(No Model.)

3 Sheets—Sheet 1.

A. RAPS.

ELECTRICITY METER.

No. 579,079. Patented Mar. 16, 1897.

Fig. 1.

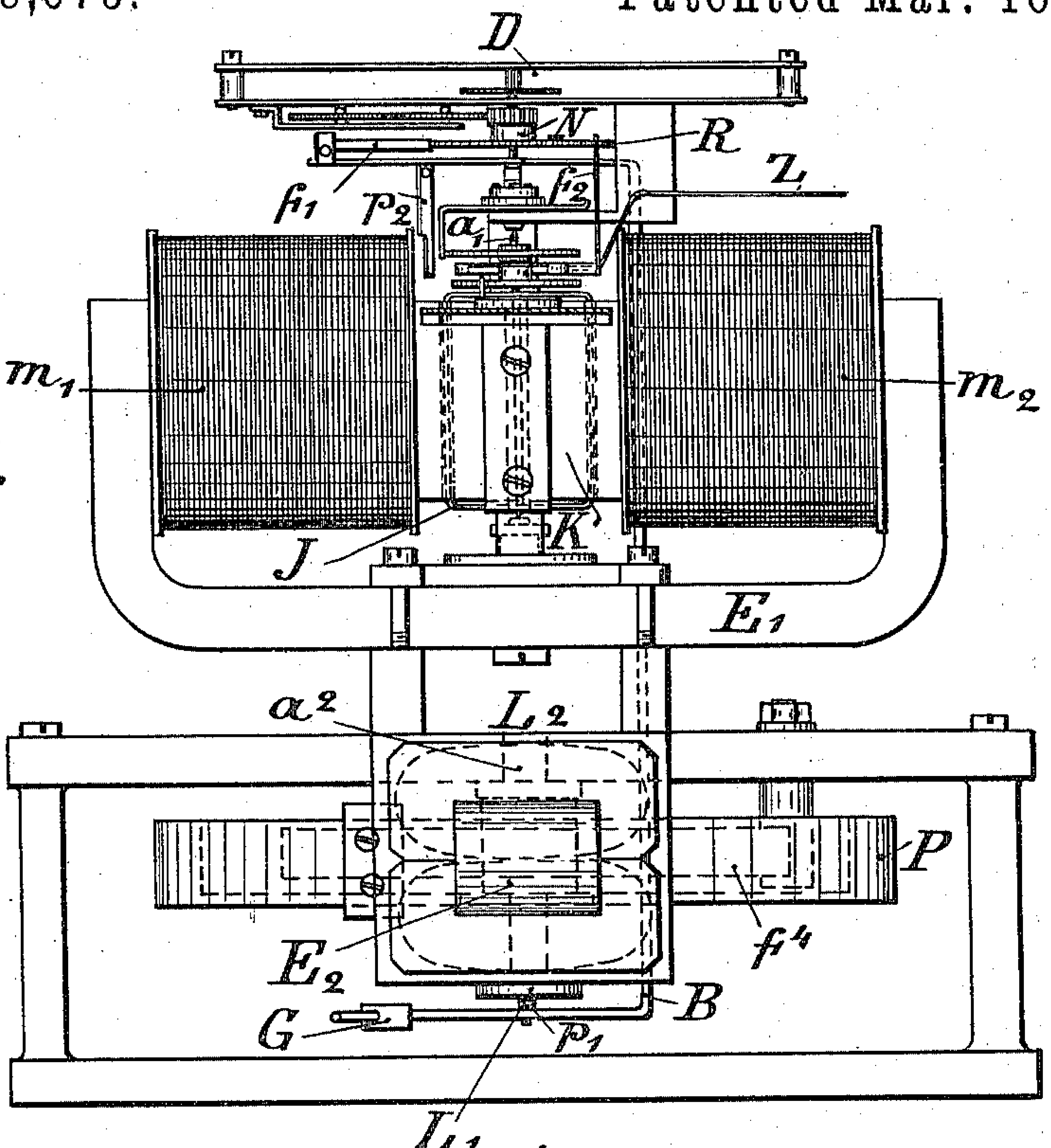
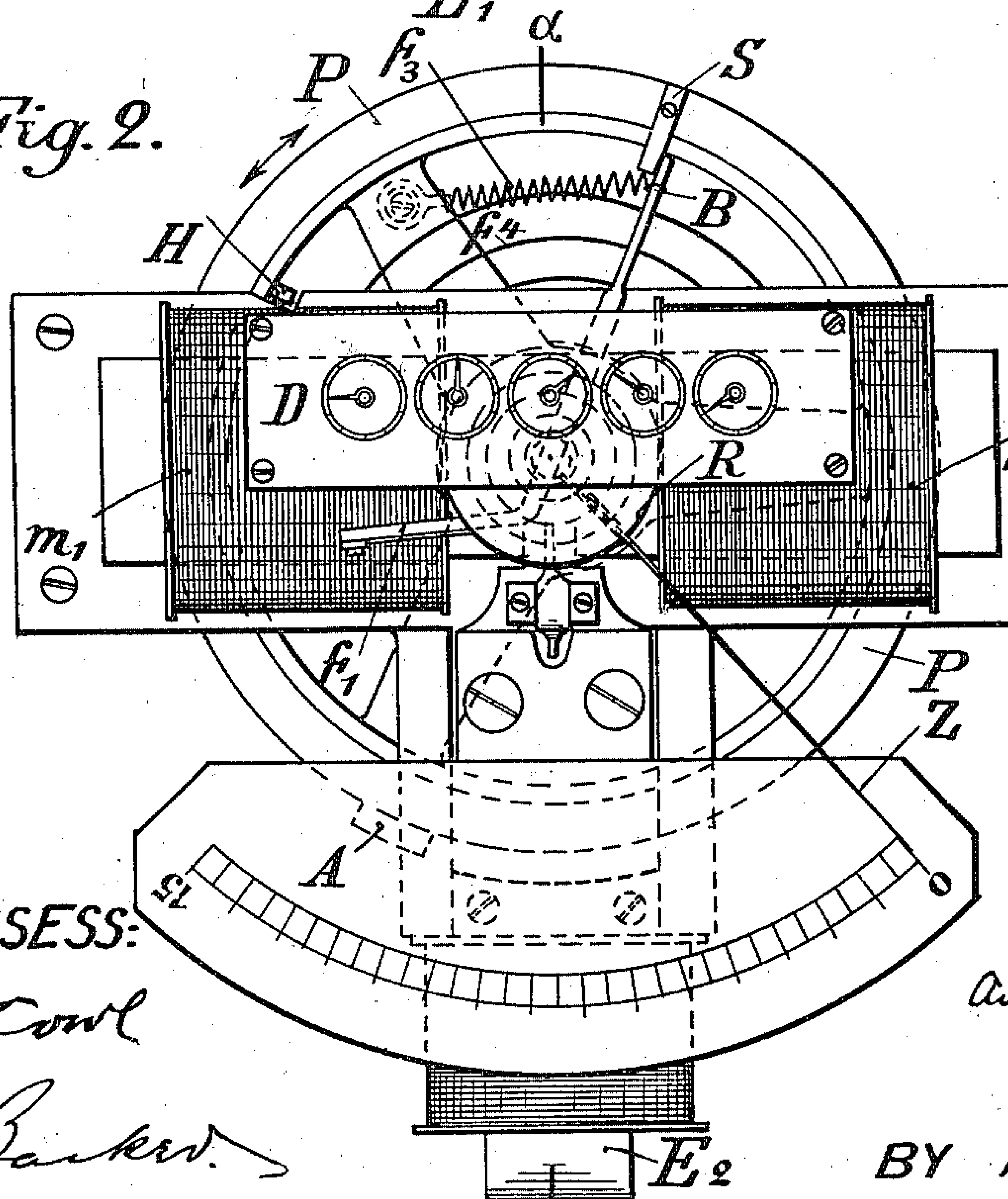


Fig. 2.



WITNESSESS:

D. P. Cowl

J. S. Barker

INVENTOR:

August Raps

BY ATTORNEY:

H. H. Low

(No Model.) 3 Sheets—Sheet 2.

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Fig. 3.

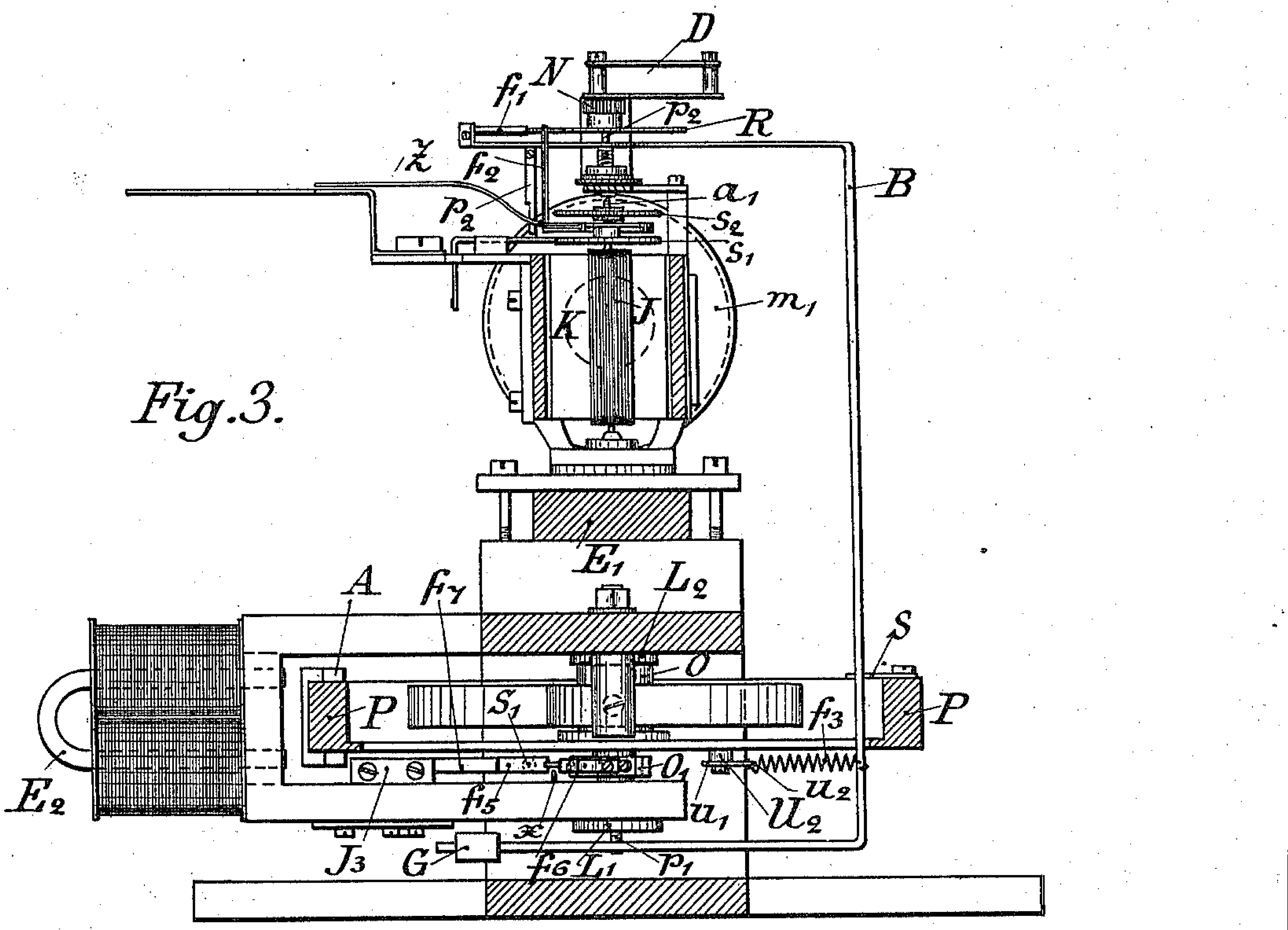
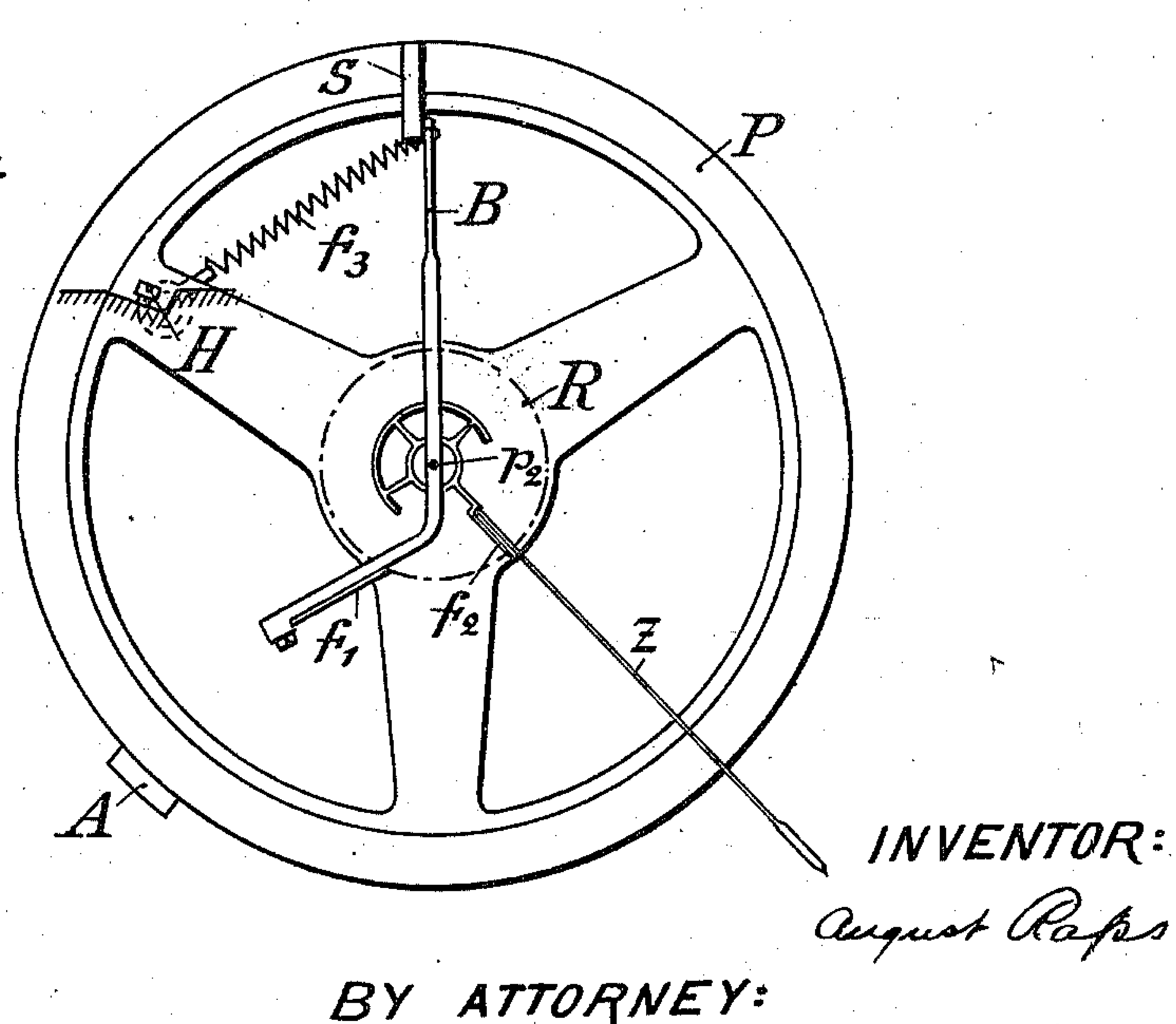


Fig. 4.



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BY ATTORNEY:

H. N. Low

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

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Fig. 5.

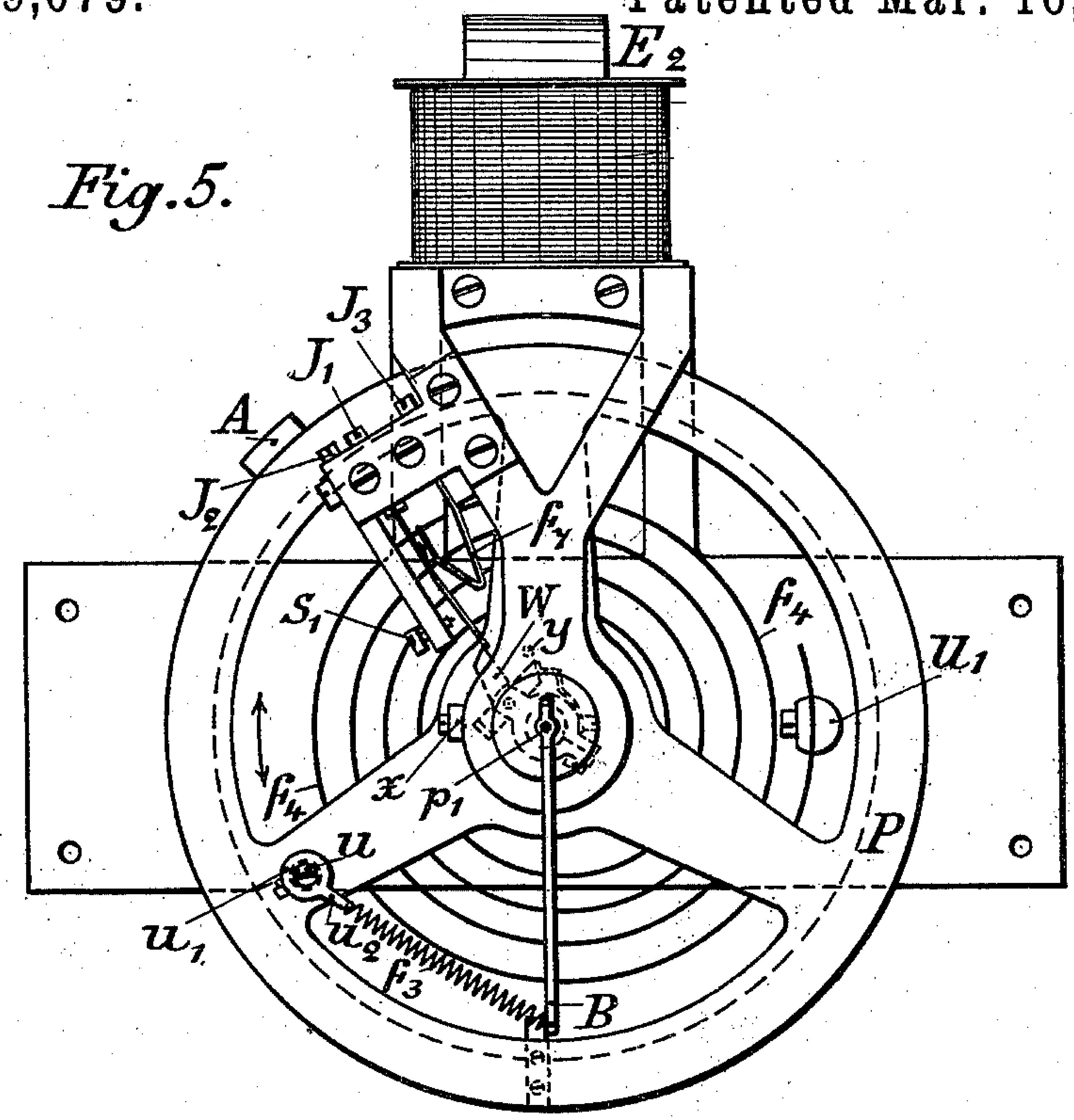
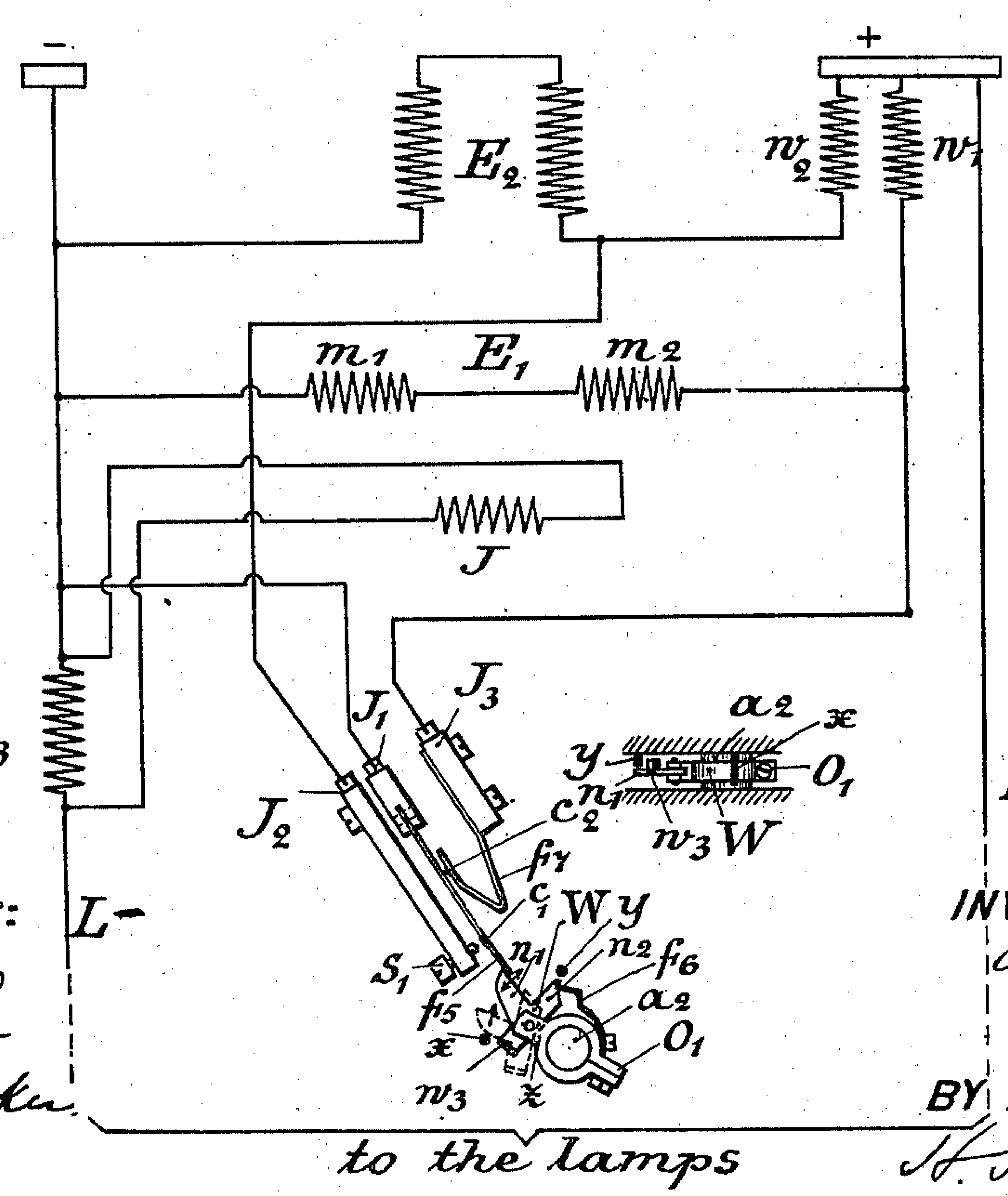


Fig. 6.



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J. S. Barker

INVENTOR:
August Raps

BY ATTORNEY:
H. N. Low

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

UNITED STATES PATENT OFFICE.

AUGUST RAPS, OF BERLIN, GERMANY, ASSIGNOR TO SIEMENS & HALSKE, OF SAME PLACE.

ELECTRICITY-METER.

SPECIFICATION forming part of Letters Patent No. 579,079, dated March 16, 1897.

Application filed July 25, 1896. Serial No. 600,574. (No model.)

To all whom it may concern:

Be it known that I, AUGUST RAPS, a subject of the German Emperor, residing at Berlin, in the German Empire, have invented certain new and useful Improvements in Electricity-Meters; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to electricity-meters.

The invention consists in the instrument hereinafter described.

Of the accompanying drawings, Figure 1 is a side elevation of the complete instrument. Fig. 2 is a plan view seen from above. Fig. 3 is a vertical section in the line α β, Fig. 2, less important parts being left out for the sake of clearness. Fig. 4 is a plan view showing only certain important parts of the instrument. Fig. 5 is a plan view of the complete instrument seen from below, unimportant parts being left out for the sake of clearness. Fig. 6 is a diagram showing the electrical connections of the different parts of the instrument.

The letters of reference indicate the same parts in all the figures.

In the drawings, m' and m^2 are the windings of an electromagnet E'.

K is a cylindrical iron core placed between the poles of said electromagnet and preferably fixed in that position.

J is a coil of thin wire mounted on the spindle a' and surrounding the iron core K in such a way that it can freely swing in the space left between said core and the pole-pieces of the electromagnet E'.

s' and s^2 are two springs connecting the two ends of the coil J electrically with a suitable source of electricity hereinafter to be more fully described and at the same time mechanically giving the coil J a certain position of rest from which it can only be deflected by bending said springs s' and s^2.

On the spindle a' is mounted an index Z, carrying a very light and flexible arm f^2.

B is a U-shaped rod pivoted on two pins p' and p^2, fastened in the frame of the instrument and forming geometrically an exact prolongation of the spindle a'. On its one end, projecting beyond the pin p', the U-shaped rod B carries a counterweight G. On its other end it carries a light strip of metal f', which is dimensioned in such a way as to just swing free of the circumference of a disk R, likewise turning freely on the pin p^2, and being coupled by a cog-wheel N with a suitable device D, such as is usually employed in similar instruments for registering the number of revolutions performed by the disk R.

The metal strip f^2, fastened to the index Z, is made of such length as to intercept the strip f' when the U-shaped rod B swings round the pivots p' and p^2.

L' and L^2 are two ball-bearings carrying a spindle a^2 in such a position that its geometrical axis coincides with the geometrical axis of the spindle a'.

P is a heavy fly-wheel mounted on the spindle a^2 and carrying at its circumference an iron armature A and a nose S, projecting inwardly and intercepting the U-shaped rod B. In the center of the fly-wheel P a sleeve O, Fig. 3, is attached, to which latter is fastened one end of a powerful spring f^4, the other end of which is held in a slot cut in a binding-post U', which is attached to the frame of the instrument. A second binding-post U^2 is attached to the fly-wheel and carries one end of a spiral spring f^3, the other end of which is attached to the U-shaped rod B and compels it to rest against the projecting nose S and thus follow the movements of the fly-wheel P.

The binding-post U^2 carries a small disk u' with a projecting arm u^2, with an eye bored at its free end, into which the spring f^3 is hooked, and by a screw u the disk u' can be fixed in different positions giving more or less tension to the spring f^3.

Opposite the armature A an electromagnet E^2 is securely fastened to the frame of the instrument.

On the spindle a^2, which carries the fly-wheel P, a clamp O' is secured, (see Figs. 3, 5, and 6,) which carries a piece W, provided with three noses n' n^2 n^3. On the clamp O' a spring f^6 is fastened by a screw. The free end of this spring f^6 rests against the nose n^2 of the piece W and is bent in a zigzag shape, so as to allow the piece W two positions of rest—viz., the one drawn with full lines and the other drawn with dotted lines in Fig. 6. The piece W is so pivoted in the clamp O′ that it can freely turn to the right, but rests against a projecting portion *z* of the clamp in the position drawn in Fig. 6, so that it cannot turn any farther to the left. The nose n^3 projects farther backward from the fly-wheel P than the noses n' and n^2.

x and *y* are two pins fixed in the frame of the instrument, the one, *x*, being longer, so that it intercepts the nose n' as it swings round the spindle a^2, and the other, *y*, being shorter, so that it allows the noses n' and n^2 to pass it freely, but intercepts the nose n^3.

J′, J^2, and J^3 are three metal blocks secured to the frame of the instrument (see Figs. 3, 5, and 6) and isolated therefrom. The block J^2 carries a contact-screw S′. The block J′ carries a spring f^5, which carries a contact-button c', preferably made of platina and corresponding to the aforementioned contact-screw S′. The spring f^5 is so adjusted that in its position of rest the contact c' remains closed and that its free end carrying the contact-button c' just intercepts the end of the nose n' of the piece W as the latter swings round the spindle a^2, together with the fly-wheel P. The spring f^5 is further provided with a second contact-button c^2, making contact with a spring f^7, which is fixed to the block J^3, but the relative adjustment of the springs f^5 and f^7 is made so as to leave the contact c^2 open when the two said springs f^5 and f^7 are in a position of rest.

H is a plug screwed into the frame of the instrument in such a position as to intercept the movement of the U-shaped rod B as the latter swings round the pins p' and p^2, together with the fly-wheel P. (See Figs. 2 and 4.)

The electric connections of the instrument are shown in Fig. 6.

w' and w^2 are two resistances, which are not shown in the other drawings, because they are made in the ordinary way. It will be readily seen that when the spring f^5 closes the contact c' the magnet E^2 is short-circuited, and when, on the other hand, the contact c^2 is closed the magnet E^2 will be excited and the coils m' and m^2 of the magnet E′ will in their turn be short-circuited.

When the apparatus is at rest, the spring f^4 is so adjusted that contact c' is disconnected. This implies that contact c^2 is closed. In this position the electromagnet E′ or the coils m' and m^2 are short-circuited, since the current can pass through the wire connecting L with binding-post J′, through spring f^5, into spring f^7, into binding-post J^3 and the wire connecting the latter with the resistance w' and the binding-post + and since the coils m' and m^2 constituting the magnet E′ are likewise placed between the conductor L and the resistance w'. The electromagnet E^2, however, is not short-circuited. It is true that the current can pass along the way indicated, but before reaching the binding-post +, to which the electromagnet E^2 is connected, it has to pass through the resistance w', and if the resistance of the magnet E^2, together with the resistance w^2, is not disproportionately greater than the said resistance w' a considerable or at any rate a sufficient portion of the current will pass through the coils of this magnet. The same holds good for E^2 and w^2 when the contact c' is closed and in consequence the contact c^2 is open.

w^3 is a resistance inserted in either of the two conductors L^+ and L^- which form the working circuit the current of which is to be registered. Between the terminals of this resistance w^3 the movable coil J is placed. This way of connecting the movable coil J, I consider to be preferable in most cases, because the current flowing in L^+ and L^- will, under ordinary circumstances, be too large to be conveniently carried through the movable coil, the wire of which will have to be made very thin for the sake of lightness. However, it will be understood that any connection will give the desired result which causes a current to flow through the movable coil the strength of which is proportional to the working current which is to be registered.

The operation of the instrument is as follows: The spring f^4 is so adjusted that the fly-wheel P, and in consequence the clasp O and the piece W, when uninfluenced by any other force, take such a position that the spring f^5 is lifted off from the contact c'. Care is taken to make the fly-wheel P perfectly symmetrical in every direction relatively to the spindle a^2, so that if its position of rest is adjusted by the spring f^4 in one position of the whole instrument it will be the same for any other position. This is important because it implies that no special care need be taken in hanging the instrument. As soon as the instrument is switched onto a source of electricity the electromagnet E^2 will be excited and will attract the armature A, thereby imparting motion to the fly-wheel. The nose n' will consequently pass the spring f^5, which will fall back upon contact c' and thereby short-circuit the magnet E^2. The fly-wheel P once set in motion will continue to turn until the resistance of the spring f^4 increases and gradually consumes its momentum, which, being stored in said spring, will reverse the motion of the fly-wheel. On its backward way the nose n' passes the spring f^5 without disturbing the contact c'. The tension of the spring f^4 again comes into play, stopping and reversing the fly-wheel, and in the moment in which the nose n' again passes the spring f^5 the electromagnet E^2 is again excited for a short time and gives an impulse to the armature A. Thus a continuous oscillating motion of the fly-wheel P is kept up, the whole device actually being in every way equivalent to an ordinary chronometer-balance.

In order to secure perfect regularity and constancy of the period of oscillation of the fly-wheel, it is necessary to provide means for keeping the length of the oscillations as nearly constant as possible. For this purpose the device shown in Fig. 6 is provided. When the oscillation of the fly-wheel P becomes too long, the projecting arm n' of the piece W is carried so far round the spindle a^2 that it knocks against the pin x. Consequently the nose n^2, by the action of its inclined surface, lifts the spring f^6 and slips into its second position of rest. (Indicated in Fig. 6 by dotted lines.) In this position of the piece W the nose n' passes the spring f^5 freely, and the electromagnet E^2 therefore remains short-circuited and no impulse is given to the fly-wheel P. On its way onward, however, the nose n^3 now knocks against the pin y, and thereby the piece W is restored to its original position. If, therefore, the impulses imparted to the fly-wheel P by the electromagnet E^2 at every oscillation are stronger than is necessary to keep up the desired rate of oscillation after a certain number of oscillations, always one impulse will be left out, and this number will adjust itself automatically in such a way that the mean length of the oscillations remains constant. However, though this device will tend to make the rate of oscillation constant, in order to make the instrument what is called "direct-reading" it is necessary to have the possibility of regulating the length of oscillation. This of course can be done in the way usual with ordinary clocks by lengthening or shortening the spring f^4, but I have found it desirable to provide a second and special means for obtaining this result.

It will be remarked that the U-shaped rod B is connected to the fly-wheel P merely by the spring f^3, which presses it against the rest S. Now every time the fly-wheel P swings out in the sense opposite to that of the clock-hand, as seen from above, (see Fig. 4,) and swings out farther than is desirable, the U-shaped rod B will knock against the plug-screw H and will be lifted off from the rest S, thereby extending the spring f^3 until the tension of the latter becomes sufficient to reverse the motion of the fly-wheel. By adjusting the arm u^2, to which the said spring f^3 is attached, any suitable tension can be given to the spring f^3 within practical limits, and by suitably adjusting the screw H the length of oscillation of the balance P can be altered within practical limits. As the balance P swings round, the U-shaped rod B is carried with it, but as the spring f'', which is attached to the end of the rod B, is adjusted in such a way as to just pass freely round the edge of the disk R the registering device D will not be influenced. However, it will be seen that except in those short intervals in which the spring f^5 is lifted off from the contact c' and pressed against the contact c^2, thereby short-circuiting the coils m' and m^2, these coils are excited, thereby causing a deflection of the movable coil J and consequently of the index Z. When this takes place, the spring f', attached to the end of the U-shaped rod B, will be intercepted on its way by the spring f^2, which is attached to the index Z. Though the index is made very light the spring f' can be made so thin that the momentum of the index Z is sufficient to slightly bend it when it strikes the latter while it is at rest. Thereby the end of the spring f' will be brought into connection with the edge of the wheel R, which is provided with very fine teeth, so that the spring f' will catch onto it and push it round as long as the motion of the balance P continues in that particular sense. As soon as the motion of the fly-wheel is reversed the spring f' will be released and will in its turn allow the index Z to follow it and to assume its former position. Thus it will be seen that the registering apparatus D, which is coupled to the wheel R, is carried forward at every oscillation of the balance P, registering a part of the revolution of the wheel R which is equal to the deflection of the index Z. Consequently if the deflection of the index is proportional to the number of watts conveyed by the conductors between which the whole instrument is inserted the registering apparatus will at any time indicate the number of watt-hours that have been used.

If the instrument is intended to register coulombs instead of watts, the coils m' and m^2 are either excited by some independent and constant source of electricity or else the whole electromagnet E' is replaced by a permanent magnet. It will be remarked that every time the nose n' passes the spring f^5 the contact c^2 is closed, and thereby the coils m' and m^2 of the measuring instrument are short-circuited. I attach importance to this arrangement, as it is specially adapted to considerably increase the exactness of the instrument.

If the coils of the measuring instrument remain inserted between the positive and the negative terminals every time the work which is being registered decreases, the instrument will tend to give faulty indications, because the iron contained in the coils m' and m^2 retains part of the magnetism once acquired. If, however, every time a registration is taken the coils are short-circuited and then excited afresh, this fault caused by hysteresis will be eliminated. A similar device may be provided to short-circuit the coil J before every registration, but this, for the sake of simplicity, is not represented and will not be generally found necessary, because the magnetic field caused by the coil J is naturally extremely weak.

I have found the form of measuring instrument described and shown specially adapted for use in current or watt meters made according to my invention, but I would have it understood that any ordinary direct-reading instrument may be employed in which the deflections of the index are proportional to the number of amperes or watts measured.

Having now particularly described and ascertained the nature of my said invention and the manner in which the same is to be performed, I declare that what I claim is—

1. An improved electricity-meter consisting of a suitable direct-reading electrical measuring instrument an oscillating balance and a registering-wheel all said parts being concentrically pivoted, means for registering the revolutions of said wheel and means for coupling the said balance with the said wheel at every oscillation at the points indicated by the deflections of the needle of the measuring instrument.

2. An improved electricity-meter consisting of a suitable direct-reading electrical measuring instrument, a wheel provided with means for registering its revolutions, and an oscillating balance provided with a flexible tongue fixed in the plane of said wheel and adjusted in such a way as to just clear its circumference, the index or needle of the said measuring instrument being provided with a similar tongue, which is adjusted in such a way as to intercept the oscillatory motion of the first-mentioned tongue, substantially as and for the purpose described.

3. An improved electricity-meter consisting of a suitable direct-reading electrical measuring instrument, a wheel provided with a finely-toothed edge, means for registering the revolutions of said wheel an oscillating balance, provided with means for propelling said wheel at every oscillation at a rate proportional to the deflections of the needle of said measuring instrument and with an armature fixed at or near the circumference of said balance a fixed electromagnet and means to close and open the exciting-coils of said magnet at every oscillation of said balance substantially as and for the purpose described.

4. In an electricity-meter comprising an oscillating balance a direct-reading electrical measuring instrument a registering-wheel and means for coupling the said balance with the said registering-wheel at every oscillation of the former and at those points of every oscillation that are indicated by the needle of said measuring instrument, means for interrupting the exciting-current of the said measuring instrument once during every oscillation of the said balance, substantially as and for the purpose set forth.

5. In electricity-meters comprising a direct-reading electrical measuring instrument a registering-wheel, an oscillating balance and means for keeping up the oscillations of the same, a **U**-shaped rod pivoted concentrically with the aforesaid parts, and coupled to said balance by means of a spring which presses it against a projecting nose fixed on said balance, said **U**-shaped rod being intercepted by a plug-screw fixed in the frame of the instrument and being provided with means for intercepting the index of said measuring instrument and propelling the said registering-wheel, substantially as and for the purpose set forth.

6. In electricity-meters comprising a direct-reading electrical measuring instrument, a registering-wheel an oscillating balance, means for coupling said balance with said registering-wheel at those points of every oscillation of the same which are indicated by the needle of said measuring instrument and a fixed electromagnet acting upon an armature fixed on or near the circumference of said balance, means for exciting said electromagnet for a short time during every oscillation and means for leaving out one of the said excitations every time the oscillations of said balance have increased beyond a certain prefixed rate, substantially as and for the purpose set forth.

In testimony whereof I have affixed my signature in presence of two witnesses.

AUGUST RAPS.

Witnesses:
JOHN B. JACKSON,
MAX TRAGAER.