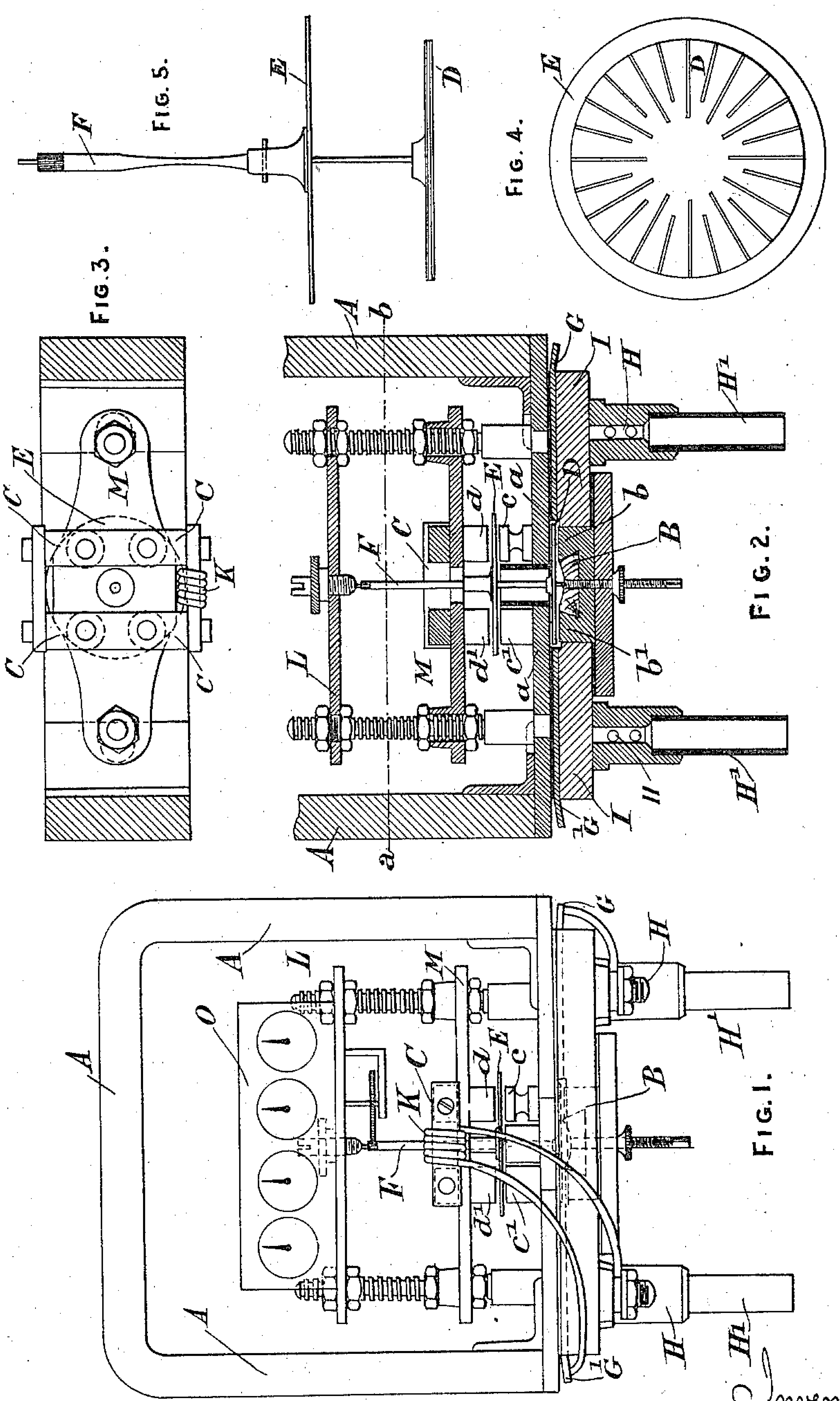
(No Model.) 2 Sheets—Sheet 1.

G. HOOKHAM.

ELECTRIC METER.

No. 579,582. Patented Mar. 30, 1897.



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

(No Model.) 2 Sheets—Sheet 2.

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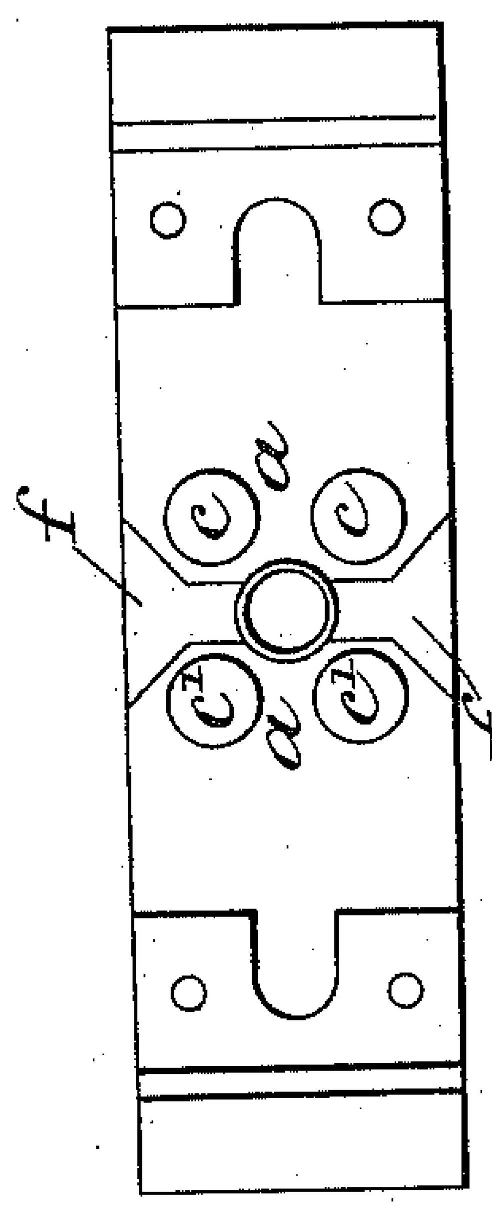

FIG. 8.

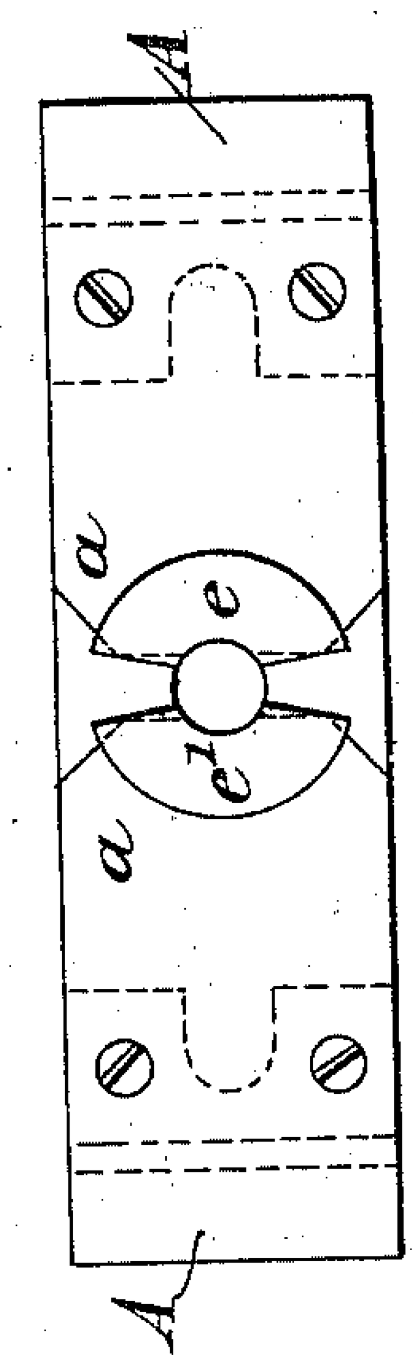

FIG. 7.

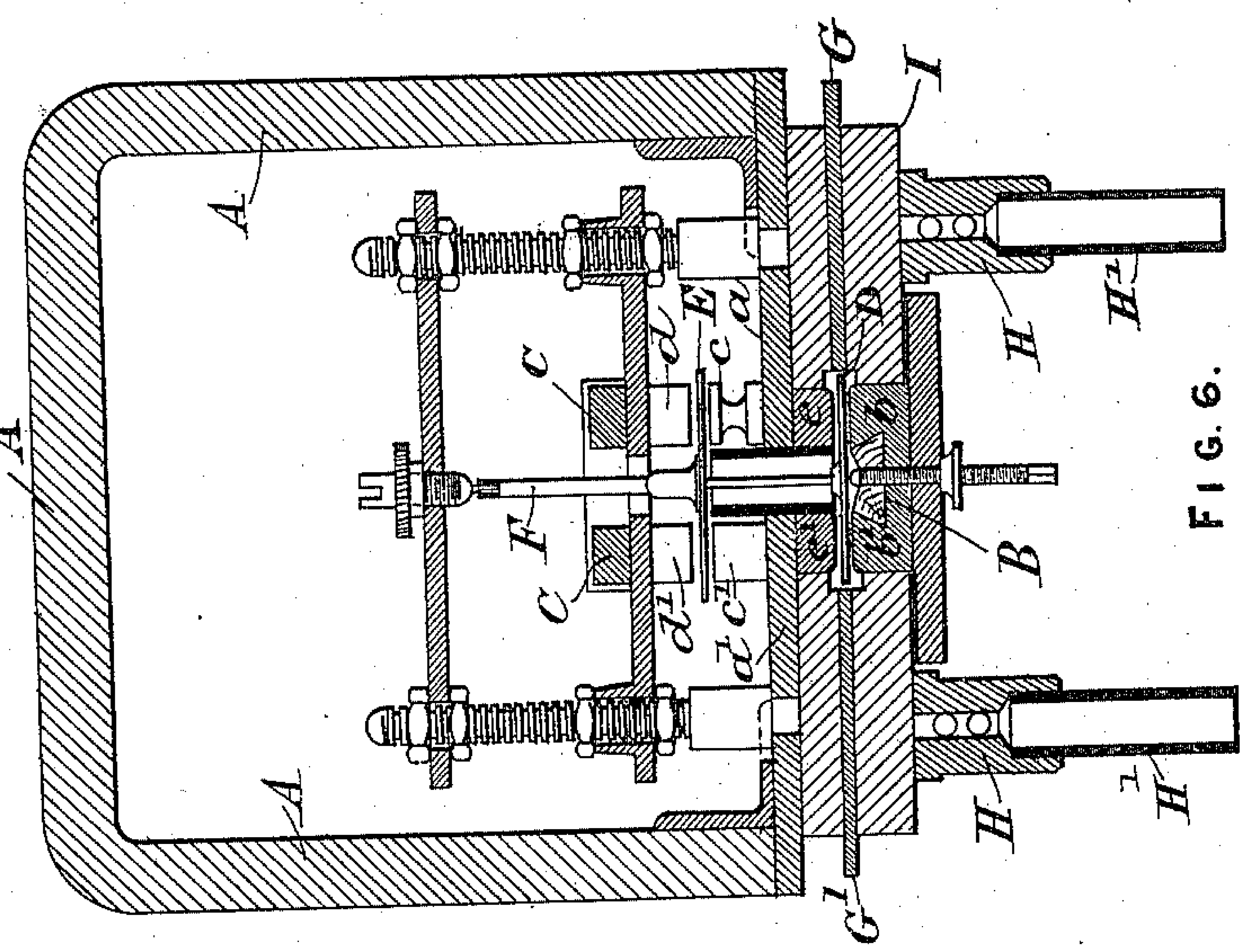

FIG. 6.

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UNITED STATES PATENT OFFICE.

GEORGE HOOKHAM, OF BIRMINGHAM, ENGLAND.

ELECTRIC METER.

SPECIFICATION forming part of Letters Patent No. 579,582, dated March 30, 1897.

Application filed September 18, 1896. Serial No. 606,255. (No model.)

To all whom it may concern:

Be it known that I, GEORGE HOOKHAM, a citizen of Great Britain, and a resident of 7 and 8 New Bartholomew Street, in the city of Birmingham, England, have invented certain new and useful Improvements in Continuous-Current Electricity-Meters, of which the following is a specification.

My invention relates to electricity-meters for continuous currents; and my object is to greatly increase the driving force actuating such meters, so as to improve the accuracy and range of the meters, while at the same time simplifying the mechanical construction and arrangement.

My invention relates to continuous-current meters of the kind in which a motor-armature is entirely immersed in mercury and the separate brake rotates between the poles of a permanent magnet and acts by the generation of Foucault currents.

My invention consists in a new mode of arranging the permanent-magnet circuit in such manner as to minimize the number of air-breaks in the circuit; in allowing a current to flow straight across the disk, when a disk is used, by providing pole-pieces of opposing polarity on the opposite sides of the disk; in arranging the brake-magnets in parallel with the motor-magnets instead of in series; in constructing the disk armature of the motor with radial slits for the purpose of limiting the area of flow of current across the disk and of diminishing Foucault currents in the motor-disks; in a new arrangement of Foucault brake and the magnets operating the brake, and in the combination of the points indicated to form a powerful and accurate continuous-current meter.

Referring to the two accompanying sheets of drawings, which illustrate my invention as carried into effect according to one modification, Figure 1 is an external elevation. Fig. 2 is a vertical section. Fig. 3 is a sectional plan on the line *a b*, Fig. 2. Fig. 4 is an inverted plan, and Fig. 5 is a side elevation, both on a larger scale, showing the motor and brake disks. Fig. 6 is another vertical section of the meter similar to Fig. 2, but with slight modifications of the magnet-poles. Fig. 7 is an inverted plan of the magnets, showing the pole-pieces; and Fig. 8 is a plan of the magnet pole-pieces from above, showing the magnetic gap between the poles.

In this construction I arrange my permanent magnet A to inclose a square or oblong space, as shown at Figs. 1 and 6, so as to provide a considerable length of magnet-steel. The said permanent magnet is bent to form three sides of a square, and pole-pieces *a a'* complete the square, leaving a suitable gap between the pole-pieces, which I fill in with non-magnetic metal, so as to secure metallic and structural continuity, but not magnetic continuity.

On the lower sides of the pole-pieces *a a'* I sometimes mount additional pole-pieces *e e'*, as shown at Fig. 6, which pole-pieces project downward and spread out considerably to form in exterior outline an arc of a circle. Each such additional pole-piece forms on its exterior surface an arc of about a quarter-circle, and the same circle is struck to include the exterior edges of both pole-pieces. The arc-outline of the pole-pieces *e e'* is clearly shown in the inverted plan, Fig. 7.

The interior edges of the pole-pieces are shaped convex inwardly, with a circular recess in the middle, and the edges of the lower surface are gently rounded. Sharp edges are in fact avoided as much as possible in order to minimize the generation of Foucault brake-currents in the rotating disk.

In some cases I dispense with the downwardly-projecting poles *e e'* and utilize the under surfaces of the main pole-pieces *a a'* to provide my magnetic field, as is shown at Figs. 1 and 2. In all cases, however, under the magnet-poles I place a bridge-shaped cast-iron or other iron bar B, Figs. 1, 2, and 6, terminating in pole-pieces *b b'* similar to those described and having its faces rounded, as described. Between this bridge-piece and the upper poles I place a disk armature D, which rotates on a vertically-disposed spindle F. The whole of this armature and the magnet-poles described I inclose in a vessel formed as to the part I of non-conducting material. Sometimes I form the circumferential part I of a glass tube, in which case I modify the other dispositions in a suitable manner. I may also use the upper and lower pole-pieces, as is shown in the drawings, to form part of the inclosing vessel.

I preferably form the armature-disk D of copper and cut slits in a radial direction toward the center all round the circumference, as shown on a larger scale at Fig. 4. I leave, however, a sufficient part of copper in the center of the disk uncut. These slits I fill with any suitable non-conducting composition, and I cover both faces of the disk with non-conducting composition, leaving only the periphery of the disk free from non-conducting compound. This periphery I amalgamate so as to get good metallic contact between the periphery and the mercury-bath in which the disk is immersed.

Above the motor pole-pieces *a a′* and attached to them in magnetic continuity I place circular brake pole-pieces *c c c′ c′*, Figs. 1, 2, 3, 6, and 8, which are necked in to a suitable extent. Opposing these pole-pieces I arrange a cast-iron or other iron bridge-piece C, Figs. 1, 2, 3, and 6, whose ends *d d′* form pole-pieces corresponding in configuration to those below. In the space between I rotate the brake-disk E, which may be of copper or other good conducting metal, and I preferably mount it on the same vertical spindle F as carries the motor-armature D.

The edges of the brake pole-pieces are purposely kept as sharp as possible, or, if necessary, grooved to produce the maximum Foucault-current effects in the brake-disk. The brake pole-pieces *c c* are necked to an extent sufficient to bring the necks near magnetic saturation, so that in the event of the magnet losing power the brake pole-piece does not lose in the same proportion.

The vertical spindle F, carrying the motor-disk and the brake-disk, is attached at its upper part to registering wheels and disks, as O, Fig. 1, of any usual construction.

Within the mercury and near to the pole-pieces, but electrically insulated from them, I place conducting-strips G G′ as close as possible without touching to the periphery of the motor-disk. To these pieces G G′, I connect the terminals H H, to which the wires carrying the main current to be metered are led by way of the tubes H′ H′, which tubes pass through the base of the instrument. The current passes from one of these pieces through the mercury into the edge of the motor-disk D, and it is confined in its course by the slits cut in the disk D, (slits shown at Fig. 4,) so that it passes almost straight across the disk, through the other edge, into the opposing piece G′. That is, the current instead of passing from the circumference of the motor-disk to the center and out at the center, as in former meters, passes right across the disk from one side to the other, that is, twice across the radius. By this device I am enabled to increase the diameter of the motor-armature to a very considerable extent without diminishing the strength of the field, and by applying my driving force at a greater diameter and utilizing the poles of opposite polarities at each side of the disk, while also limiting the area affected by the magnet-poles, I am enabled to greatly increase the torque of the motor-disk. In an arrangement such as this, for example, I may double the intensity of the magnet-field by rearranging the magnet-circuit as described, and I also double the radius and double the effect by causing the current to flow twice across the radius. In this way for a given current it is possible for me to give eight times the driving force to the motor-disk as compared with present meters, minus, however, a small escape of current due to part of the current flowing through the mercury and around by the sides of the disk instead of straight across. In this continuous-current meter I thus cause the current to flow twice across the radius, I double the field by having opposite poles at the opposed sides of the circumference, I limit the current to a path across the disk by the cut armature, and also reduce Foucault brake-currents in the motor-disk, I reduce the area of the armature-field, and I reduce the air-break to half, and so increase the intensity of the field. I obtain my driving-line at double the radius, and I arrange my brake-field pole-pieces in parallel with the armature-field pole-pieces instead of in series, and, lastly, I shape my armature pole-pieces so as to reduce Foucault currents. In a meter constructed in this manner the constancy of brake-field is not so necessary as in other constructions, as in the event of fall in the magnetic intensity of the permanent magnets the intensity of the motor-field also falls, and by experiment I so arrange the necking down of the brake pole-pieces that the brake-field falls off to a less extent than the motor-field falls off—roughly, so that the brake-field falls off at about the square root of the motor-field falling off, or, say, half the percentage, and so speed is rendered constant for any strength of magnet-field within wide limits. By these devices I obtain a very narrow or flat meter of small dimensions, giving great accuracy both for small and large currents. In this, as in other meters, the mercury-friction requires to be compensated for at high speeds, and I obtain compensation by winding a wire in series on a piece or part of the motor or the brake magnets. Such a winding on the upper brake bridge-piece is shown at K, Figs. 1 and 3. The connecting-plates L and M, mounted adjustably on pillars rising from the main magnet pole-pieces, are merely structural and do not form part of the magnetic or electrical essentials of the meter.

Although a disk armature and brake is hereinbefore described, it is to be understood that the invention may be readily carried into effect with armature and brake of any other figure of revolution, such, for example, a cylinder.

In explaining the statement that the brake-field pole-pieces are arranged in parallel with the armature-field pole instead of in series it may be said that when poles are in series the lines of force pass right through the series or poles, but when poles are in parallel with each other the lines of force are divided at the top and bottom of each pole. Now, referring to Figs. 1 and 2 of the drawings, it will be seen that the main pole-pieces *a a* of the permanent magnets act on the under side upon the motor-disk D and that the extensions *c c'* are fitted above the pole-pieces. These extensions are the pole-pieces of the brake-disk, and these extensions carry a portion of the lines of force from the main pole-pieces *a a* upward, while the other lines of force pass downward to the motor-disk. In this case the motor pole-pieces are in parallel with the brake pole-pieces.

Having now described my invention, I declare that what I claim, and desire to secure by Letters Patent, is—

1. In an electricity-meter for continuous currents, in which the motor-armature is immersed in mercury and rotates together with the brake in the field of a permanent magnet, in combination, the arrangement of the brake magnetic pole-pieces in parallel with the motor magnetic pole-pieces instead of in series so that the magnetic polarities at the opposite sides of the rotating armature are opposite in kind; and the passage of the current across the armature from side to side instead of from side to center to increase the driving force substantially as hereinbefore described.

2. In an electricity-meter for continuous currents in which the motor-armature is immersed in mercury and rotates together with the brake in the field of a permanent magnet, and in combination, the brake magnetic pole-pieces arranged in parallel with the motor magnetic pole-pieces instead of in series so that the passage of the current is across the armature from side to side instead of from side to center to increase the driving force; and the armature provided with slits, the said armature being filled in at the slits, and coated on both sides with non-conducting composition, only the periphery being left conducting to limit the path of the current across the disk, all substantially as hereinbefore described.

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

GEORGE HOOKHAM.

Witnesses:
EDWARD MARKS,
HERBERT BOWKETT.