No. 706,982. Patented Aug. 12, 1902.

C. L. R. E. MENGES.

GALVANOMETER.

(Application filed Dec. 28, 1897.)

(No Model.)

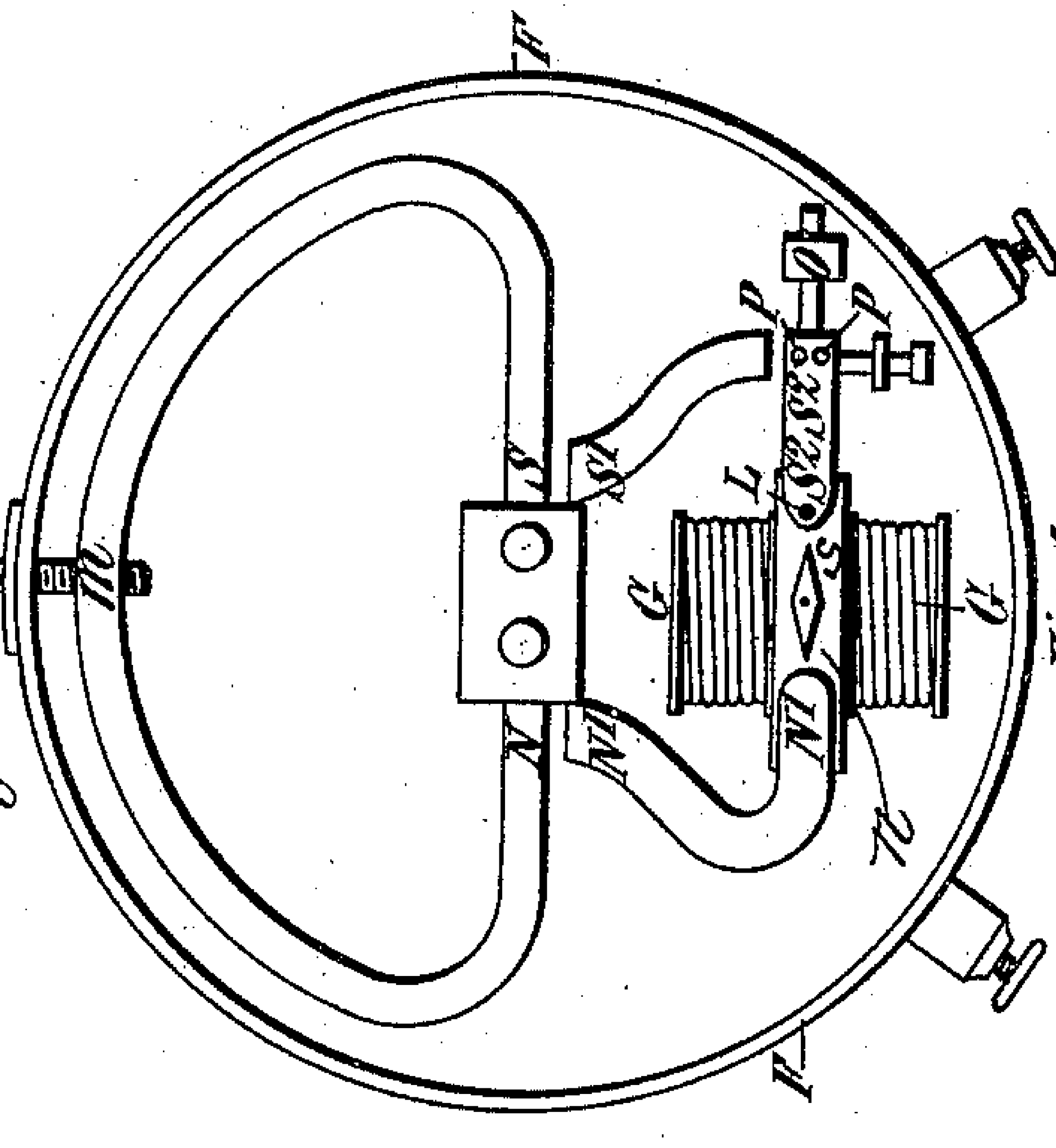

Fig. 3.

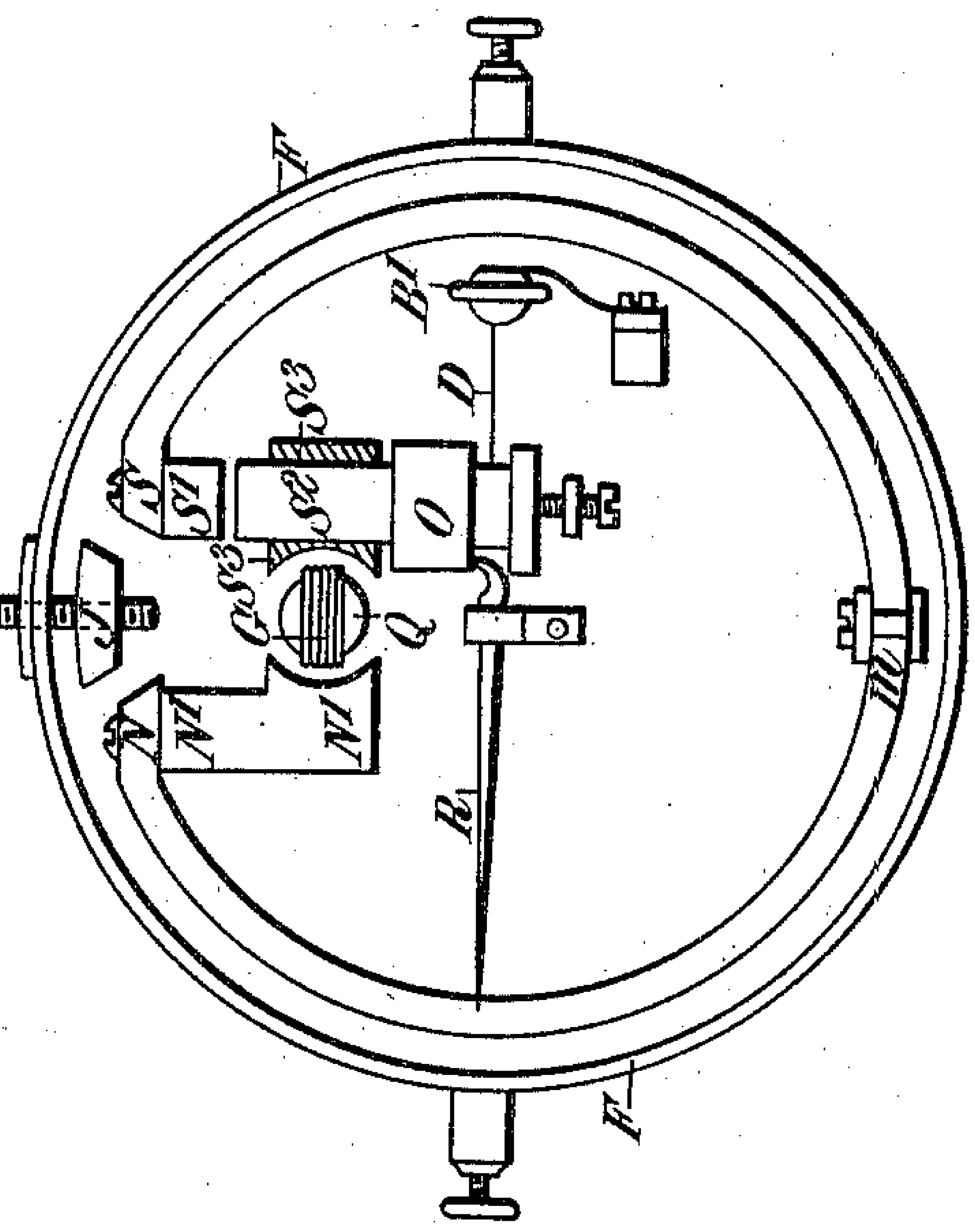

Fig. 4.

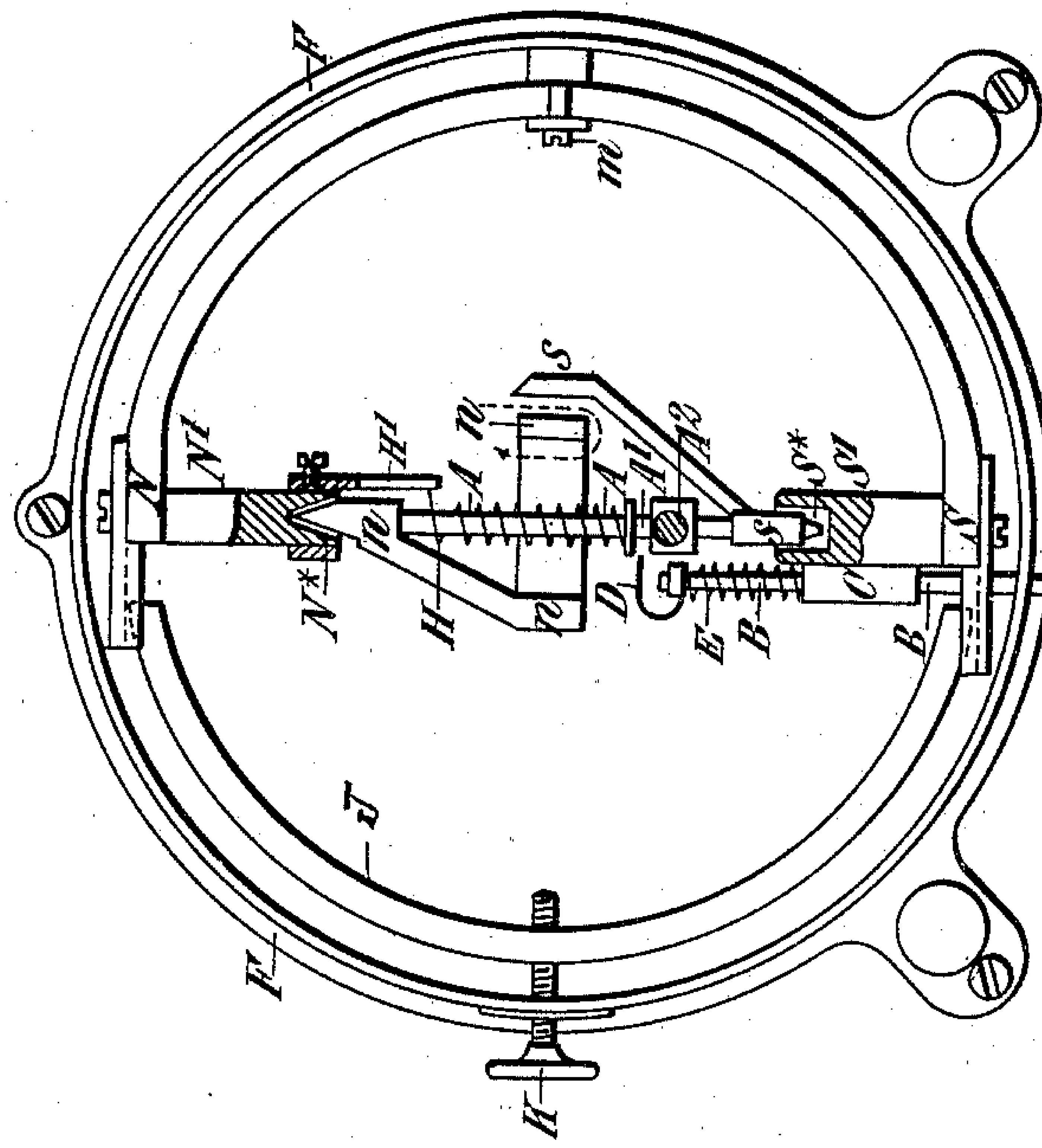

Fig. 1.

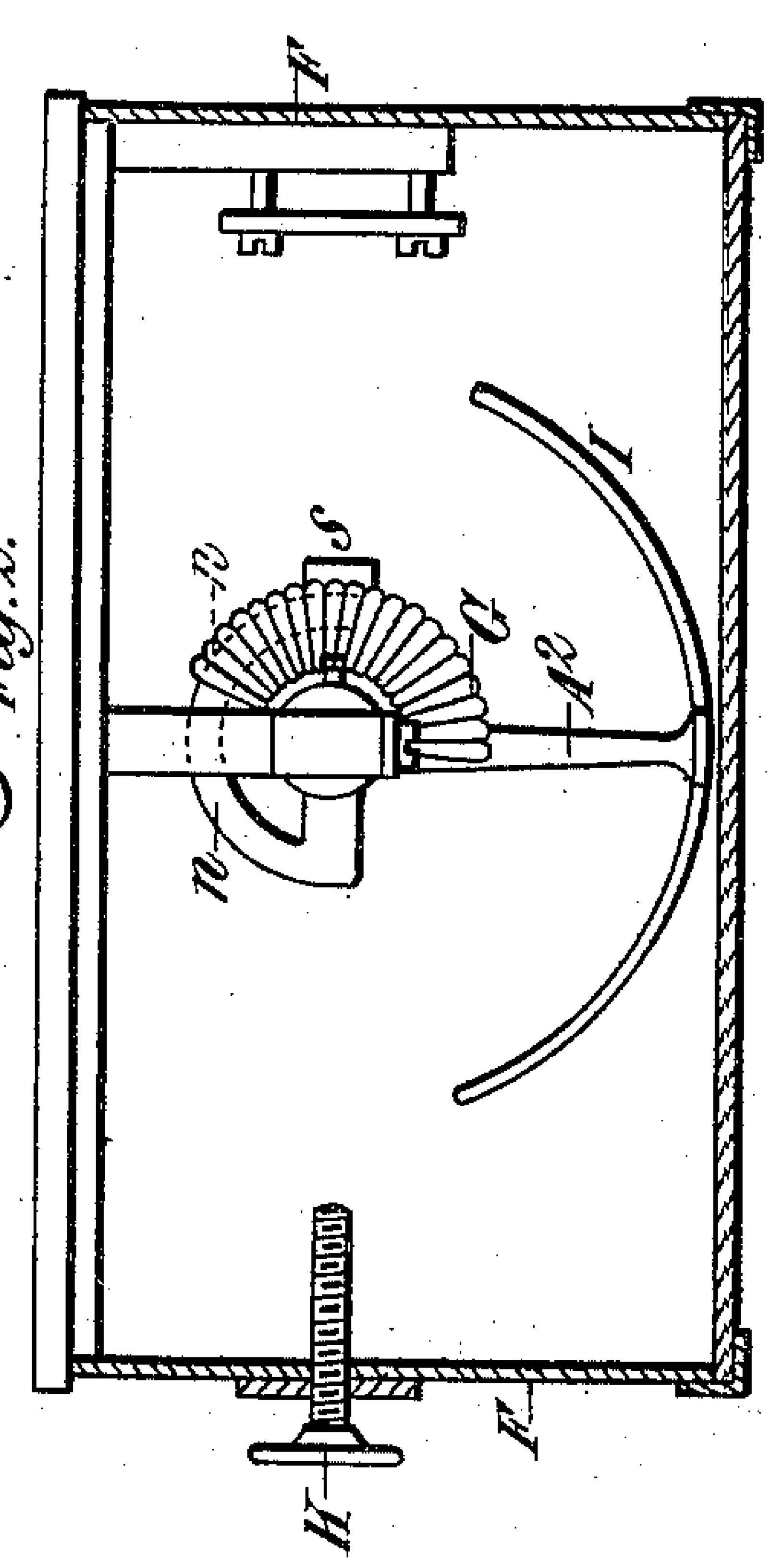

Fig. 2.

Witnesses:
N. L. Bryan
C. L. Kesler

Inventor
Charles L. R. E. Menges
By James L. Norris
Atty.

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

UNITED STATES PATENT OFFICE.

CHARLES LUDWIG RUDOLPH ERNEST MENGES, OF THE HAGUE, NETHERLANDS.

GALVANOMETER.

SPECIFICATION forming part of Letters Patent No. 706,982, dated August 12, 1902.

Application filed December 23, 1897. Serial No. 663,249. (No model.)

To all whom it may concern:

Be it known that I, CHARLES LUDWIG RUDOLPH ERNEST MENGES, electrician, a subject of the Queen of the Netherlands, residing at 82 to 84 Balistraat, The Hague, in the Kingdom of the Netherlands, have invented certain new and useful Improvements in or Relating to Galvanometers, (for which I have obtained patents in Great Britain, No. 1,265, dated January 18, 1895; in France, No. 248,956, dated July 17, 1895; in Belgium, No. 116,592, dated July 18, 1895, and in Germany, No. 83,180, dated January 5, 1895,) of which the following is a specification, reference being had to the accompanying drawings.

My invention relates to self-controllable electromagnetic galvanometers—that is to say, to galvanometers that do not require any separate instrument for controlling them—and especially to galvanometers intended to be used as volt meters or ammeters.

According to my invention a galvanometer is provided wherein the magnetic field is controlled by means of the attraction of one part of the magnetic circuit upon another part in combination with suitable means for varying the magnetic flux. If the magnetic field in such a construction changes, then with the aid of the said controlling apparatus the field can be readjusted to its original strength, so that the deflections of an indicating-pointer produced by given electric currents will be the same as when the apparatus was originally graduated.

My invention may be applied to various systems of electromagnetic galvanometers and can be performed chiefly in the three following methods: first, a method in which the controlling apparatus itself acts also as a current-meter; secondly, a method in which the controlling apparatus conducts the magnetic flux directly to the movable part of the current-meter, and, thirdly, one in which the controlling apparatus forms a separate part of the magnetic circuit between the magnet and the current-meter proper. These three methods are illustrated by the accompanying drawings, in which—

Figure 1 is a front elevation, and Fig. 2 is a plan, of an improved form of galvanometer embodying my invention, the fixed magnet and soft-iron "keeper" being removed. Figs. 3 and 4 are front elevations of galvanometers, illustrating the application of my invention to existing types of galvanometers.

Like letters denote corresponding parts throughout the drawings.

Referring now to Fig. 1, which shows an improved form of galvanometer or current-meter illustrating, by way of example, my first method of controlling such instruments—viz., a method in which the controlling apparatus itself acts also as a current-meter—N *m* S is a magnet to which are attached pole-pieces N′ S′. Between the said pole-pieces is a movable device consisting of magnetizable pole projections *n n n* and *s s*, carried by the upper and lower ends, respectively, of a rod or spindle A, of non-magnetic material. The device *n* A *s* is pivoted at its lower end in a cylindrical recess S* in the pole-piece S′ and at its upper end, which is conical, in a conical recess N* in the pole-piece N′. The bearings N* and S* in the pole-pieces are so arranged that the device *n* A *s* has a small amount of "play" in an axial direction. On account of the conical shape of the upper part of the device *n* A *s* the magnet exerts an upward attraction thereon, and if such attraction is greater than the weight of the said device the latter will be lifted against the conical recess N*. The device *n* A *s* may be moved up and down when desired by a suitable hand contrivance comprising a rod B, adapted to move in a guide-block C, secured to the pole-piece S′ and carrying at its upper end a spring-finger D, adapted to engage at its two extreme positions with the upper and lower faces of an annular groove A′, formed by two collars on the rod A. A spiral spring E, which surrounds the rod B between the finger D and the block C, serves to keep the said finger D normally out of contact with and midway between the two faces of the groove A′, and thus the rotary movement of the device *n* A *s* is not impeded. A knob or button B′ is provided on the rod B, preferably outside the case F of the instrument, by means of which an axial movement may be imparted to the movable device *n* A *s* when desired. The lower part of the pole projection *n n n* is of a semicircular or halfring shape, as shown in Fig. 2, and is arranged to move in a wire coil or solenoid G. This coil is not shown in Fig. 1, but the dotted arrow indicates the direction in which the current should pass around the curved part of the pole projection *n*. A spiral spring H, surrounding the spindle A and connected thereto at one end and bearing against a fixed abutment-finger H′ at the other end, furnishes a force which tends to counteract the turning action of the solenoid G on the lower semicircular part of the pole projection *n n n*. The resulting deflection due to the turning of the device *n* A *s* by the action of the solenoid G may be indicated by means of a fixed pointer (not shown) in connection with a movable cylindrical scale I, which latter is carried by an arm A^2, attached to the rod or spindle A.

J is a soft-iron armature or keeper movable in guides by means of a screw K, whereby its poles can be caused to approach or to recede from the fixed pole-pieces N′ S′. The said armature acts as a magnetic shunt to the magnetic lines. Now disregarding that part of the magnetic flux of the magnet N *m* S which is lost by leakage all of the magnetic lines that do not pass through the keeper J pass through the fixed pole-pieces N′ S′ and the movable pole projections *n n n* and *s s*. By shifting the position of the keeper J we may obtain just sufficient flux through the movable device *n* A *s* to furnish an upward magnetic attraction equal to the weight of the device *n* A *s*, and thus maintain the said device floating in the "field." The equilibrium, however, is unstable. Therefore if the device *n* A *s* be moved by the finger D on the rod B up or down in its bearings it will when it passes a certain intermediate position jump over to the other extreme position, showing thereby that there is exact equilibrium in that intermediate position. If the instrument be now calibrated with respect to the deflections produced by various strengths of current, the instrument will again indicate correctly if, after some alterations in the magnetic field, the magnetic state of the movable device *n* A *s* is restored to its original value by suitably shifting the keeper or armature J. The magnetic leakage cannot have a detrimental effect, since it depends on the shape or configuration of the parts, which remains practically the same, and on the magnetic state, which when altered is again restored to the original state in the main parts of the instrument by shifting the keeper J. Some variable magnetic leakage may occur between the poles of the keeper and the fixed pole-pieces N′ S′; but these points of leakage are so far away from the movable device as to have no detrimental effect.

I may apply my improvements to existing types of galvanometers—such, for example, as a Deprez or Ayrton and Perry ammeter—in which the current-meter proper consists of a movable needle *n s*, placed between coils G G, Fig. 3, the magnetic flux from an adjustable magnet N *m* S being conveyed to the needle *n s* by means of the extended pole-pieces N′ and S′ S^2. In applying my improvements to such an instrument I divide the magnetic circuit by forming one of the pole-pieces in two parts S′ and S^2, and I make the part S^2 adjustable to act as a controlling device for the instrument. For this purpose the said controlling-piece S^2 is pivoted at L at the end nearest the needle *n s*, while its opposite end is capable of being lifted by the attraction of the adjacent part S′ of the pole-piece and is provided with an adjustable counterpoise-weight O. A suitable arrangement may be employed for moving the controlling-piece S^2 up and down to control the attraction of the magnet, as hereinbefore explained, similar to that described with reference to Fig. 1. The two pins P P in this case serve as projections for the spring-finger to engage with. The necessary changes in the magnetic flux are obtained by varying the distance between the adjustable magnet N *m* S and the fixed portions of the pole-pieces N′ and S′ by means of the adjusting-screw K. By shifting the counterpoise O and by a corresponding alteration of the magnetic flux by means of the screw K, so as to maintain the piece S^2 floating in the field, a predetermined deflection of the needle may be obtained for a given strength of current.

In the instrument shown in Fig. 4, which illustrates my third method, the magnetic lines from the magnet N *m* S pass through the divided pole projections S′ S^2 to a pole-piece S^3 and thence to the pole-piece N′ by way of the cylindrical core Q, which is fixed midway between the faces of the pole-pieces N′ and S^3. Around the core Q a wire coil G is adapted to swing, as in the well-known d'Arsonval galvanometer. The part S^2 is adapted to slide within the pole-piece S^3, so as to be easily movable in a vertical direction. A counterpoise-weight O acts against the attraction of the pole S′ on the movable part S^2. The movement of the part S^2 is effected by means of the spring-finger D, operated by the handle B′. The required changes in the magnetic flux are obtained by causing a soft-iron armature or keeper J to approach or recede from the pole-pieces N′ S′. The movement of the movable pole-piece S^2 may be indicated on an enlarged scale by means of a long pivoted pointer R. A glance at the instrument then suffices to see whether the magnetic attraction is still sufficient to maintain the movable piece S^2 lifted against the force of gravity. Such an index-finger may obviously be applied to various other forms of instrument.

I may also apply the constant magnetic field obtained in the manner hereinbefore described for calibrating or checking the constants of ballistic galvanometers. For instance, an apparatus may be used the main features of which are similar to that described with reference to Fig. 4. If the terminals of that instrument are connected with the ballistic galvanometer and the coil G is swung around through a definite angle, (by hand or by the action of a spring, for instance,) then a current will be generated therein, which may be used in the well-known manner for calibrating or checking the constants of the ballistic galvanometer. The only difference in construction I prefer to make is that I construct the coil G somewhat larger and more substantial. For the same purpose I may also use other forms of magnetic fields—for example, a ring-shaped field, one pole-piece being cylindrical and surrounded by the other pole-piece. In that case I use a cylindrical coil, which I let drop through the field, as in Hibbert's instrument.

In all the forms of apparatus I have described by way of example I have utilized gravity as the controlling force; but I may obviously also employ a spring for this purpose. I sometimes prefer to use electromagnets instead of the permanent magnets hereinbefore described.

What I claim is—

1. The combination of a magnet, a movable electrically-acting device situated in the magnetic flux produced by said magnet, means for measuring the said magnetic flux, and means for varying the said magnetic flux and adjusting it to the required magnitude as indicated by the said measuring means, substantially as described.

2. The combination of a magnet, a movable electrically-acting device in the field produced by said magnet, a magnetic circuit including an adjustable part and a movable part, and means for adjusting and measuring the magnetic attraction acting on said movable part so as to adjust the magnetic flux to the required magnitude as shown by the said means for measuring the magnetic attraction, substantially as described.

3. The combination of a magnet, a movable electrically-acting device arranged in the field of said magnet, a magnet-circuit provided with a movable part, means for measuring the magnetic attraction on that movable part, and means for varying the magnetic flux so that the magnetic attraction balances the effect of the counteracting force on the said movable part of the magnetic circuit, substantially as described.

4. The combination of a magnet, a magnetic circuit provided with a movable part and an adjustable part, means for varying the relative position of the said adjustable part in order to adjust the magnetic flux so as to produce a definite attraction on the movable part of the magnetic circuit, and means for measuring said attraction, substantially as described.

5. The combination of a magnet, a magnetic circuit provided with a movable part, an adjustable magnet-shunt to the magnetic circuit, means for adjusting said shunt relatively to said magnetic circuit in order to adjust the main magnetic flux so as to produce a definite attraction on the said movable part of the magnetic circuit, and means for measuring said attraction, substantially as described.

6. In a galvanometer, the combination of a magnet, an armature adjustable toward and from said magnet, pole-pieces projecting toward each other, a deflectable device arranged vertically between said pole-pieces, and means for raising said device toward the upper pole-piece to the position where the magnetic attraction counteracts the force of gravity, substantially as described.

7. In a deflectable device for a galvanometer, the combination of a vertical rod or spindle of non-magnetic material, a magnetic piece or pole extending from the top of said rod in an inclined direction and terminating in a curved piece, a stationary segmental coil or solenoid acting on said curved piece; and a second magnetic piece or pole extending upward from the lower end of the aforesaid rod, and terminating opposite the end of the curved portion of the first pole-piece, substantially as described.

8. In a galvanometer, the combination of a magnet, pole-pieces having recesses to receive the extremities of a deflectable device, a magnet-piece on said device forming an extension of the upper pole-piece and terminating in a curved portion, a segmental solenoid acting on said curved portion and a second magnetic piece forming an extension of the lower pole-piece, substantially as described.

In testimony whereof I have hereunto set my hand this 6th day of December, 1897.

CHARLES LUDWIG RUDOLPH ERNEST MENGES.

Witnesses:

H. C. J. GRITTERS,

A. Y. RUELOPE.