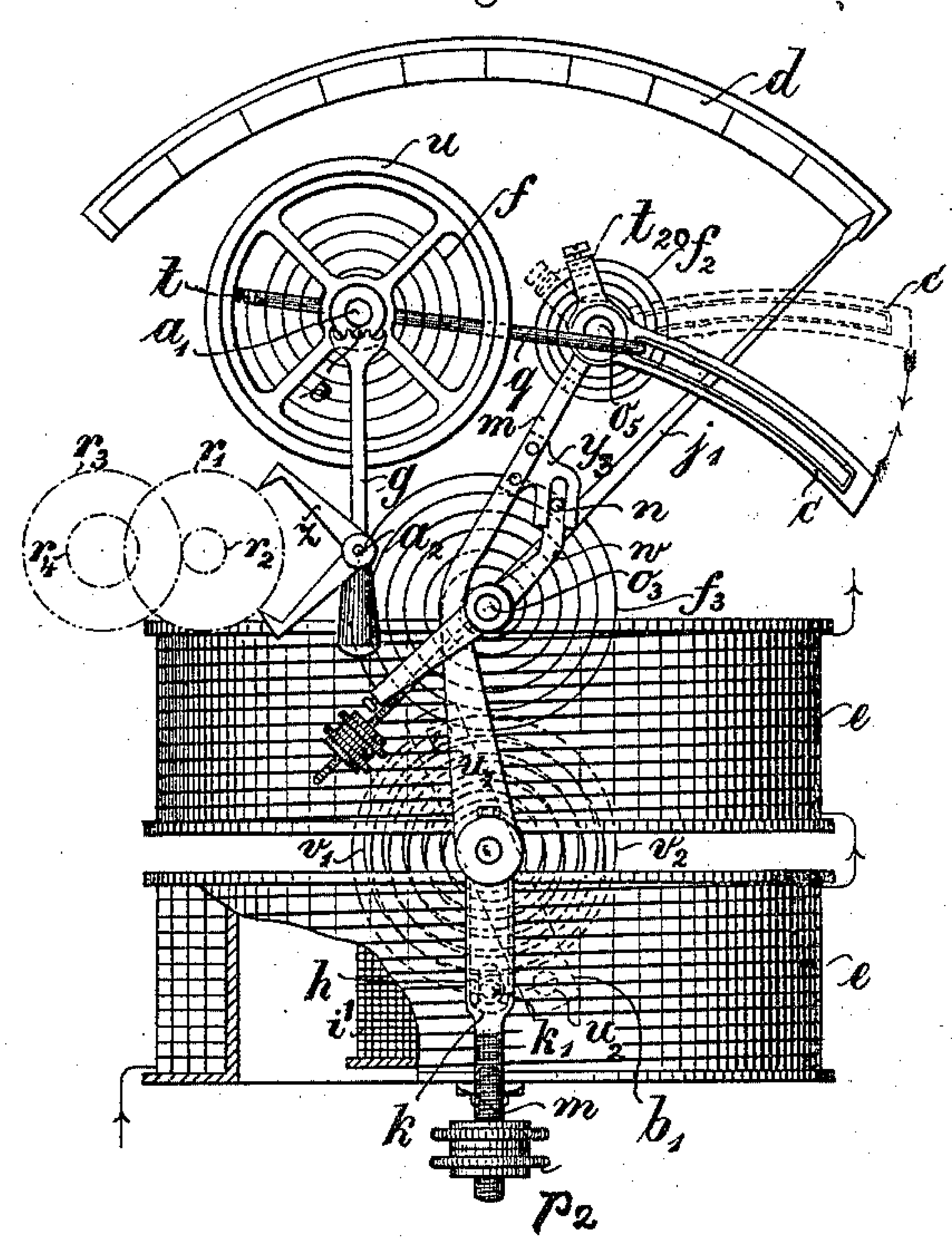


Fig. 6.



Witnesses.

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(No Model.)

4 Sheets—Sheet 4.

C. ERBEN.
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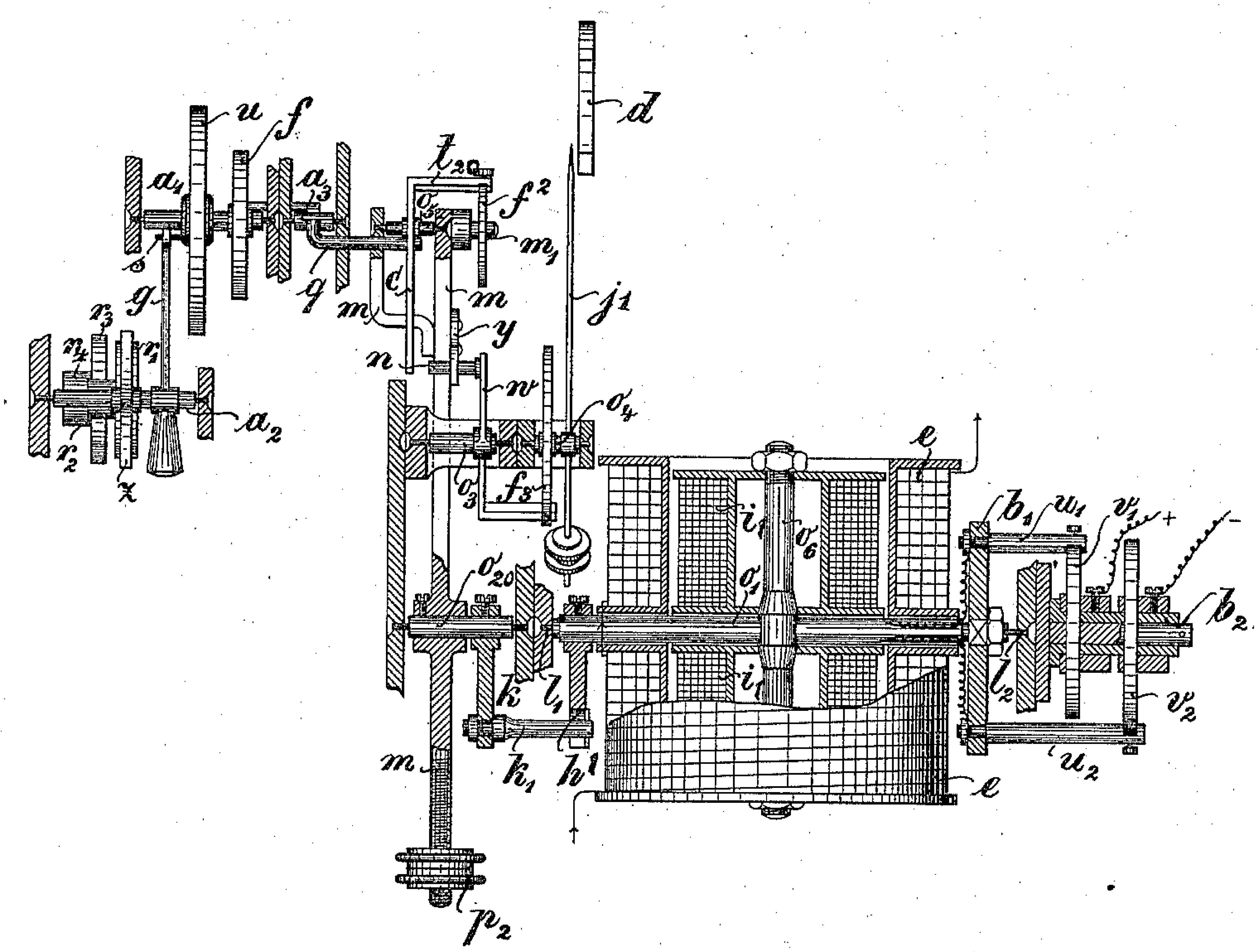
Fig. 7.



Witnesses.

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Carl Erben

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Attorney.

United States Patent Office.

CARL ERBEN, OF BERLIN, GERMANY, ASSIGNOR TO EMANUEL BERGMANN, OF SAME PLACE.

ELECTRIC METER.

SPECIFICATION forming part of Letters Patent No. 573,082, dated December 15, 1896.

Application filed October 10, 1895. Serial No. 565,255. (No model.) Patented in Germany June 21, 1892, No. 80,299; in Austria-Hungary November 6, 1893, No. 60,660 and No. 95,352; in England November 9, 1893, No. 21,327; in France November 11, 1893, No. 233,983; in Belgium November 13, 1893, No. 107,145, and in Switzerland February 21, 1894, No. 8,124.

To all whom it may concern:

Be it known that I, CARL ERBEN, a subject of the King of Prussia, German Emperor, residing at Berlin, in the Kingdom of Prussia, in the German Empire, have invented certain new and useful Improvements in Electric Meters, (for which Letters Patent have been granted to me jointly with another in Germany, No. 80,299, dated June 21, 1892; in Austria-Hungary, No. 60,660 and No. 95,352, dated November 6, 1893; in England, No. 21,327, dated November 9, 1893; in France, No. 233,983, dated November 11, 1893; in Belgium, No. 107,145, dated November 13, 1894; in Switzerland, No. 8,124, dated February 21, 1893, and in France, additional patent, dated March 30, 1895,) of which the following is a specification.

The electric meter which is the object of the present invention is based upon the principle that the passage of the electric current may influence magnets or solenoids in such a way as to transfer an equivalent influence upon the speed-regulating mechanism of a clockwork, so that such clockwork may be caused to move quicker or slower, as the case may be, in order that by a comparison between the indications of this clockwork and those given by a normal clockwork not influenced as aforesaid a measurement of the current that has passed through the meter may be obtained.

This invention is illustrated in the annexed drawings, in which—

Figures 1 and 2, Sheet 1, are elevations at right angles to one another, showing the balance-wheel of a clockwork and the means for influencing it, as above described. Fig. 3, Sheet 2, is an elevation, Fig. 4 a section on line 4 4, Fig. 3, and Fig. 5 a section on line 5 5 in Fig. 4, showing another form of such mechanism. Fig. 6, Sheet 3, is an elevation, Fig. 7, Sheet 4, is an elevational section, and Fig. 8, Sheet 3, a detail view in plan, showing a further modification, the Figs. 6 to 8 also showing the clockwork, which is the same for all the modifications.

Referring more particularly to Fig. 7, the clockwork which is to be influenced in the manner described comprises the spring-barrel r^4, the wheel-train r^3 r^2, and the escapement-wheel r', with the teeth of which the anchor-escapement z coöperates in the usual manner, a^2 being its shaft and g the forked arm thereon, engaging with pin s on the balance-wheel u, as is usual with this form of escapement.

Reverting now to Figs. 1 and 2, f is the balance-spring, the inner end of which is attached to the shaft of balance-wheel u. Its outer end is connected to one end of a rod t', which forms a cross-head to the arm which radiates from the shaft a^3, the axis of which lies in prolongation of the axis of shaft a'. The rod t' is thus enabled to move in an arc of a circle about the axis of shafts a' a^3, while maintaining its parallelism with said axis. Thus movement of one end, t, of rod t' is accompanied by equal and simultaneous movement of the other end, t^{10}, and whatever restraint is given to end t^{10} is equally represented at end t. The end t^{10} projects through a quadrilateral frame g', carried by an arm o on a shaft a^4, the axis of which is preferably in prolongation of that of shafts a' a^3. On the other side of shaft a^4 the arm o carries a permanent magnet i, to be influenced by the bobbin e, through which the current is to be passed. The weight of rod t' and its arm may be exactly counterbalanced by a screw-threaded weight p' on the screw-threaded arm j, which projects from shaft a^3 diametrically opposite to the arm carrying rod t'. The movement of the magnet i may also be adjusted—that is to say, increased or diminished in effect—by adjustment of a screw-threaded counterweight p on a screw-threaded projection of arm o beyond the frame g'.

The action of the clockwork causes a tendency to be given to the outer end of spring f to oscillate, and this movement is transferred to rod t' and to the parts g' o i p. So long as no current is passing, this oscillation has only to overcome the inertia of these parts, which may be regulated by adjustment of screw-weight p so as to oppose the oscillation to some extent. The vibrations of the balance-spring f are then at their slowest, and the clock consequently moves at its slowest rate. When current passes through bobbin e, the magnet i is attracted and a greater resistance or smaller limits given to the oscillation of rod t'. The vibrations of spring f are thus proportionately accelerated and the clock moves quicker. The stronger the current the greater is the resistance and stability given to rod t' and the quicker the movement of the balance-spring f and of the clock.

The modification shown in Figs. 3 to 5 differs from the above in the following particulars: In place of a magnet i acting as a pendulum the arms o carry solenoids i' i', balancing each other and brought within the field of the two fixed bobbins e e, traversed by the current. Current is supplied to the solenoids i' i' by means of two elastic and flexible bands y' y^2 of silver-foil or other suitable conductive material, which are attached one on each side of the insulating-block x on the axle a^4, whence wires carry the current to the solenoids. The rod t' is not carried by a special arm and shaft, but is fixed to the arm o, which it embraces with its forked end g^{10}, the arm o being secured by set-screw h. The arm o therefore serves to hold rod t'. The action of spring f seeks to oscillate the pair of solenoids, while the current passing through coils e e tends to restrain such movement in proportion to its strength. By adding to rod t' an indicator j' and placing in relation to the latter a fixed scale d the intensity of the current prevailing at the moment of observation may be observed from the amplitude of the oscillations of the indicator j'. To prevent excessive amplitude of oscillation and afford means for regulation, the oscillations of rod t' may be controlled by two spiral springs v' v^2, equal in power but contrary in the application of their force to the rod t', their inner ends being attached to the framework and their outer ends to the rod t'. These springs give a counter tension to the oscillations of rod t' and its attendant parts, and by giving greater or less tension to these springs the oscillations may be controlled in a suitable degree exactly as in the previously-described modification the moment of pendulum-magnet i was rendered adjustable for the same purpose—that is to say, to adjust the time gain of the clock in proportion to the electric current.

In the modification shown in Figs. 6 to 8 the meter is so constructed that the limiting of the oscillations of the free end of the balance-spring is performed by an angle or forked piece of mechanism rotarily supported by a counter-spring. By thus cushioning the resistance the action is easier and expenditure of force less. In this example the solenoids i' are mounted upon their carrier o' in such a way in relation to the bobbins e e that they oscillate on an axis longitudinally central with carrier o', which therefore becomes their axle and is carried in bearings l' l^2. The balancing-springs v' v^2, which control the oscillations of the solenoids, are here applied as shown in Fig. 7, being mounted on insulating-blocks b^2 and connected severally by rods u' u^2 with a disk b' on the shaft o'. The springs v' v^2 also here serve as conductors for the current to the solenoids. The movement of shaft o' is transferred by crank h' and pin k' to shaft o^{20}, on which is a lever m, one end of which carries a balance-weight p^2, while the other end serves as a bearing for a shaft o^5, on which oscillates an angularly-bent plate t^{20}, of which one arm is elongated at c to form a slotted lever, Fig. 6, while the other angularly-bent arm engages the outer end of a spiral spring f^2, the inner end of which is secured to a pin m' at the end of lever m. The balance-spring f has its outer end secured to an arm t of shaft a^3, which has also an arm q, engaging in the slotted lever c aforesaid. The operation of this construction is as follows: The position of the solenoids i' governs that of the lever m, so that the shaft o^5 is moved more or less to the left of the position shown in Fig. 6. The arm q thus engages in the slot of lever c at a point more or less removed from the axle o^5, and consequently the counter-spring f^2 has more or less restraining force on the oscillations of the arm q, according as the point of engagement of the latter varies in its distance from the center o^5, on which the lever c, governed by spring f^2, rocks. As this distance is governed by the position of lever m, that is to say, by the force of current passing through coils e, the oscillations of arm q are restrained with more or less power, according to the force of the current, while the solenoids are, however, in this construction outside the counter influence of the clock. Resistance to arm q is equivalent to resistance to arm t', that is to say, to the free end of spring f. The indicator j' is here operated by the spring f^3, controlled by an arm of shaft o^3, the latter having an arm w with a pin n, engaging in a fork y on the lever m.

Having now described my invention, I claim—

1. In an electric meter; the combination with the oscillatory balance spiral spring of a clockwork of an arm secured to said spiral spring, movable abutments for said arm and magnets adapted to be influenced by the current to be measured for the movement of said abutments into such position that they limit the free space for the oscillations of the said balance-spring substantially for the purpose set forth.

2. The combination with the oscillatory balance spiral spring of a clockwork, of a second counter-spring connected with the balance-spring by a lever-arm, and magnets adapted to be influenced by the current to be measured adapted to control the operative length of said lever-arm and thus adjust the

counter action of the second spring upon the first substantially as and for the purpose set forth.

3. The combination of an oscillatory balance-spring of a clockwork with a counter-spring connected to its outer end magnets, and means for causing the magnets to control the arc of oscillation of such counter-spring for the purpose set forth.

4. The combination of the balance-spring of a clockwork and an arm attached to said spring, of a scale, a pointer adapted to be moved before said scale, magnets adapted to be influenced by the current to be measured means for causing the magnets to control the arc of oscillation of said balance-spring and means for connecting said magnets with the pointer for the purpose set forth.

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

CARL ERBEN.

Witnesses:
W. HAUPT,
CHAS. H. DAY.