(No Model.)

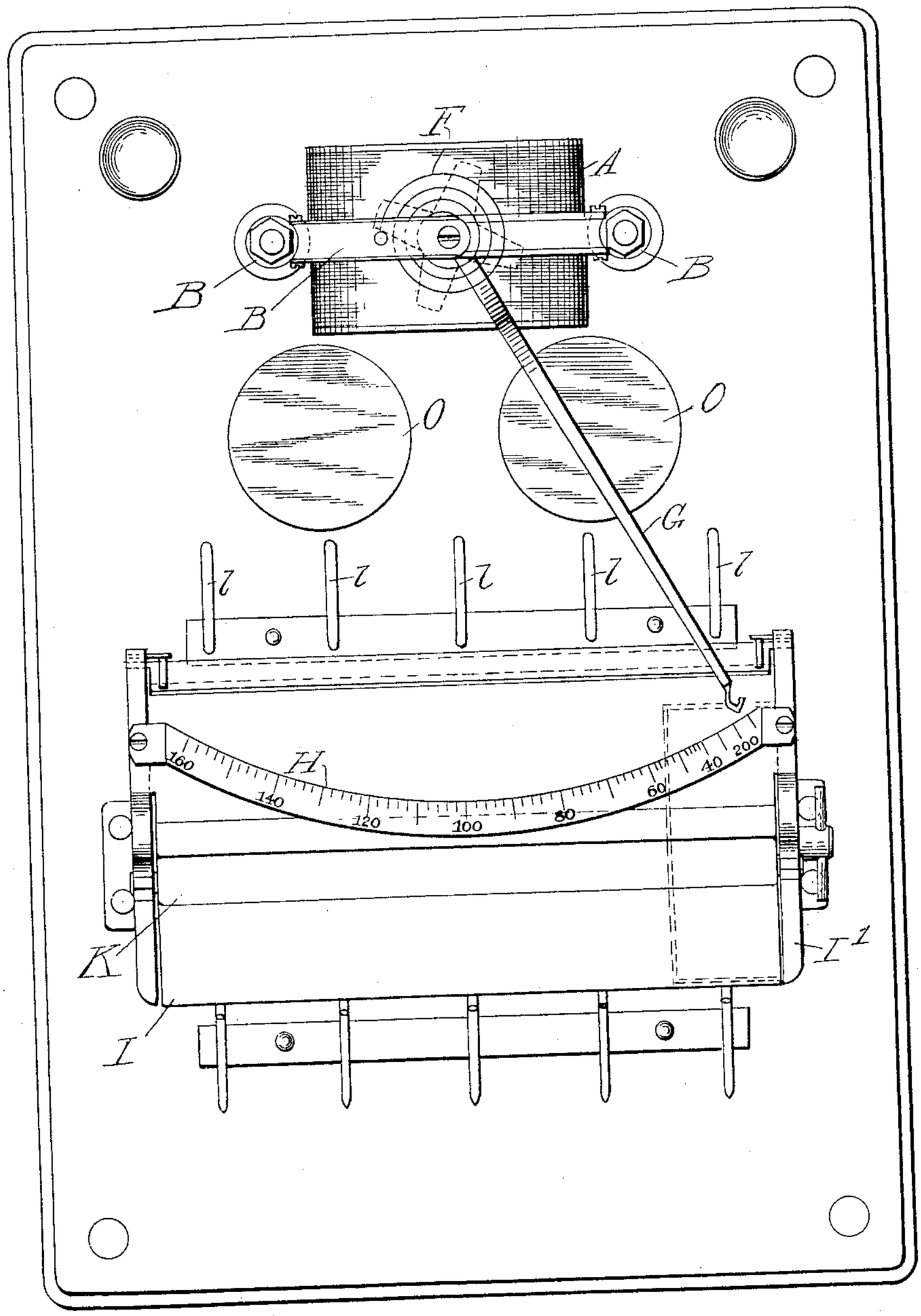
7 Sheets—Sheet 1.

E. J. KING.

ELECTRIC METER.

No. 588,999. Patented Aug. 31, 1897.

Fig. 1.



Witnesses:
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Albert K. Williams Jr.

Inventor:
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by. Carter & Graves
his Attorneys.

(No Model.) 7 Sheets—Sheet 2.

E. J. KING.

ELECTRIC METER.

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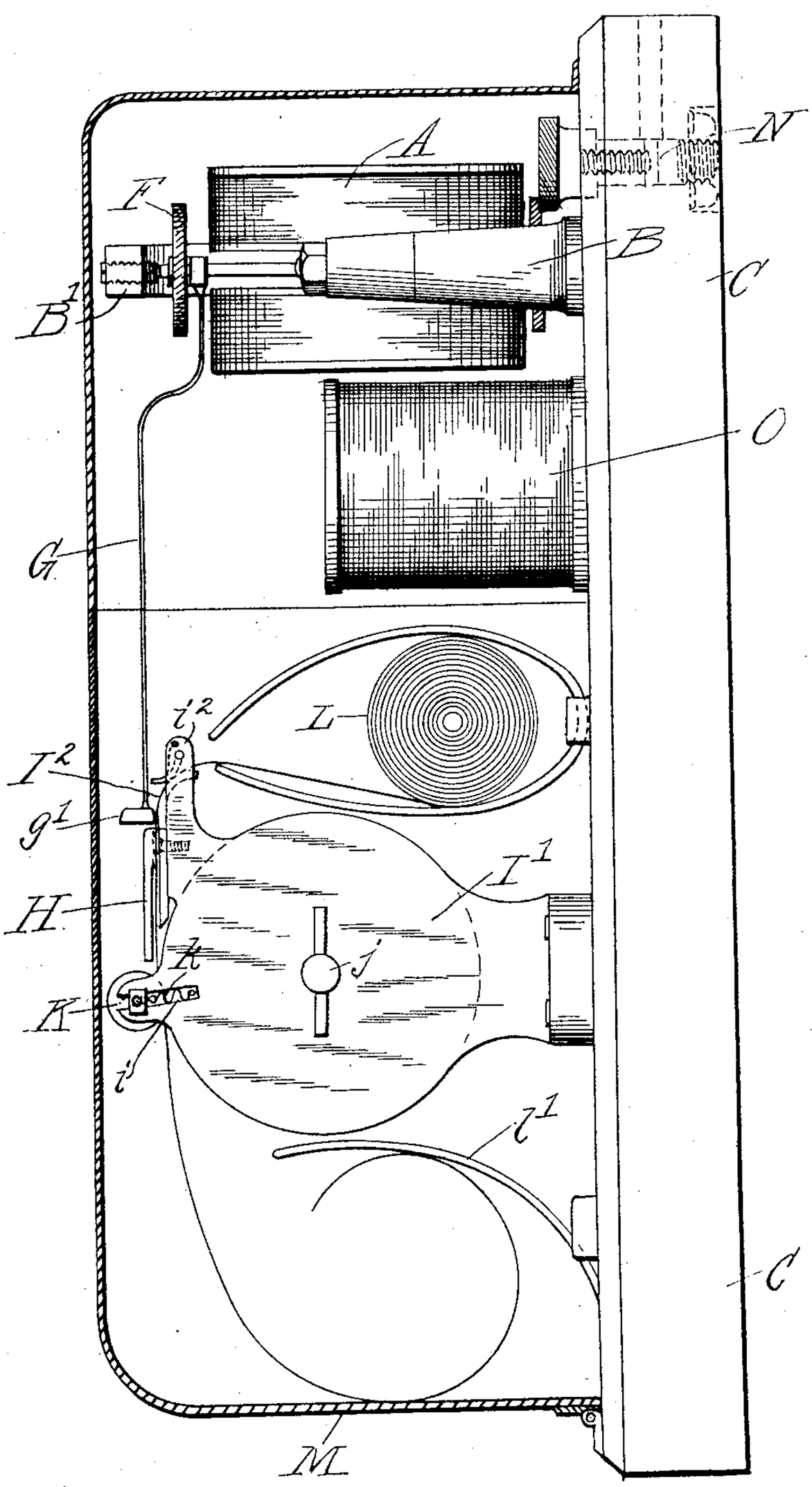
Fig. 2.



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(No Model.) 7 Sheets—Sheet 3.

E. J. KING.

ELECTRIC METER.

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Fig. 3.

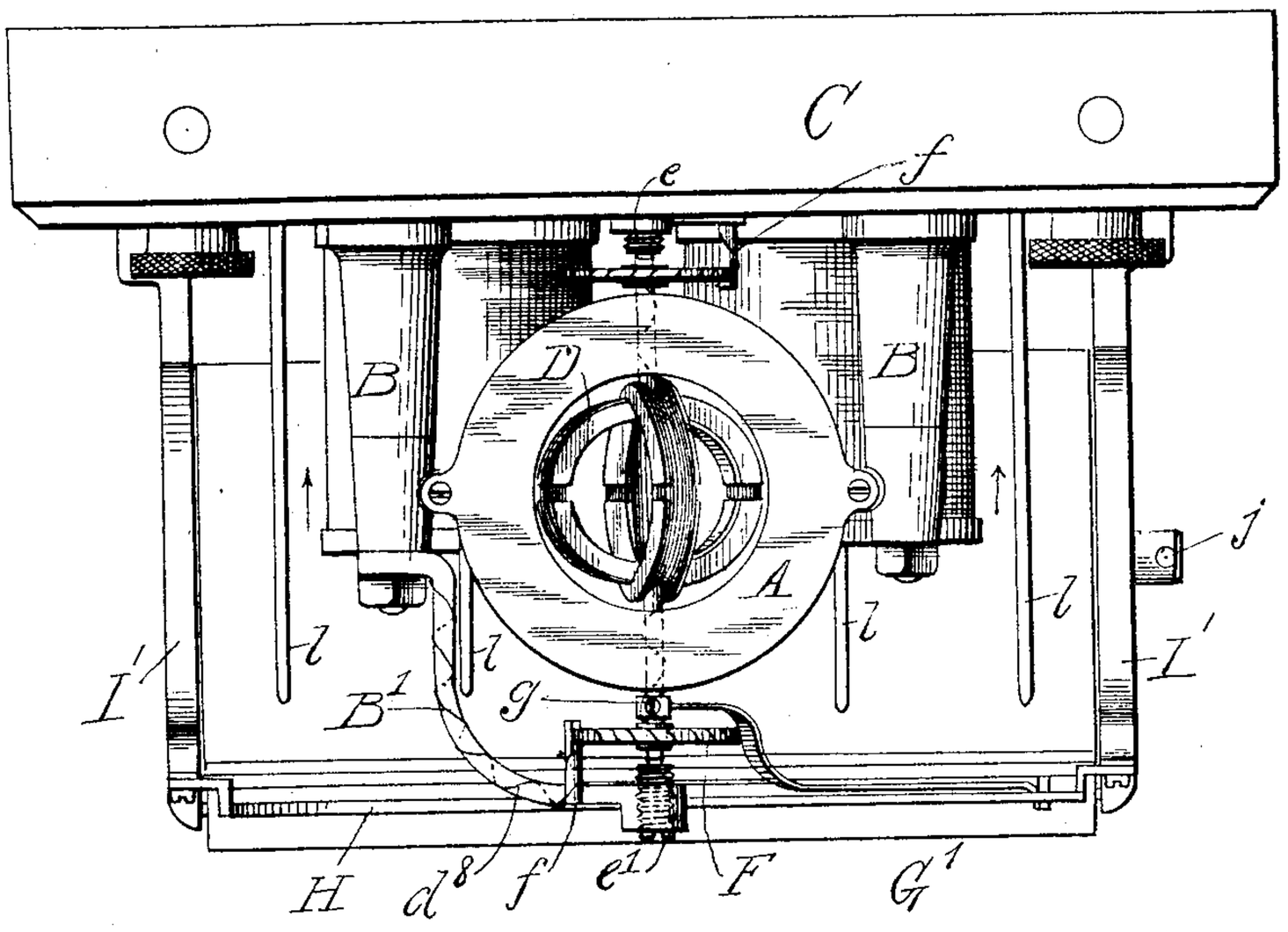


Fig. 3a.

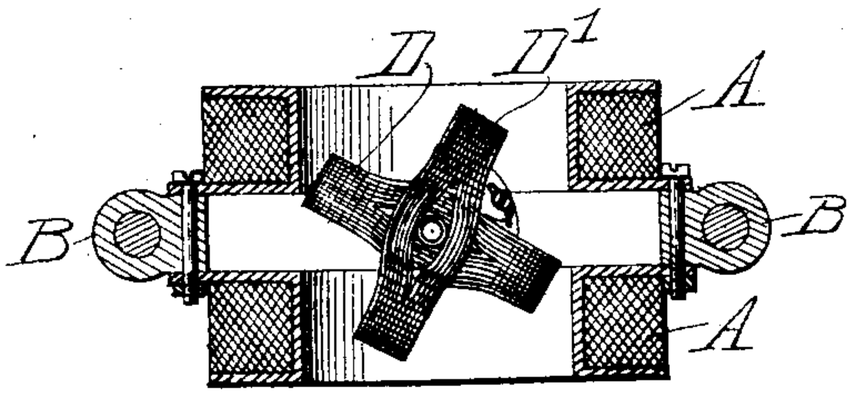


Fig. 3b.

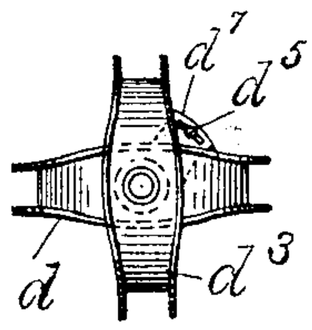
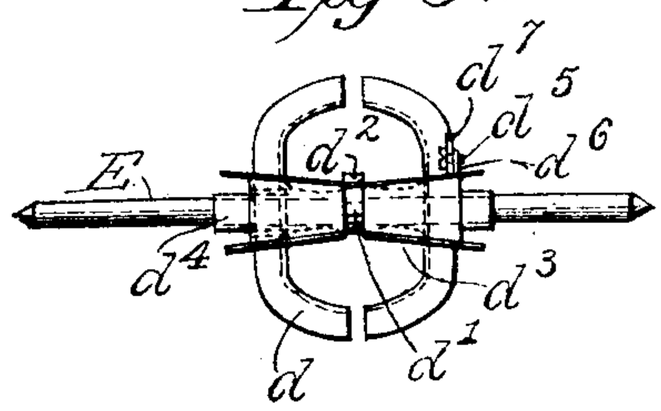


Fig 3c.



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(No Model.)

7 Sheets—Sheet 4.

E. J. KING.

ELECTRIC METER.

No. 588,999. Patented Aug. 31, 1897.

Fig. 4

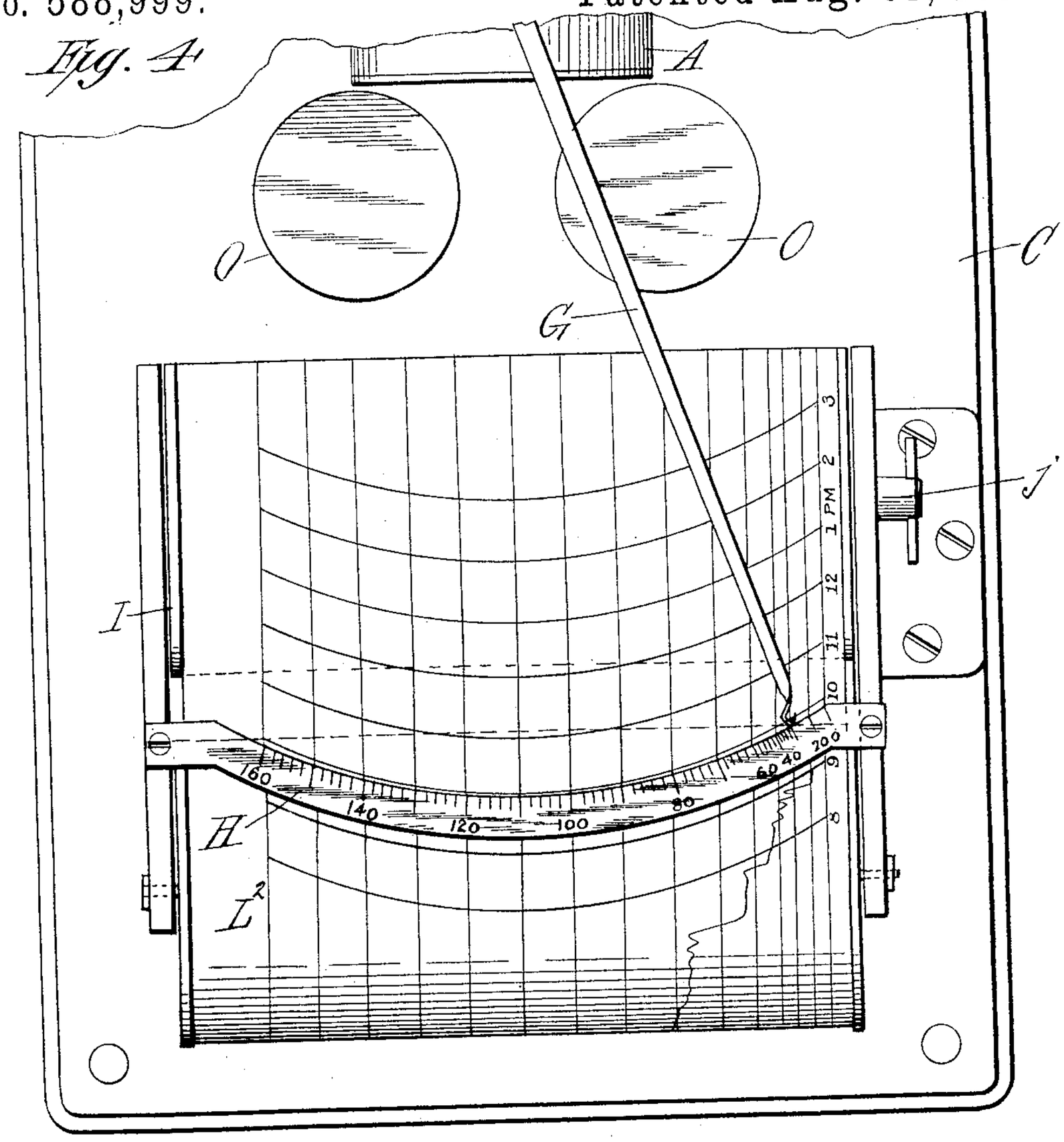
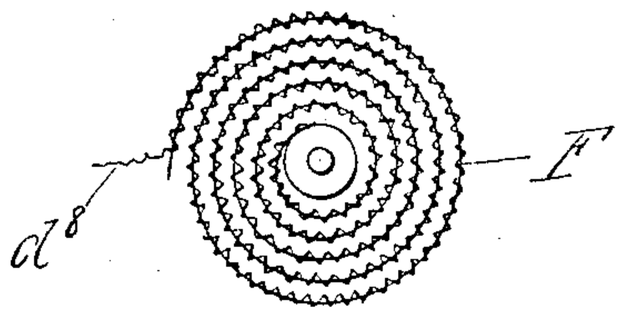


Fig. 5



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(No Model.) 7 Sheets—Sheet 5.

E. J. KING.

ELECTRIC METER.

No. 588,999. Patented Aug. 31, 1897.

Fig. 6

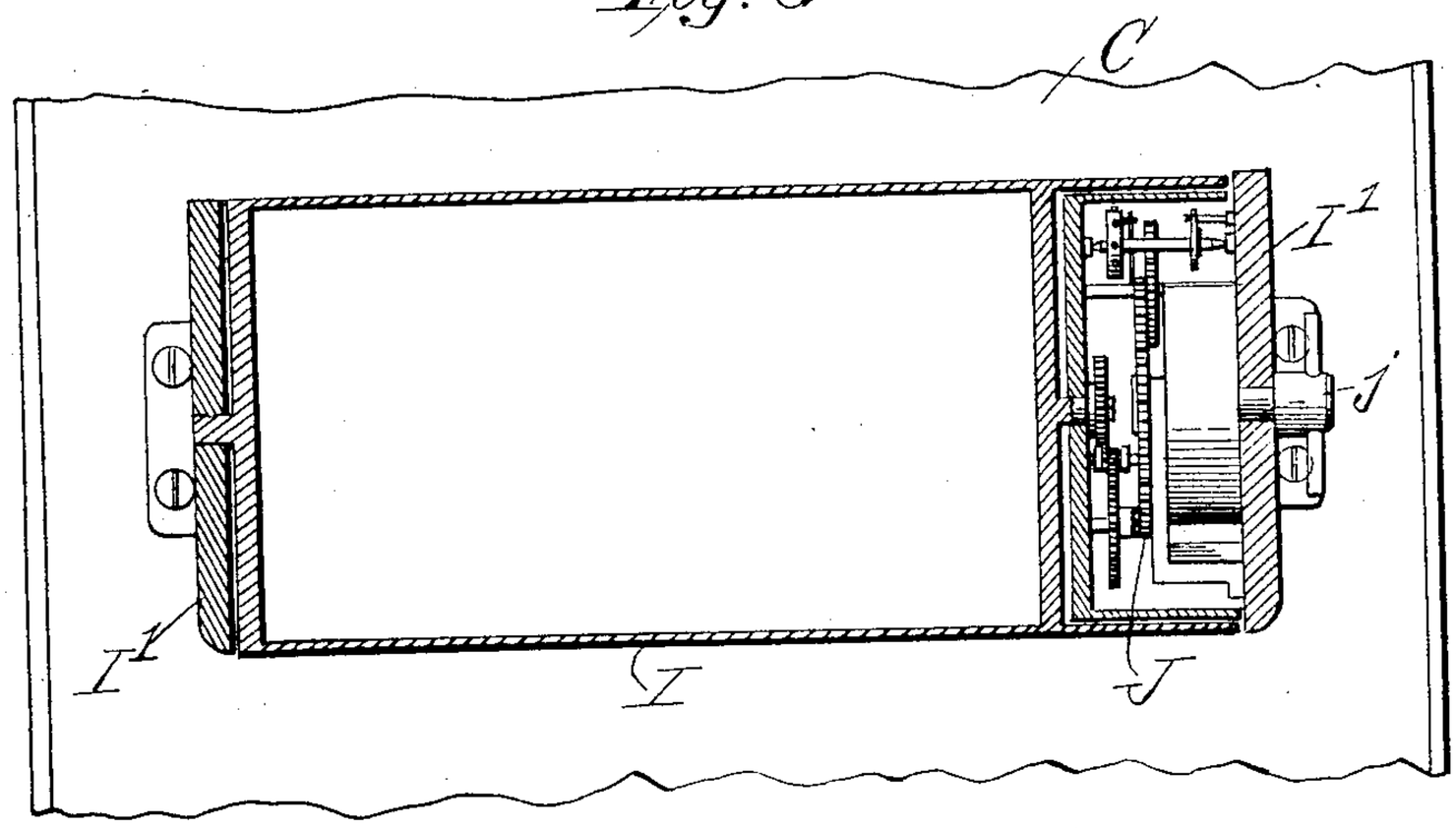
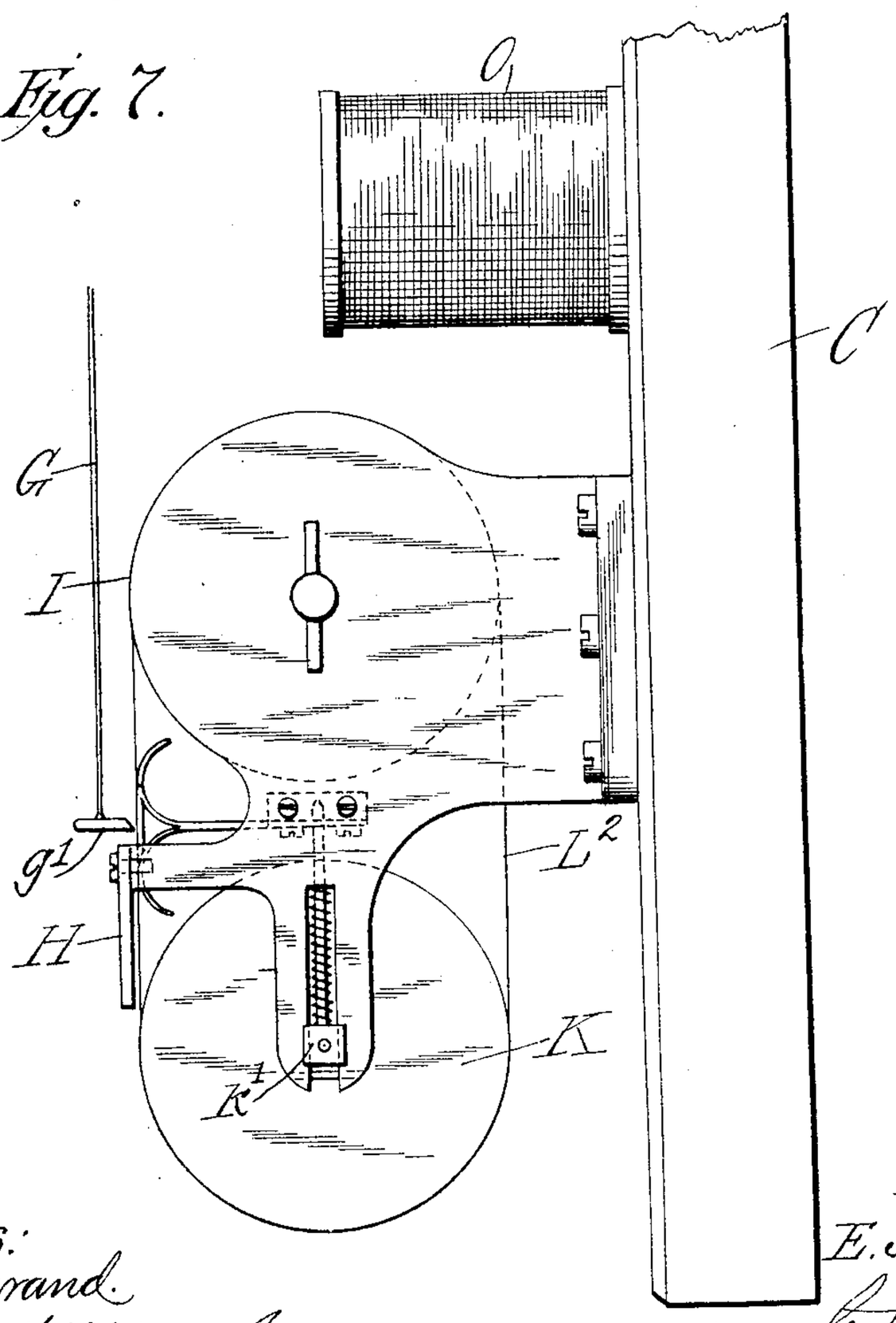


Fig. 7.



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7 Sheets—Sheet 6.

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ELECTRIC METER.

No. 588,999. Patented Aug. 31, 1897.

Fig. 8

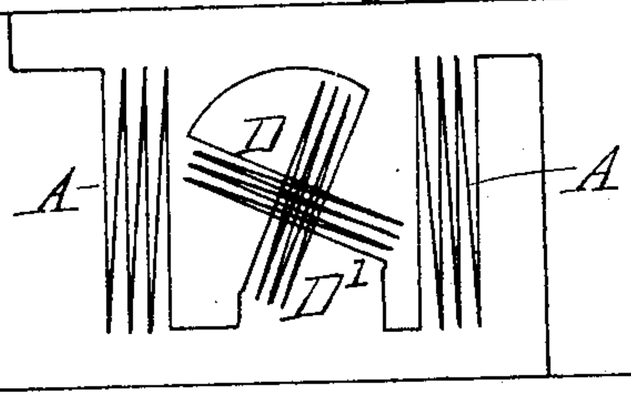


Fig. 8a

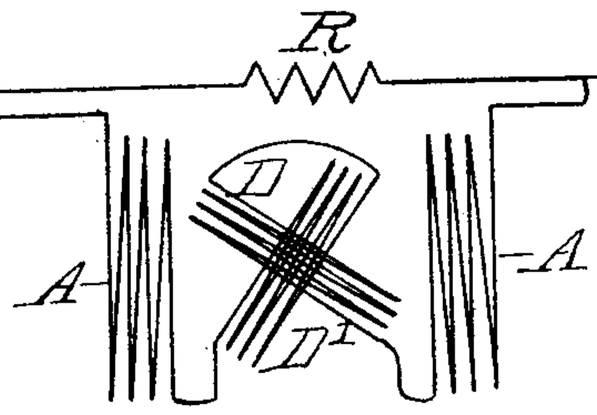


Fig. 9

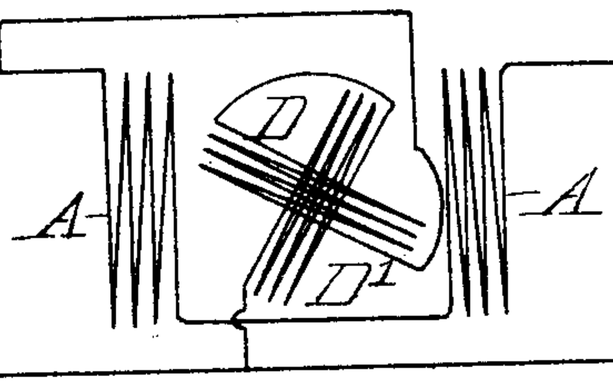
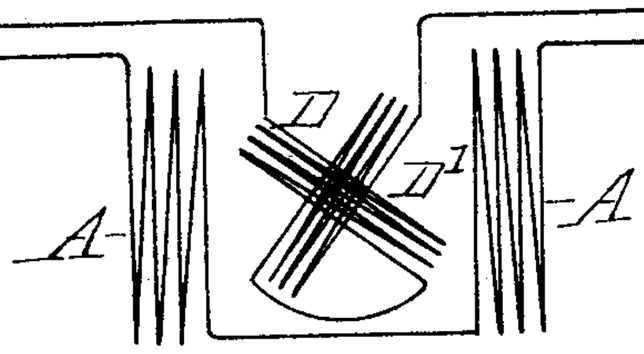


Fig. 10



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(No Model.) 7 Sheets—Sheet 7.

E. J. KING.

ELECTRIC METER.

No. 588,999. Patented Aug. 31, 1897.

Fig. 11.

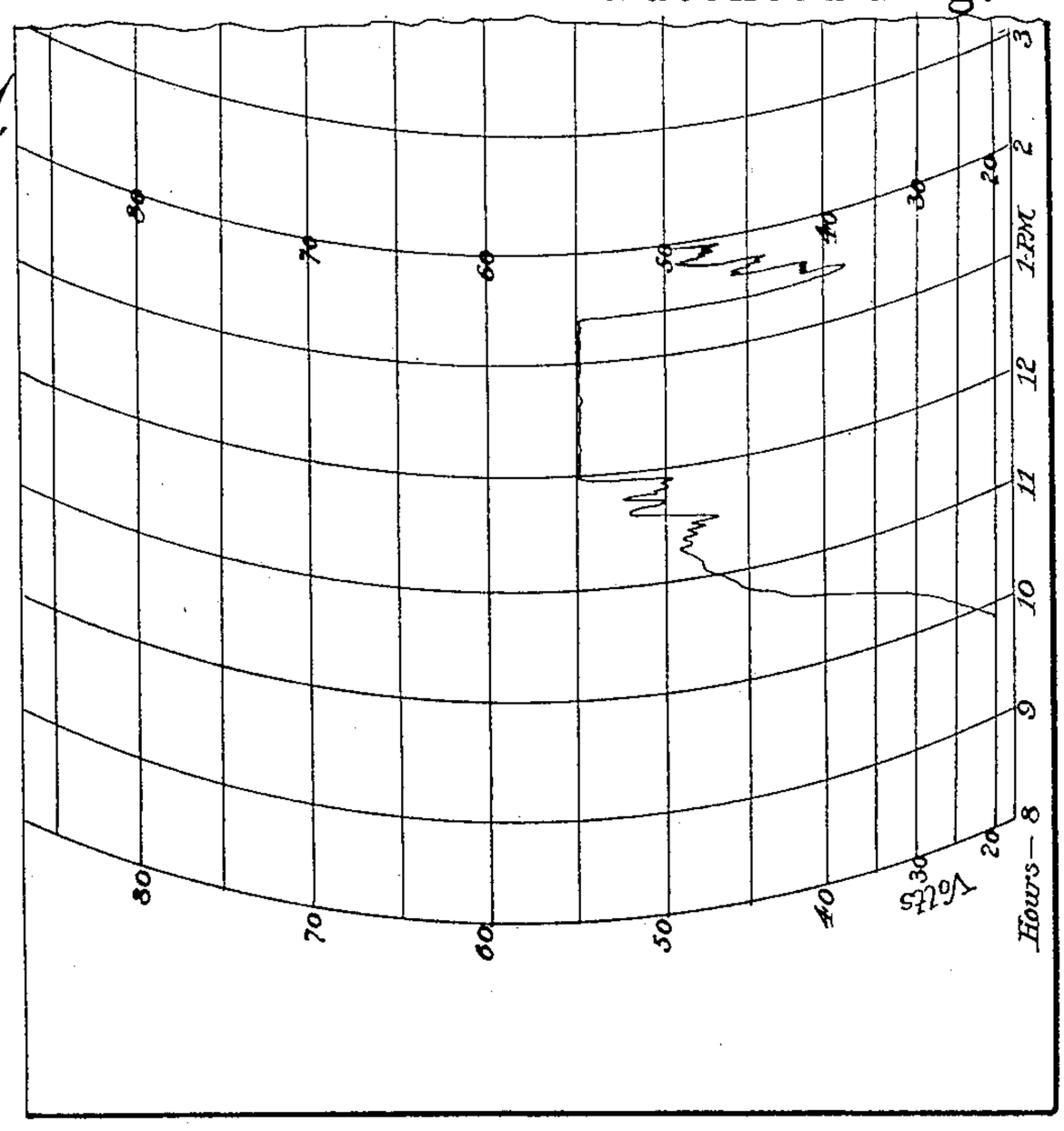


Fig. 12.

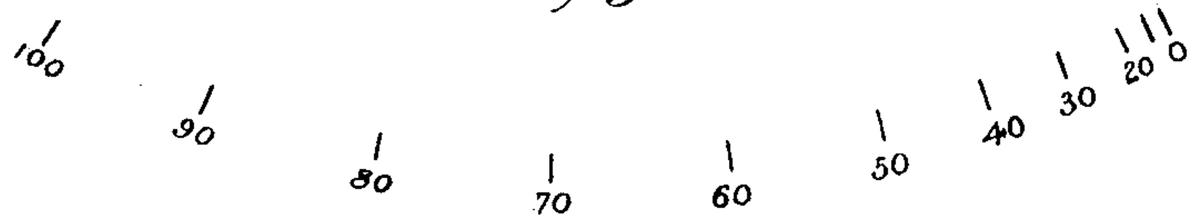
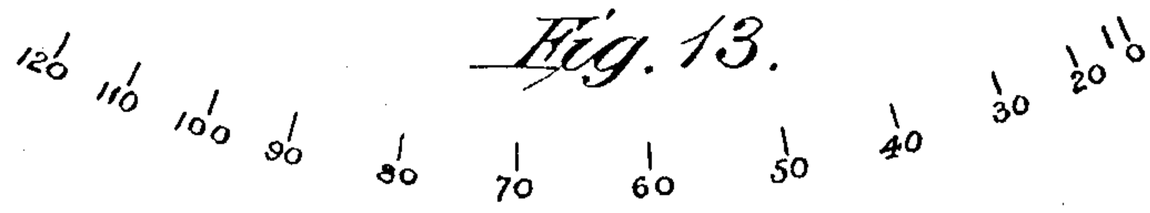


Fig. 13.



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UNITED STATES PATENT OFFICE.

ELTON JACOB KING, OF FORT WAYNE, INDIANA.

ELECTRIC METER.

SPECIFICATION forming part of Letters Patent No. 588,999, dated August 31, 1897.

Application filed May 1, 1897. Serial No. 634,673. (No model.)

To all whom it may concern:

Be it known that I, ELTON JACOB KING, of Fort Wayne, in the county of Allen and State of Indiana, have invented certain new and useful Improvements in Electric Meters, of which the following is a specification.

This invention relates to electric meters of that class in which the torque of a coil pivotally mounted within a magnetic field acts in opposition to a yielding or spring resistance to produce a movement which is greater or less, according to the amount of current, pressure, or energy passing in the circuit in which the instrument is connected. Meters of this type may be either simple indicating instruments or may be also provided with recording mechanism, and they may be used for either direct or alternating currents. The meter shown in this instance as illustrating one embodiment of my invention is of the recording variety, and the present improvements embrace some features of connection peculiar to recording instruments, as well as broader features of improvement which are generic to the entire class.

The object of the invention is to provide a superior instrument of the class referred to; and it consists in the matters herein set forth, and particularly pointed out in the appended claims.

In the accompanying drawings, Figure 1 is a front elevation of a recording-voltmeter constructed in accordance with my improvements, with the closing case or cover omitted. Fig. 2 is a sectional side elevation thereof; Fig. 3, the top plan view of the meter. Fig. 3^a is a sectional detail taken transversely through the field-coils. Fig. 3^b is a detailed end elevation of the spiders upon which the movable coils are wound. Fig. 3^c is a detailed side elevation of the spiders and supporting-spindle. Fig. 4 is a front elevation of a somewhat modified form of recording device. Fig. 5 is a detail of one of the spiral springs, showing the manner in which the connecting-wires to the movable coils are carried by the spring. Fig. 6 is a transverse sectional elevation of the actuating-cylinder of the recording mechanism. Fig. 7 is a side elevation of the modified form of recording mechanism shown in front elevation in Fig. 4. Figs. 8, 8^a, 9, and 10 are diagrammatic views showing the manner in which the instrument is connected in circuit to serve as a voltmeter, wattmeter, or ammeter, as the case may be. Fig. 11 is a fragmentary view of the record-sheet. Figs. 12 and 13 illustrate the differences in scale resulting from the use of two movable coils instead of one.

In said drawings, A designates the field-coils, which are secured by supporting brackets or standards B to a back or base board C. Within the field-coils A two movable coils D and D′ are secured upon a spindle E to oscillate therewith. One end of the spindle E is mounted in a bearing *e* on the back board C. At the other end its bearing *e′* is carried by an arm B′, which projects from one of the standards B.

The coils D D′ are secured upon the spindle at an angle with each other closely approaching a right angle, and as a further improvement are so applied that the angle between them may be adjusted. In the approved construction shown one coil D is wound upon a spider *d*, having a hub *d′*, fastened to the spindle by a set-screw d^2. The other coil D′ is wound upon a similar spider made in two sections d^3, the hubs d^4 of which are slipped over the spindle from each end after the coil D is in place. The coil D′ is secured in correct angular relation to the coil D by means of a clamping-screw d^5 in a flange d^6 of one of the spider-sections d^3, which screw also passes through an arc-shaped slot in an adjacent flange d^7 of the spider *d*. This construction obviously permits the angular arrangement of the coils with relation to each other to be varied as desired within the limits of the length of the slot.

For the purpose of affording a yielding resistance to the torque of the coils I have herein shown the usual spiral springs F, the inner ends of which are made fast to the spindle, while the outer ends are secured to projecting pins *f* or other stationary portions of the meter-frame. Said springs are desirably arranged to spiral in opposite directions, so that they will mutually compensate for any tendency to straighten with age. The tension of the springs is such as to just counterbalance the weight of the usual pointer G and hold the latter normally at the zero-point of the scale H. Said pointer is rigidly secured

to the spindle by a set-screw *g* or otherwise, and the scale H is of the usual arc shape and is secured concentrically to the spindle in proximity to the end of the pointer. When the instrument is connected up and the current is passing, a torque is produced which acts in opposition to the springs F to swing the pointer along the scale through a greater or less distance, according to the strength of the torque exerted, and the scale will be graduated in suitable units to give the correct readings.

In practice the field and movable coils will be connected in the circuit in any suitable manner consistent with the service demanded. For example, in Fig. 8 I have shown a voltmeter connection in which all the coils are in series with each other in a shunt-circuit between the main leads. In the ammeter connection shown in Fig. 8ª the coils are similarly connected in a shunt-circuit around a resistance R in one of the leads. For a wattmeter the field-coils may be in series in the circuit and the movable coils in shunt across the leads, and this connection may serve also for an ammeter on a constant potential circuit. A different ammeter connection is shown in Fig. 10.

Any suitable method of conducting the currents to the movable coils may be employed. In the improvement herein shown the wire d^8, which connects the coils in circuit, is wrapped around the spiral F and so brought to the spindle and along the latter to the coils. (See Figs. 3 and 5.) The purposes sought are in this manner accomplished with greatest simplicity and without interfering in the least with the movement of the pointer.

The effect of employing two or more movable coils arranged at an angle, as described, instead of a single coil, as heretofore practiced in this class of instruments, is to produce an increased torque varying more nearly in proportion to the changes in current, pressure, or energy passing in the circuit and results in a more even and open scale, especially in those parts beyond the middle of the scale or toward the higher readings, where a reduction in the lengths of the scale-divisions usually occurs. For example, Fig. 12 represents the scale of one of my improved voltmeters with both movable coils in circuit and Fig. 13 the scale of the same instrument with one of its movable coils cut out. It will be noted that in Fig. 12 the scale-divisions are much longer and are more nearly equal in length, especially toward the outer end. This result may be attributed to the fact that the reaction between the field and movable coils remains very nearly constant for all positions of the latter, since when one of the movable coils reaches an angular position beyond which its torque begins to decrease the increasing torque of the other coil compensates for the loss and renders their combined action nearly uniform. The angular adjustability of the coils with relation to each other is also a feature of greatest practical importance, since it enables the scale of each instrument to be varied—*i. e.*, it enables the movement of the pointer due to given changes in current to be varied, for example, as may be found necessary in calibrating or standardizing the instrument. In practice, therefore, it is possible, after ascertaining the most desirable manner in which to graduate the scale, to adjust each instrument to such standard scale by altering the angular distance between its two movable coils.

Referring now more particularly to the improvements in the recording devices of the meter and first describing the construction shown in Figs. 1, 2, 3, and 6, I designates a cylinder or drum revolubly supported between plates I′, which project from the back board C. Said drum is caused to rotate at a uniform rate of speed by a clock mechanism J, which may be conveniently mounted upon the inner side of one of the plates I′ in position to be inclosed by the adjacent end of the drum. A suitable handle *j* projects through the adjacent plate I′ and enables the clockwork to be wound in the usual manner.

K designates a small or idle roller also journaled between the plates I′, but with its bearings mounted in slots *i* of the side plates and with springs *k* applied thereto, so as to constantly press the roller K against the drum. A sheet or roll of paper L is suitably provided, in this instance by being loosely inserted between spring-fingers *l*, which project from the back board above the drum. The end of said roll is drawn from between the fingers *l* and carried down between the drum I and the roller K, so that thereafter the friction of the drum will draw the paper out at a uniform rate of speed. Before passing between the drum and roller the paper is carried over a stationary plate I^2, secured to brackets i^2 of the side plates I′, this plate I^2 being located in close proximity to the freely-swinging end of the pointer G, so that by providing an inking-point or pencil *g′* on the end of said pointer a record of the position of the pointer at each particular instant may be traced upon the recording-sheet. The scale H is herein shown as secured to the brackets i^2 just beneath the path of the pointer and far enough in front of the plate I^2 to enable the paper to pass between them. As it passes from between the drum and roller the paper is permitted to coil up loosely in the lower portion of the projecting casing M of the meter beneath spring-arms *l′*, which keep it clear of the drum.

Instead of being made in a roll as thus described the record-sheet may be made in the form of a continuous band L^2, as shown in Figs. 4 and 7, in which an idle-roller K is shown as placed within the sheet and is provided with spring-pressed bearings *k*, which serve to force the roller away from the drum I, and thereby keep the sheet taut.

In practice the instrument will be connected in circuit by suitable binding-screws, as N,

and will be provided with such resistance-coils O as are found necessary.

It will be obvious that such features of improvement as relate to the torque-producing devices of the meter are quite independent of the particular recording devices shown, and vice versa; that the improvements in the recording portion of the meter, though of a minor character, may be advantageously employed with other forms of meter of this general class.

It will also be understood that various changes may be made in the details of the construction shown without involving a departure from the broad spirit of the invention.

I claim as my invention—

1. An electric meter comprising field-coils and a plurality of movable coils secured at an angle to each other upon a common axis within the field, connections for energizing the coils, and means for measuring the resulting torque.

2. An electric meter comprising field-coils and two movable coils secured approximately at right angles to each other upon a common axis within the field, connections for energizing the coils, and means for measuring the resulting torque.

3. An electric meter comprising field-coils and a plurality of movable coils secured in adjustable angular relation to each other upon a common axis within the field, connections for energizing the coils, and means for measuring the resulting torque.

4. An electric meter comprising field-coils and a plurality of movable coils secured at an angle to each other upon a common axis within the field, connections for energizing the coils, a spring-resistance normally holding the movable coils stationary, and a pointer and scale for measuring the movement effected by the torque in opposition to said spring-resistance.

5. An electric meter comprising field-coils and a plurality of movable coils secured in adjustable angular relation to each other upon a common axis within the field, connections for energizing the coils, a spring-resistance normally holding the movable coils stationary, and a pointer and scale for measuring the movement effected by the torque in opposition to said spring-resistance.

6. An electric meter, comprising field-coils and a plurality of movable coils secured at an angle to each other upon a common axis within the field, a yielding resistance opposing the movement of the movable coils, a pointer secured thereto and provided with a marking-point, and means for moving a record-sheet past said marking-point.

7. An electric meter comprising field-coils and a plurality of movable coils secured in adjustable angular relation to each other upon a common axis within the field, connections for energizing the coils, a yielding resistance opposing the movement of the movable coils, a marking-point actuated by the movable coils, and means for moving a record-sheet past said marking-point.

8. An electric meter provided with stationary and movable coils, the latter being mounted on an oscillatory spindle, spiral springs applied to resist the movement of the spindle, and connecting-wires carried along the convolutions of the springs to connect the movable circuit without affecting the oscillations of the meter.

9. An electric meter comprising field-coils and a plurality of movable coils secured at an angle to each other upon a common axis within the field, spiral springs applied to resist the movement of the movable coils, and connections for energizing the coils including connecting-wires carried along the convolutions of the springs to connect the movable circuit without affecting the oscillations of the meter.

In testimony that I claim the foregoing as my invention I affix my signature, in presence of two subscribing witnesses, this 28th day of April, A. D. 1897.

ELTON JACOB KING.

Witnesses:
ROBT. S. TAYLOR,
REGINALD P. DRYER.