No. 701,965. Patented June 10, 1902.

E. THOMSON.

ELECTRIC METER.

(Application filed Oct. 23, 1900.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

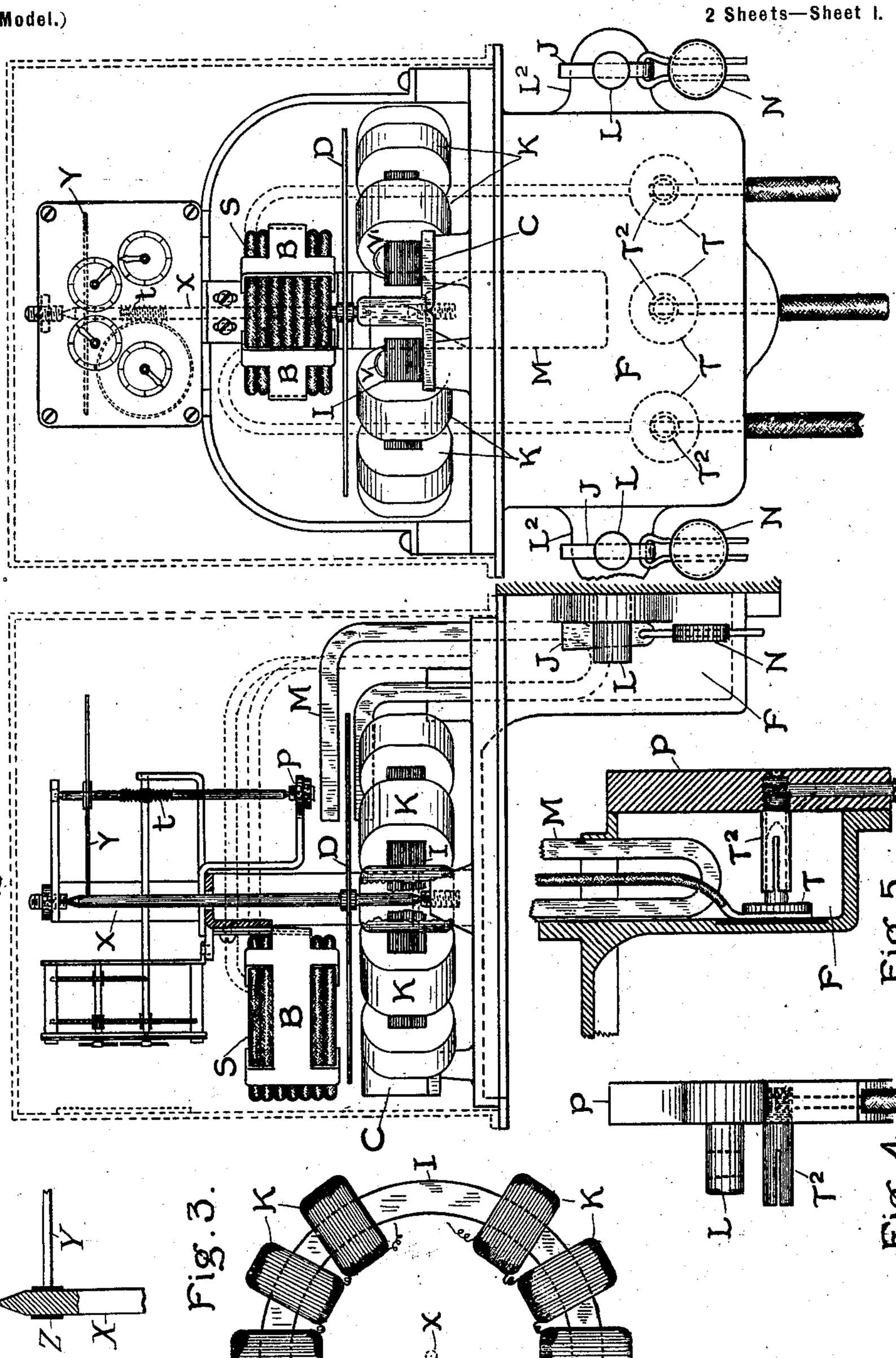


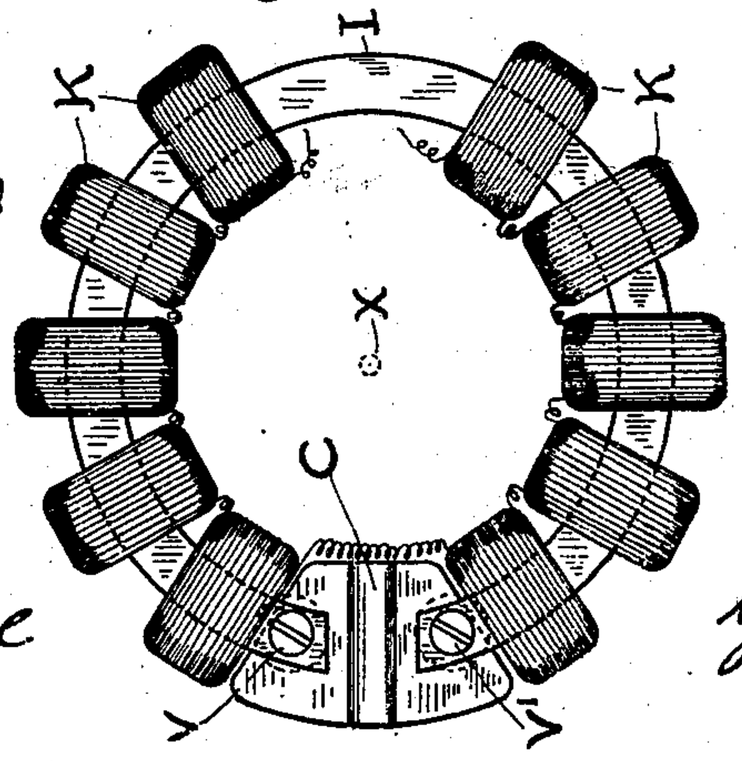
Fig. 2.

Fig. 5.

Fig. 4.

Fig. 8.

Fig. 3.



WITNESSES—
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Benjamin B. Hull

INVENTOR—
Elihu Thomson
by Albert G. Davis
Atty

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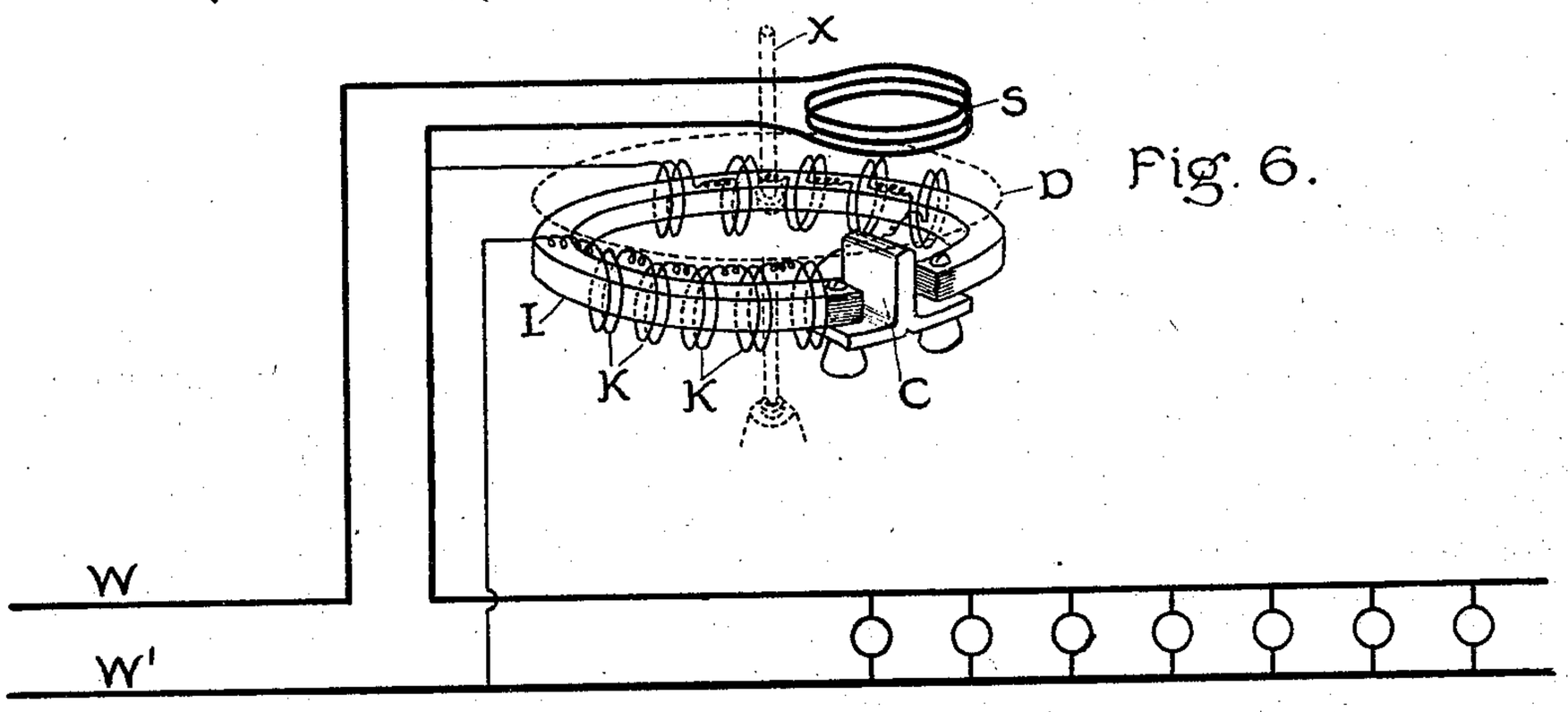

Fig. 6.

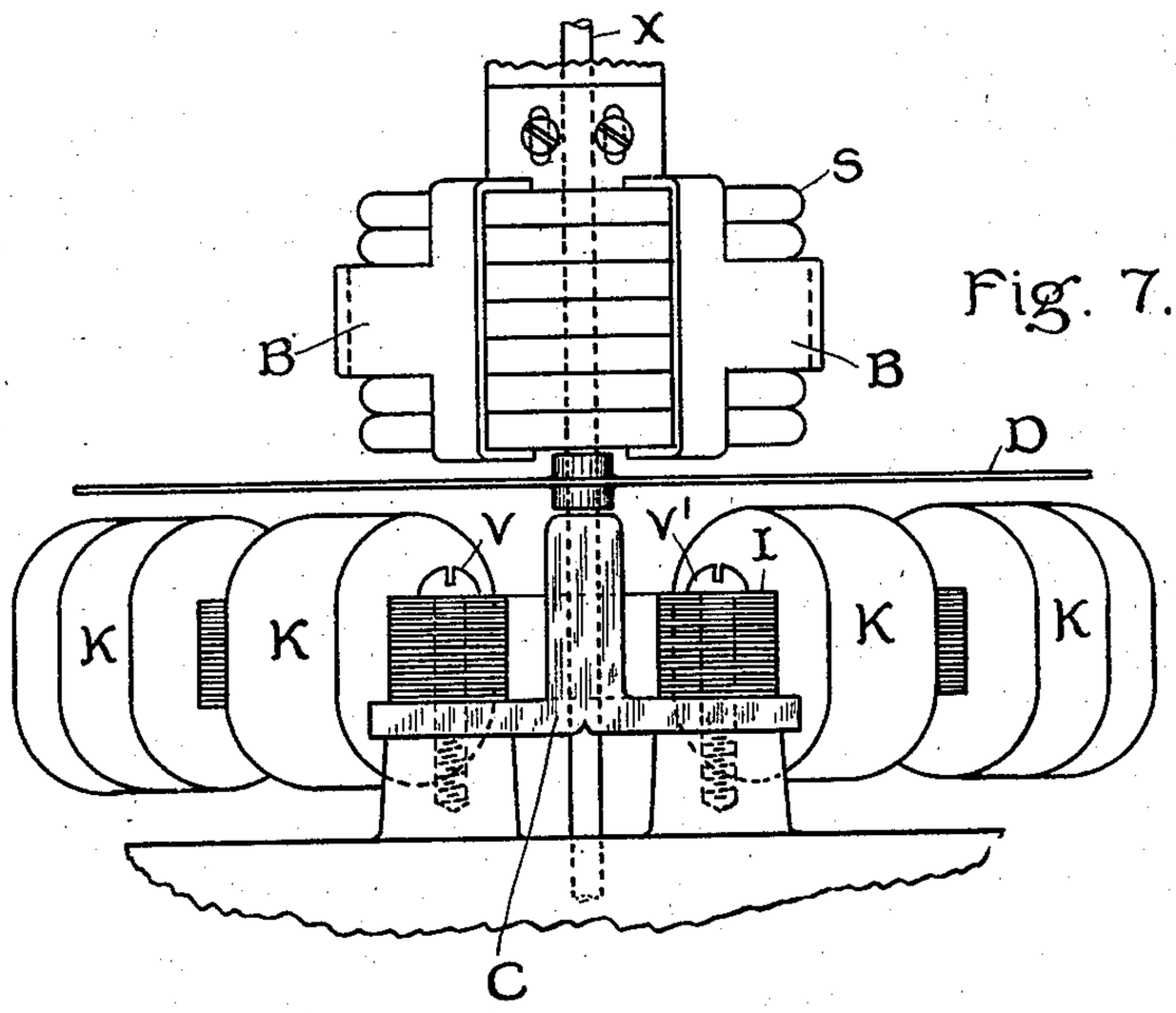

Fig. 7.

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UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF SWAMPSCOTT, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELECTRIC METER.

SPECIFICATION forming part of Letters Patent No. 701,965, dated June 10, 1902.

Application filed October 23, 1900. Serial No. 34,017. (No model.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, residing at Swampscott, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Electric Meters, (Case No. 1,495,) of which the following is a specification.

My invention relates to electric meters, and has for its object to produce a new and improved meter for measuring alternating electric currents which shall be simple in construction, light in weight, and effective in operation.

The invention comprises a new arrangement for obtaining the desired phase displacement of the shunt-field in an alternating-current meter, a new arrangement for transmitting motion from the driving-shaft to the recording mechanism, a new arrangement of the terminal connections, whereby the meter may be readily installed or removed, and certain details of construction hereinafter described.

The character of my invention will be better understood by reference to the following specification, taken in connection with the accompanying drawings, while its scope will be pointed out in the appended claims.

Referring to the drawings, which show my invention applied to a meter of the induction type, Figure 1 is a front elevation of the improved meter; Fig. 2, a side elevation thereof; Figs. 3, 4, and 5, detail views of parts of the meter; Fig. 6, a diagrammatic view showing the actuating elements of the meter together with their circuit connections; Fig. 7, an enlarged front elevation of the actuating elements; and Fig. 8 is an enlarged view in partial cross-section, showing a coating of non-magnetic material on the armature-shaft of the meter.

Referring particularly to Figs. 1 and 2, D is a disk armature mounted on a shaft X, supported at its lower end in a jewel-bearing, as usual. A portion of this armature is included between the poles of the permanent magnet M, which constitutes the retarding-magnet for the meter. At a point removed from the retarding-magnet and above the armature is located a series coil S. On the other side of the armature and arranged in a plane parallel thereto is located the shunt-magnet, comprising a laminated iron core I and a series of coils K, surrounding said core. The shunt-magnet is so positioned that the free poles of the laminated core lie directly below the center of the series coil on either side thereof. Interposed between the poles of the magnet-core is a mass of conducting material C, the function of which will hereinafter be described.

The structure of the shunt-magnet is shown in plan in Fig. 3 and in front elevation in Fig. 7. The coils K, constituting the shunt-winding, are connected in series with one another across the mains through which the current to be measured is supplied. It is not necessary that the core of the shunt-magnet should be constructed as is shown in the drawings. It may be made of a different form than that shown or it may be constructed in sections. The object of the construction shown is to secure as high an inductance as possible in the shunt-circuit, so that the free shunt-field may be as nearly as possible in quadrature with the electromotive force impressed on the shunt-circuit.

The free field across the gap between the poles of the laminated ring I would naturally tend to be greatest directly across the space between the poles and would have a phase displacement somewhat less than ninety degrees behind the field due to the series coil on non-inductive loads. In order to deflect this free field toward the armature and at the same time to give this deflected field a certain increased phase displacement up to ninety degrees on non-inductive load, I insert into this gap a body of copper or other suitable conducting material C. This body of copper has a thick portion constituting a heavy inclosing circuit around the flux between the poles of the ring I. The flux being rapidly alternating in character cannot easily pass through the heavy conducting-circuit which the copper piece presents, and therefore tends to be deflected, so as to pass around the same. This deflection is produced in virtue of the induced currents set up in the copper piece C. In or-

der that the deflection may be toward the armature, the copper body is provided with a portion extending laterally beneath the poles of the shunt-magnet and is also made of considerable width, so that the shortest path around the copper mass is over the top of the portion projecting upwardly between the magnet-poles.

The magnetic flux which actually passes over the part C and affects the armature D comprises two components, one of which consists of a portion of the main shunt-flux actually diverted around the mass C and the other of which consists of a flux due to the induced currents set up in the copper mass itself by that portion of the main shunt-flux which threads the said mass. By properly proportioning the parts the resultant flux which affects the armature D may be made to lag by substantially ninety degrees behind the electromotive force of the circuit in which the meter is included.

In order that the flux may be caused to cut the armature D, it is desirable that the mass C be extended until it almost touches the armature, and, as already stated, in order that the flux may not be diverted in other directions it is desirable that the copper mass be extended to a considerable distance both below and at the sides of the shunt-magnet poles. The mass of copper tends, as it were, to shield the free field and to concentrate the effect on the armature, and at the same time it produces a field acting on the armature which is slightly later in phase than the magnetic flux induced in the core of the shunt-magnet.

The coils K K, constituting the shunt-winding, may be wound separately and inserted in the gap between the poles of the ring I, and so slipped upon the ring before the piece C is placed in position.

In Fig. 6 the circuit connections of the meter are shown. They are the connections usually employed in induction-wattmeters. The series coil is included directly in circuit with the mains W, and the shunt-coils, connected in series with each other, are connected between the mains W and W'. The copper piece C is shown in this figure, and the position of the meter-disk with respect to the shunt and series magnets is indicated in dotted lines. With the arrangement described the armature-disk will not rotate unless current is flowing in the winding S, and its speed of rotation will be proportional to the energy to be measured.

The manner in which the shunt and series windings are supported in position in the meter is shown most clearly in Figs. 1 and 7. The series coil S is adjustably supported from the meter-frame by means of two brass clips B, which are provided with T-shaped ends arranged to be bent over the edges of the coil. The shunt-magnet is supported on bosses extending upwardly from the base or frame of the meter and is fastened in position by two screws V and V'. This construction is shown most clearly in Fig. 7, from which it will be seen that the screws V V' are passed through the ends of the shunt-magnet core and through openings in the lateral extensions of the copper piece C into the framework of the meter. The screws V and V' may be made of iron, if desired, and the heads may be enlarged to project upwardly toward the armature D, so as to assist in determining the flux in this direction, or the ends of the laminæ of the shunt-magnet may be bent upwardly for the same purpose. Although the screws V and V' project, as indicated in dotted lines in Fig. 7, into the framework of the meter, no harmful effect is produced, even though the screws are constructed of iron, for they are each surrounded by a mass of copper where they pass through the lateral projections of the piece C.

In order to reduce as much as possible the friction of the moving parts of the meter and at the same time to render it possible to make the parts small and compact, I interpose a magnetic gearing between the meter-shaft and the recording mechanism. This gearing comprises a thin disk Y, of magnetic material, so positioned that it has a rolling engagement with the shaft X, which is constructed of some magnetic material, preferably of soft steel and which may be slightly magnetized. The disk Y is mounted on a shaft of magnetic material, the lower end of which is pivoted in a bearing *p* in proximity to one of the poles of the retarding-magnet M. The supports for the different parts of the meter are constructed of brass or other non-magnetic material, and therefore the magnetism induced by the retarding-magnet in the shaft upon which the disk Y is mounted finds a nearly-closed circuit of magnetic material through the disk Y and the shaft X back to the other pole of the permanent magnet. The amount of sticking between the edge of the disk Y and the shaft X may be nicely adjusted, so that the disk may be rotated as the shaft X revolves without any considerable frictional resistance. The upper pivot of the shaft upon which the disk Y is mounted is of course made free enough to permit the shaft and the disk to always remain in engagement.

In order to prevent actual magnetic contact between the shaft and the disk, a thin coating of non-magnetic material, such as brass or copper, may be applied either on the shaft or on the edge of the disk, or, if desired, both may be coated. In Fig. 8 I have shown such coating Z on the armature-shaft. The shaft upon which the disk Y is mounted is provided with a worm-gear *t*, which through suitable gearing actuates the recording mechanism in the usual manner. With the arrangement just described a very slight torque exerted on the armature D is sufficient to turn the disk Y through the shaft X, and the advantage of the leverage obtained by this construction materially reduces the retard-

ing effect of the recording mechanism upon the meter-shaft. If the worm-gear *t* were placed directly on the shaft X, not only would the friction be considerably increased, but the parts could not be made so delicate or so small as is possible with the constuction shown, and, as already stated, it is one of the objects of my invention to so construct the meter that it shall be small and compact.

The mechanism of the meter may be covered by any suitable protecting-casing, as is indicated in dotted lines in Figs. 1 and 2.

Below the compartment containing the actuating mechanism of the meter I have provided, as will be seen from an inspection of Figs. 1 and 2, a separate compartment F, containing fixed terminals T, to which the meter-windings are connected. These terminals are arranged to engage with corresponding terminals T^2, carried upon a base or back plate P and placed in permanent connection with the wiring of the building in which the meter is to be installed. By this construction it is possible to wire a building for the installation of a meter without leaving loose ends to be connected to the terminals of the meter-windings. Further, the placing of the meter in position automatically completes the necessary circuit connections, and since the terminals are contained in a compartment separate from the compartment containing the operating parts the meter may be installed or removed without removing the protecting-casing therefrom, and therefore without danger of injury to the actuating mechanism of the meter. The particular type of meter shown in the drawings requires three terminals arranged to engage with corresponding terminals connected to the house-wiring; but this feature of my invention is evidently not limited to any particular number of terminals or to any particular type of meter.

The base or back plate P, upon which the terminals connected to the house-wiring are mounted, may be arranged to constitute a support for the meter, and to this end I have shown this back plate provided with lugs or projections L and the meter-casing with corresponding lugs L^2, having openings therein adapted to receive the projections L. In order to hold the meter in position, a set of keys may be inserted transversely in slots in the projections L. Such keys are indicated at J J, Fig. 1. In order to prevent an unauthorized removal of the meter, these keys may be secured in place by the wires and lead seals shown at N N. The form of fastening device by which the meter is held to the base or back plate may evidently be widely varied without departing from my invention.

The construction and arrangement of the terminals T^2 may also be widely varied, and the compartment F, containing the corresponding terminals T, may, if desired, be entirely isolated from the main compartment of the meter. As shown in the drawings, there is an opening between the two meter-compartments, this opening being provided so that the permanent retarding-magnet may be projected therethrough, thereby rendering it possible to make this magnet occupy a small space laterally.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In combination, a connection-board provided with fixed terminals, and an electric meter having its actuating-windings provided with corresponding terminals constructed and arranged to engage therewith.

2. A connection-board for electric meters, comprising a base and a set of terminals mounted thereon constructed and arranged to engage corresponding terminals connected to the meter-windings when the meter is placed in position.

3. A connection-board for electric meters, comprising a base, a set of terminals mounted thereon constructed and arranged to engage corresponding terminals connected to the meter-windings when the meter is placed in position, and means for fastening the meter to said base.

4. A connection-board for electric meters, comprising a base, a set of terminals mounted thereon constructed and arranged to engage corresponding terminals connected to the meter-windings when the meter is placed in position, and fastening devices for the meter also mounted on said base.

5. In an electric meter, a set of terminals supported from the meter-frame and connected to the meter-windings, said terminals being constructed and arranged to engage a corresponding set of terminals, connected to line, when the meter is placed in position.

6. In combination in an electric meter, a separate compartment, and a set of terminals to which the meter-windings are connected mounted therein, said terminals being constructed and arranged to engage a corresponding set of terminals connected to line.

7. In combination, in an electric meter, a compartment containing the actuating mechanism of said meter and a separate compartment containing a set of terminals to which the meter-windings are connected, said terminals being constructed and arranged to engage corresponding terminals connected to line.

8. An electric meter provided with terminals to which the meter-windings are connected, said terminals being constructed and arranged to engage corresponding terminals on the meter-support when the meter is placed in position.

9. An electric meter provided with terminals to which the meter-windings are connected, said terminals being constructed and arranged to engage corresponding terminals on the meter-support when the meter is placed in position, and means for fastening said meter in position on said support.

10. In an electric meter, a magnetized meter-shaft and a magnetized disk in rolling engagement therewith.

11. In an electric meter, a magnetized meter-shaft, a magnetized disk in rolling engagement therewith, and a layer of non-magnetic material interposed between said shaft and said disk.

12. In an electric meter, a shaft of magnetic material, a disk of magnetic material in rolling engagement therewith, and means for magnetizing said disk and shaft.

13. In an electric meter, a shaft of magnetic material, a disk of magnetic material in rolling engagement therewith, and operatively connected to the recording mechanism, and means for magnetizing said shaft and disk.

14. In combination in an electric meter, a magnetized meter-shaft, a magnetized disk in rolling engagement therewith and means for transmitting the motion of said disk to the recording mechanism.

15. In combination in an electric meter, a permanent magnet, a shaft of magnetic material adjacent to one of the poles of said magnet, and a disk of magnetic material mounted on said shaft and arranged to have a rolling engagement with the main driving-shaft of the meter.

16. In combination in an electric meter, a retarding-magnet, and a magnetic gearing between the driving-shaft and the recording mechanism, arranged to be magnetized by said magnet.

17. In combination in an electric meter, a main driving-shaft of magnetic material, an armature of conducting material mounted thereon, a retarding-magnet having its poles extended to include a portion of said armature, a second shaft operatively connected to the meter recording mechanism, and a disk of magnetic material mounted on said shaft and arranged to have a rolling engagement with the main driving-shaft of the meter, said shafts and said disk being so positioned with respect to the retarding-magnet, that they are magnetized thereby.

18. In an electric meter a means for producing a shunt magnetic flux, lagging by substantially ninety degrees behind the flux due to the series winding on non-inductive load, comprising, in combination, a core of magnetic material constituting a nearly-closed magnetic circuit, a winding thereon connected across the mains, and a mass of conducting material interposed between the poles of said core.

19. In an electric meter a means for producing a shunt magnetic flux, lagging by substantially ninety degrees behind the flux due to the series winding on non-inductive load, comprising, in combination, a core of magnetic material constituting a nearly-closed magnetic circuit, a winding thereon, comprising a plurality of coils separated from one another, connected and across the mains, and a mass of conducting material interposed between the poles of said core.

20. In an electric meter an armature of conducting material, a shunt-winding having its magnetic axis so positioned that it does not intersect said armature, and means for diverting a portion of the shunt-flux toward the armature.

21. In combination in an electric meter, an armature, a series winding having its magnetic axis substantially at right angles to said armature, a shunt-winding having its magnetic axis substantially parallel to the surface of said armature, and means for diverting a portion of the shunt-flux toward the armature.

22. In an electric meter an armature of conducting material, a shunt-winding having its magnetic axis substantially parallel to the surface of the said armature, and means for diverting a portion of the shunt-flux toward the armature.

23. In an electric meter an armature of conducting material, a shunt-winding provided with a core of magnetic material having its magnetic axis substantially parallel to said armature, and a body of conducting material, constituting a closed circuit, interposed between the poles of said core.

24. In an electric meter, an armature of conducting material, a shunt-winding provided with a core of magnetic material having its magnetic axis substantially parallel to said armature, and a body of conducting material interposed between the poles of said core and extending into proximity to the meter-armature, the said body being so extended in other directions that the shortest magnetic path around the body of conducting material is on the side adjacent to the armature.

25. In an electric meter an armature of conducting material, a shunt-winding provided with a core of magnetic material having its magnetic axis substantially parallel to said armature, and a body of conducting material interposed between the poles of said core, said body having portions extended laterally beyond the said poles on the side away from the armature.

26. In an electric meter, an armature of conducting material, a shunt-winding provided with a core of magnetic material substantially concentric with said armature, and means for diverting a portion of the shunt-flux toward the armature.

27. In combination, in an electric meter, a metallic armature, a series winding adjacent to said armature on one side, a shunt-winding, provided with a core of magnetic material, located on the other side of said armature and having its magnetic axis substantially parallel thereto, said core being so positioned that its free poles lie opposite to said series winding, and means for diverting a portion of the shunt-flux toward the armature.

28. In combination, in an electric meter, a

metallic armature, a series winding adjacent to said armature on one side, a shunt-winding provided with a core of magnetic material located on the other side of said armature and having its magnetic axis substantially parallel thereto, said core being so positioned that its free poles lie opposite to said series winding, and a body of conducting material, constituting a closed circuit, interposed between the poles of said core.

29. In combination, in an electric meter, a metallic armature, a series winding adjacent to said armature on one side, a shunt-winding provided with a core of magnetic material located on the other side of said armature and having its magnetic axis substantially parallel thereto, said core being so positioned that its free poles lie opposite to said series winding, and a body of conducting material interposed between the poles of said core and extending into proximity to the meter-armature, the said body being so extended in other directions that the shortest magnetic patch around the body of conducting material is on the side adjacent to the armature.

30. As a means for deflecting flux toward an armature, conducting material in the normal path of said flux.

In witness whereof I have hereunto set my hand this 20th day of October, 1900.

ELIHU THOMSON.

Witnesses:
DUGALD MCKILLOP,
JOHN J. WALKER.