L. E. KNOTT.

GALVANOMETER.

APPLICATION FILED NOV. 24, 1906.

901,013. **Patented Oct. 13, 1908.**

2 SHEETS—SHEET 1.

Fig. 1.

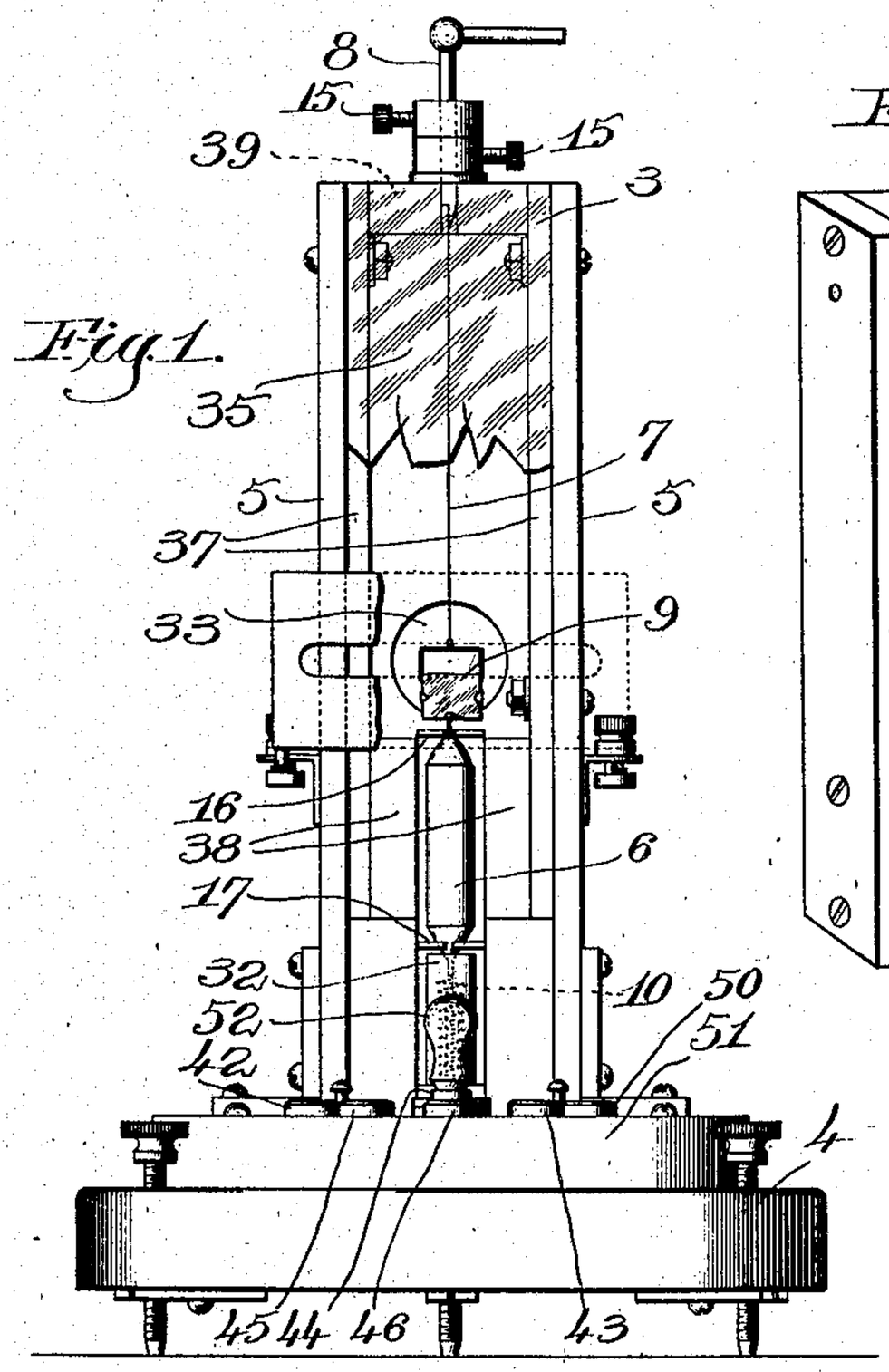


Fig. 8.

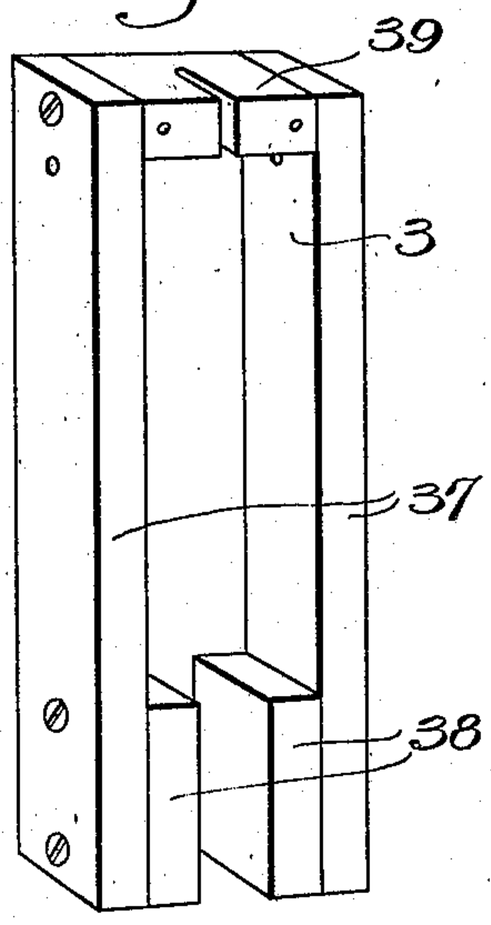
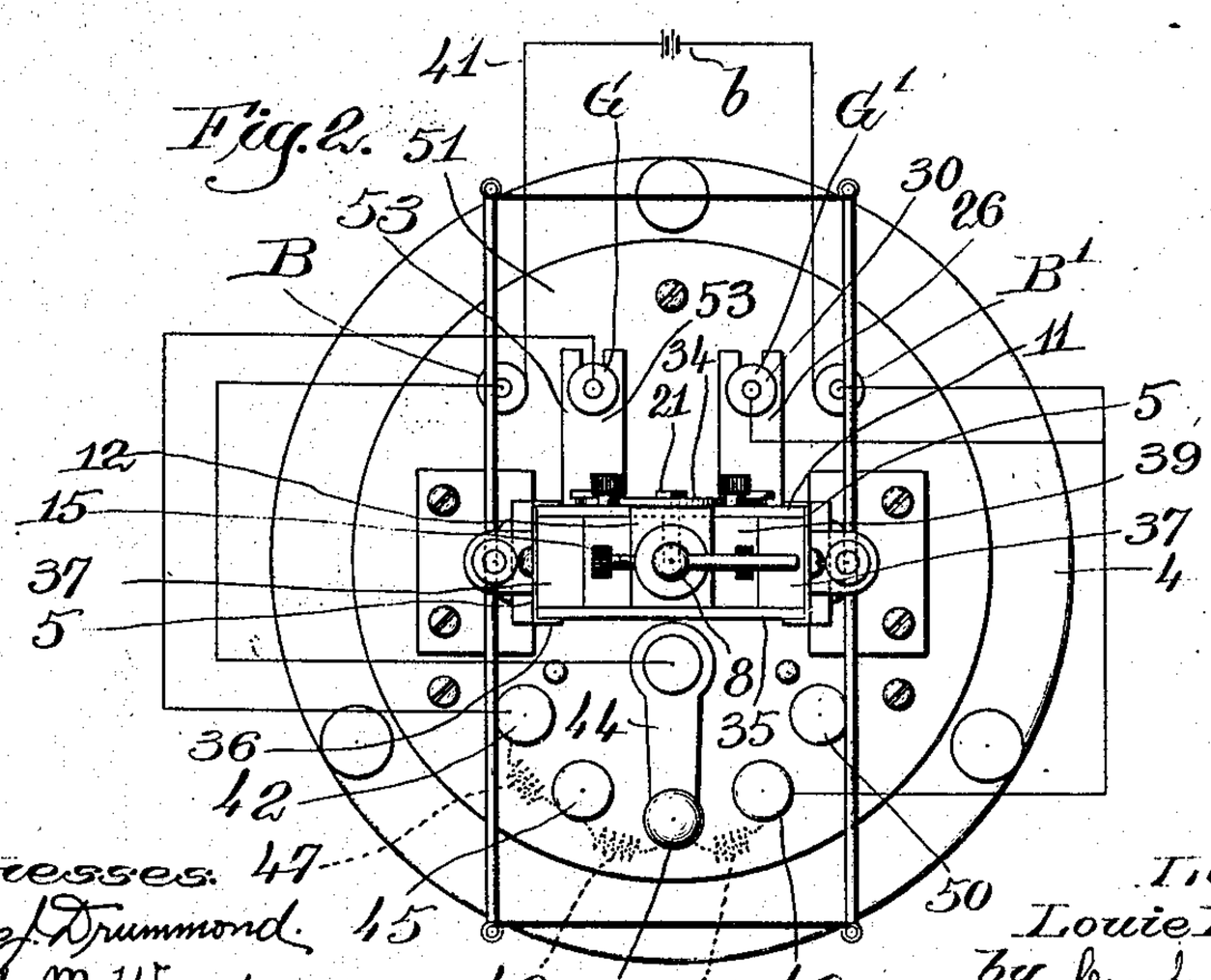


Fig. 2.



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2 SHEETS—SHEET 2.

Fig. 3.

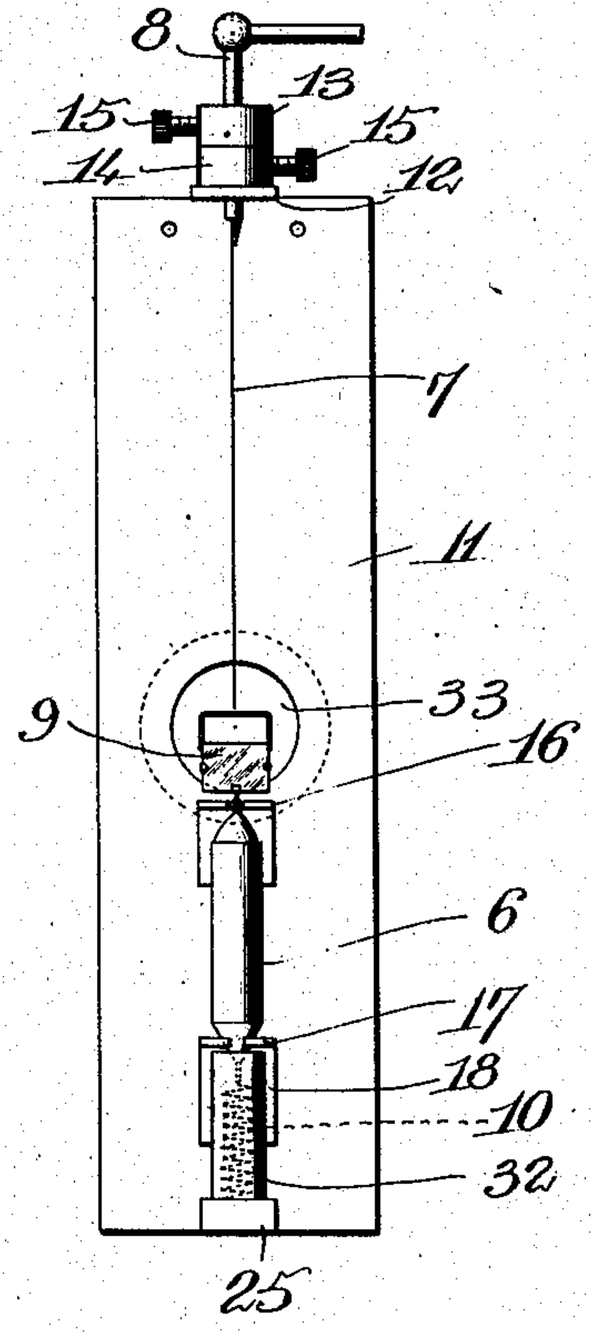


Fig. 4.

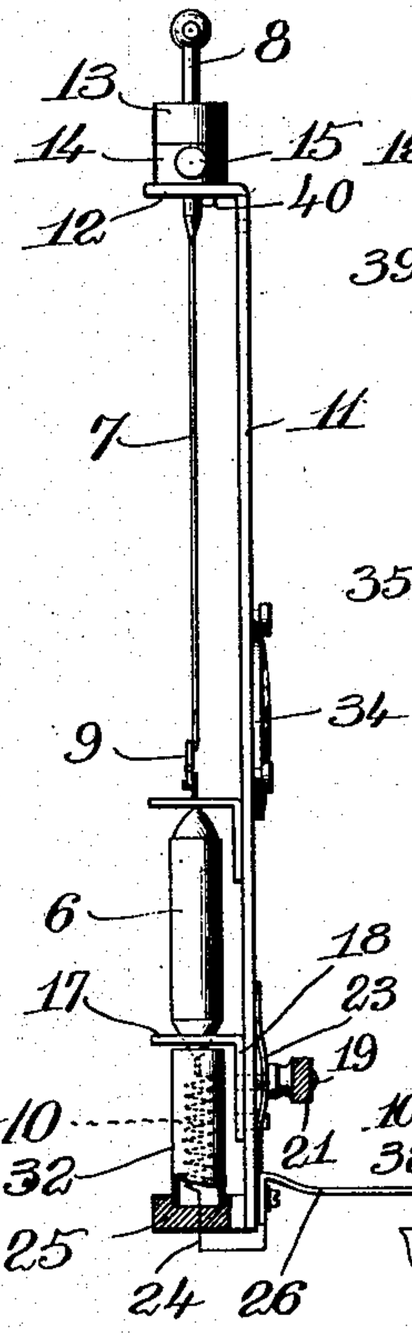


Fig. 5.

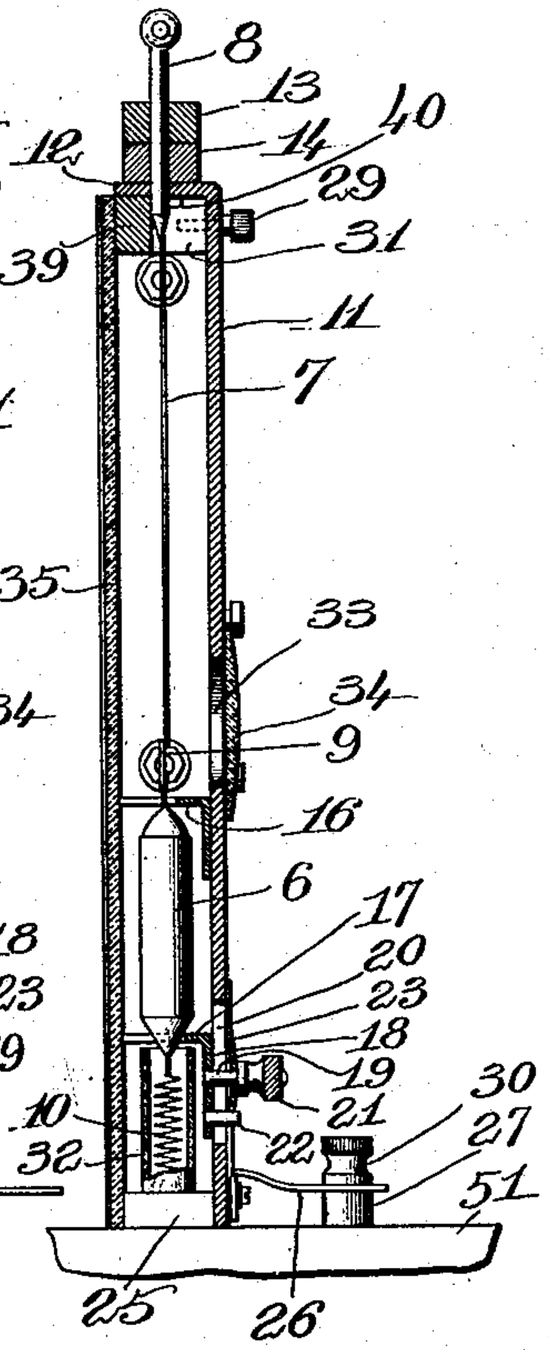


Fig. 6.

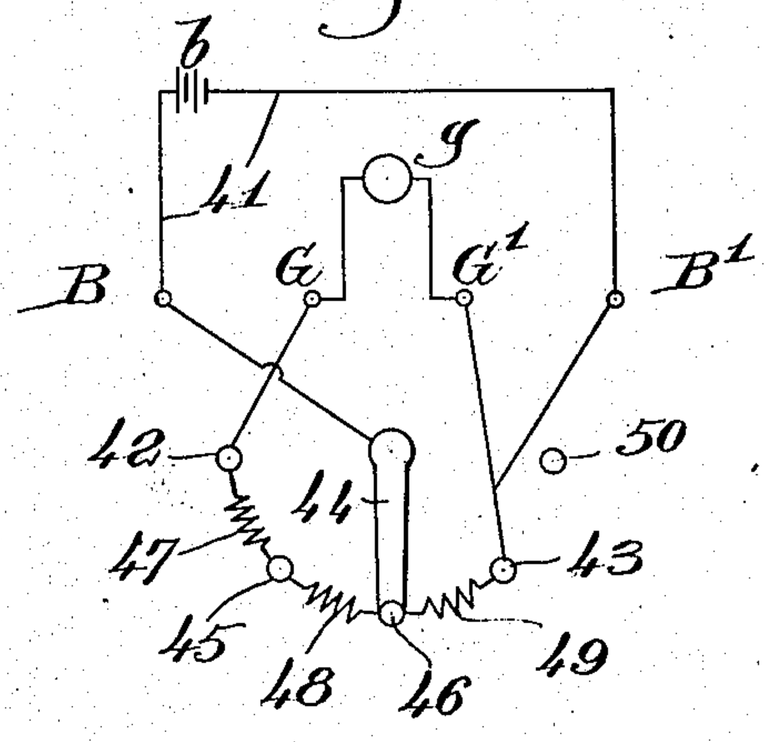
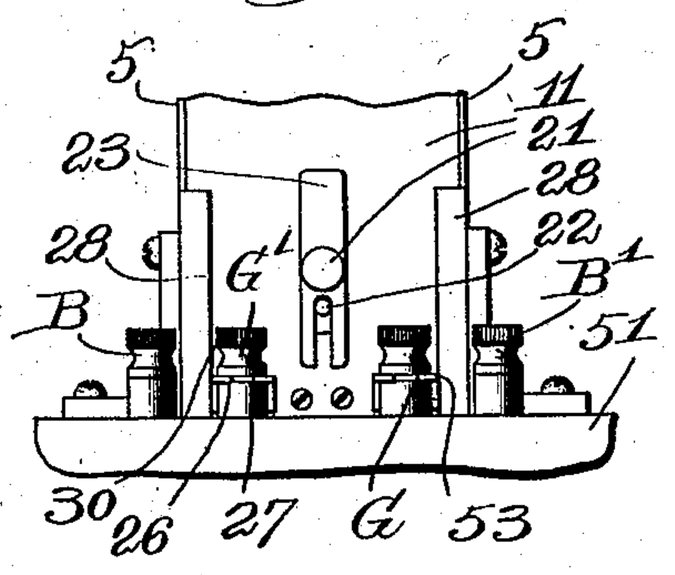


Fig. 7.



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UNITED STATES PATENT OFFICE

LOUIE E. KNOTT, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO L. E. KNOTT APPARATUS COMPANY, OF BOSTON, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS.

GALVANOMETER.

No. 901,013. Specification of Letters Patent. Patented Oct. 13, 1908.

Application filed November 24, 1906. Serial No. 344,836.

To all whom it may concern:

Be it known that I, LOUIE E. KNOTT, a citizen of the United States, residing in Boston, county of Suffolk, and State of Massachusetts, have invented an Improvement in Galvanometers, of which the following description, in connection with the accompanying drawing, is a specification, like letters on the drawing representing like parts.

This invention relates to galvanometers and particularly to galvanometers of the "D'Arsonval" type.

Some features of my invention are especially applicable to a galvanometer of the type shown in Patent No. 813,269, dated February 20, 1906, although other features of the invention are applicable to other types of galvanometers. In the galvanometer illustrated in said patent, the suspension ribbon by which the coil is supported is suspended from a suspension post that is permanently secured to the magnet and the coil is permanently associated with the magnet and cannot be removed therefrom without breaking either the suspension ribbon or the spiral at the lower end of the coil. Both the suspension ribbon and the spiral are very delicate and are easily broken, and if either becomes broken, a new one must be put in place with the coil and other parts in proper position relative to the magnet, and because of the narrow space to work in between the sides of the magnet, this operation is a rather difficult one. To avoid this difficulty, is one of the objects of my present invention, and it is accomplished by providing means whereby the suspension ribbon may be attached both to the coil and to the suspension rod before these parts are associated with the magnet, and after the coil, suspension ribbon, suspension rod and spiral have been properly connected up, the parts thus assembled may be assembled with the magnet to complete the galvanometer structure. To permit this, I have, in this embodiment of my invention, provided for supporting and sustaining the suspension rod, suspension ribbon and coil independently of the magnet and by a member which is detachable from the magnet, all as will be more fully hereinafter described.

Another object of the invention is to provide a novel construction of magnet which can be easily and inexpensively manufactured.

Still another object is to provide a suitable protection for the spiral to prevent it from becoming accidentally broken.

Still another object is to embody in a single instrument both a galvanometer and a shunt or réducteur, and still another object is to provide a réducteur of special form, so that the deflections of the galvanometer when the réducteur is set up at different positions, will have a definite and predetermined relation to each other.

I will first describe one embodiment of my invention and then point out the novel features thereof in the appended claims.

In the drawings,—Figure 1 is an elevation of a galvanometer embodying my invention with the parts thereof broken out to better show the construction; Fig. 2 is a top plan view; Fig. 3 is a front view of the backing piece with the suspension rod, suspension ribbon, and coil sustained thereby separated from the other elements of the instrument. Fig. 4 is a side view of Fig. 3; Fig. 5 is a central vertical section through the portion of the galvanometer above the base; Fig. 6 is a diagrammatical view showing the wiring of the instrument; Fig. 7 is a rear view of the galvanometer immediately above the base; Fig. 8 is a view of the magnet.

In the instrument shown in the drawings which has been selected for the purpose of illustrating my invention, the magnet 3, which is shown as a horse shoe magnet, is mounted on a suitable base 4 and is held in position by the supports 5 which are situated either side of the magnet and which rise from and are rigidly secured to the base 4.

The coil is inclosed within a suitable casing 6 and is suspended by means of a suspension ribbon 7 which is secured at its upper end to a suspension rod 8, said suspension ribbon carrying the usual mirror 9. The lower end of the coil is connected to the spiral 10, which connects with one of the binding posts on the base.

The parts thus far described are substantially the same as the similar parts shown in the Patent No. 813,269, above referred to. In my invention, however, the coil is supported by a member which is independent and detachable from the magnet, while in the device shown in the patent above re-

ferred to, the coil is supported directly by the magnet itself. In my improvement, therefore, the coil, suspension ribbon and the suspension rod may be removed bodily from the magnet without disturbing their coöperative relation. This is provided for in the present embodiment by sustaining these parts on a backing piece 11 which, when in position, lies against the magnet and forms one side of the inclosing case for the coil. This backing member 11 may be of any suitable material and it has extending from its upper end a flange or lip 12, through which the suspension rod 8 passes. Said suspension rod has thereon two collars 13 and 14 provided with clamping screws 15, so that either or both may be clamped to the suspension rod to hold it in adjusted position. These collars are similar to the ones shown in the above mentioned patent. The backing piece 11 has also extending therefrom two arms 16 and 17 between which the case 6 for the coil is suspended. For the purpose of clamping the coil firmly in place and thus taking all the weight off from the suspension ribbon when the instrument is not in use, or when it is to be transported, one of the arms is adjustable relative to the other arm and both arms are provided with apertures to receive the pointed or coned ends of the case 6 when the case is clamped between the arms.

In the present embodiment of my invention, the arm 17 is the adjustable arm and the adjustment thereof is provided for by making the arm with a body 18 carrying a screw-threaded stud or pin 19 which extends through a slot 20 in the backing member 11 said screw-threaded stud or pin having thereon a clamping nut 21. The body 18 is guided in its adjustment by a guide pin 22 which projects therefrom and extends through the slot 20. By loosening the nut 21, the arm 17 may be adjusted upwardly to clamp the case 6 securely in place or may be lowered sufficiently to allow the case to be suspended from the suspension ribbon 7.

If desired, I may employ a spring member 23 between the clamping nut 21 and the backing piece 11 to act as a sort of nut lock and also to take up any loose play between the parts.

The spiral 10, which is connected at one end of the coil, is connected to a terminal 24 located in a block 25 of insulating material which is fixedly secured to the backing member 11, and said terminal is electrically connected with a contact member 26 secured to and projecting from the back side of the backing member 11 but insulated therefrom. This contact member 26 is slotted at its end and is adapted to embrace the binding post 27 rising from the base 4. It will thus be seen that the suspension rod 8, suspension ribbon 7, coil and spiral 10 when assembled, form, with the backing piece 11, a unitary structure. This backing member 11, with the parts connected thereto, as shown in Figs. 3 and 4, may be secured to the magnet or to the supports therefor in any suitable way. I have herein shown the supports 5 as having at their lower ends inturned lips 28 which embrace the lower edge of the backing member and hold it in position. The upper end of the backing member may be secured in place by means of suitable clamping screws 29 which screw into the magnet, as shown in Fig. 5. When the backing piece 11, with its connected parts is thus in position, the flange 12 overlies the top of the magnet, as shown in Fig. 5 and the lower end of the suspension rod 8 is received in a slot or recess 31 formed in the top of the magnet, see Fig. 5. With this construction, it will be seen that by simply removing the clamping screws 29 and removing the clamping nut 30 from the binding post 27, the backing member 11, with the coil, suspension ribbon, suspension rod and spiral may be removed bodily from the magnet, and this may be done without in any way disturbing the operative relation between the parts supported by the backing member and without any liability of breaking or injuring the suspension ribbon, or spiral.

The suspension ribbon 7 is one of the delicate parts of the D'Arsonval galvanometer and is very likely to become broken. Its repair or the placing of a new suspension ribbon in the instrument is a comparatively simple matter with the construction herein shown, because the backing member and its associated parts may be quickly and easily entirely removed from the magnet, thus affording ready access to the parts to which the ends of the suspension ribbon are secured. The spiral 10 is also one of the delicate elements of the instrument, and in order to protect this, I have inclosed it within a protecting tube or casing 32 which is preferably made of glass or some transparent material. The protecting tube herein shown is open at each end and is set into and carried by the block 25 of insulating material. This protecting tube 32 therefore forms one of the elements which is carried by the backing member 11. If the backing member 11 is opaque, as herein shown, it will be provided with a sight opening 33 which will preferably be covered with a piece of glass 34.

As above stated, the backing member 11 forms the back side of the inclosing case for the magnet. The front side of this inclosing case may be formed by the glass or transparent member 35 which is held in place between the magnet and the inturned lips 36 on the support 5, all as shown in said above-mentioned patent.

In order that the instrument may be suffi-

ciently sensitive, it is essential that the poles of the magnet be true and perfectly parallel with each other. Where the magnet is made in one piece, as is shown in said above-mentioned patent, it sometimes requires considerable labor to true the pole pieces up after the magnet has been tempered and magnetized. To produce a magnet in which all necessity for truing up the pole pieces is avoided, I propose to make my magnet in sections, as shown best in Fig. 8, it comprising the two side members 37, the two pole pieces 38 and the bridge, or connecting piece, 39. The pole pieces and the bridge are separate members and the magnet is assembled and completed by securing these various parts together by any suitable means, such as screws, as shown in Fig. 8. The side members, pole pieces and bridge can be readily trued up separately, and when assembled, the pole pieces will always have proper relationship to each other.

The suspension rod is capable of vertical adjustment, as in the patent above referred to, and in order to prevent it from being adjustable vertically a sufficient distance to break the suspension ribbon, I have provided it with stop projections 40, which, by their engagement with the flange 12 prevent the suspension rod from being elevated sufficiently high to break the suspension ribbon.

In operating a galvanometer, it is customary to use in connection therewith a réducteur or shunt coil, by which the amount of current passing through the coil of the galvanometer may be varied, as desired. Heretofore, so far as I am aware, these shunt coils have always been entirely separate from the galvanometer and the use of the galvanometer, therefore, has involved the use of two separate instruments. In my improved galvanometer, I combine in one instrument the galvanometer and the réducteur and provide a single switch for controlling both instruments. The réducteur or shunt coil is so arranged that when the switch arm is moved from one contact to another, the readings of the instrument will increase or decrease a predetermined number of times.

For convenience, I propose to arrange the resistances in this réducteur so that as the switch arm passes from one contact to an adjacent contact, the reading of the instrument will increase or decrease ten-fold. This feature of my invention will, perhaps, be best understood by reference first to Fig. 6, in which the wiring of the galvanometer and réducteur is shown diagrammatically. In this figure, *g* represents diagrammatically the galvanometer, G, G′ the terminals of the galvanometer circuit, 41 the circuit in which the galvanometer is connected and the current of which is to be tested, *b* the battery or source of electrical energy in said circuit and B, B′ the terminals of the battery circuit.

The terminal G of the galvanometer circuit is connected with the contact 42 of the shunt coil or réducteur and the other terminal G′ of said galvanometer circuit is connected with the contact 43 of said réducteur. One terminal B of the battery circuit is connected to the movable switch arm 44 while the other terminal B′ of the battery circuit is connected with the terminal G′ of the galvanometer circuit. Between the contact points 42 and 43 are a plurality of other contact points and between any two adjacent contact points is a resistance coil. In the present embodiment, I have shown two contacts 45 and 46 between the contacts 42 and 43 and the réducteur thus contains the three resistances 47, 48 and 49. These resistances are so proportioned relative to each other and relative to the resistance of the galvanometer circuit, that each time an added resistance is thrown into or out of the galvanometer circuit the readings of the galvanometer will decrease or increase ten-fold. In other words, when the movable arm 44 is in the position shown in Fig. 6, the reading of the galvanometer will be ten times what it is when the movable arm is in contact with the contact 43, and similarly, when the arm 44 is moved over to contact 45, from the position shown in Fig. 6, the reading of the galvanometer will be increased ten-fold, and when the movable arm 44 is moved over to the contact 42, the readings of the galvanometer will be increased again ten-fold.

The instrument will be provided with a dead contact 50 over which the arm 44 will be moved to break the circuit. In embodying this feature of my invention in the instrument shown in the drawings, the variable resistance constituting the réducteur or shunt is inclosed in a casing or housing 51, which is mounted directly on the base 4 and which forms, in effect, part thereof. This casing or housing 51 may also be that part of the instrument on which the magnet is sustained.

In Figs. 1 and 2, the contacts, 42, 45, 46, 43 and 50 are shown projecting slightly above the housing 51 and the resistance is indicated diagrammatically in Fig. 2. The movable switch arm 44 is also shown pivoted to the casing and provided with a handle 52 by which it may be moved from one contact to the other.

The binding post G′, Fig. 2, corresponds to the terminal G′ in Fig. 6, and the other terminal G of the galvanometer circuit is a binding post which is adapted to be received in a slotted end of a contact 53 extending from and electrically connected to the backing member 11. The terminals B, B′ of the battery circuit are illustrated as binding posts to which the battery wires may be suitably connected.

In Fig. 2, the wiring of the instrument is

shown, except the galvanometer circuit and this circuit comprises the terminal G, arm 53, backing member 11, suspension rod 8, suspension ribbon 7, the coil, the spiral 10, the contact 26, (which it will be noted is insulated from the backing member 11), and the terminal G'.

In using the galvanometer, the switch arm 44 is first placed over the dead contact 50, and the connections with the circuit may be as above described. The operator then carries the switch arm 44 over the contact 43, thus completing the circuit. When the switch is in this position, however, all the resistance is in the galvanometer circuit and comparatively little will flow therethrough, so that if the current is a small one, the deflection of the galvanometer may not be sufficient to permit of accurate reading. On the other hand, if the current to be tested is a heavy one, sufficient current may flow through the galvanometer even with all the resistance in to permit of a proper reading of the deflection. If the deflection is found to be insufficient, the arm 44 is advanced to the next contact 46, thus cutting out part of the resistance in the galvanometer circuit, without, however, cutting it out of the battery circuit.

As stated above, the resistances in the réducteur are so proportioned relative to each other and to that of the galvanometer circuit that the deflection of the galvanometer, when the resistance 49 is cut out of the galvanometer circuit, is just ten times that which it is when all the resistance is in the galvanometer circuit.

If, when the switch is in the position shown in Fig. 6, the deflection of the galvanometer is still too small to be properly read, the switch arm 44 may be moved another step forward, thus throwing the resistance 48 out of the galvanometer circuit. This will result in increasing the deflection of the galvanometer ten-fold more, the resistances 48, 49 being so proportioned relative to each other and to that of the galvanometer circuit as to accomplish this end. If the deflection of the galvanometer is still insufficient, the switch arm may be moved one step further or into register with the contact 42, thereby to increase ten-fold more the deflection of the galvanometer. By thus working gradually from one contact to another, a current of any strength can be readily tested without any danger of injuring the instrument. Furthermore, the comparative strength of two different currents can readily be tested and ascertained with my instrument without any complicated arithmetical operations, for, if in testing one current, the arm 4 is placed over contact 46, for instance, while in testing another current said arm is placed over contact 45, the relative strength of the two currents tested can be seen by merely either multiplying or dividing the readings taken when testing one current by ten and then comparing them with the readings taken in testing the other current.

Since the values of the resistances in the réducteur are arranged on the decimal system, it will be seen that the deflection, when the movable arm 44 is registered with the contact 43, is one one-thousandth of what it is when said arm registers with the contact 42, and similarly, when the said arm registers with contact 46, the deflection is one one-hundredth of what it is when the arm registers with contact 42, and when said arm registers with contact 45, the deflection is one tenth this amount. In all positions of the arm 44, however, all of the resistance is on the battery circuit and therefore the shifting of the arm 44 will not cause the current generated by the battery to fluctuate, although it does control the amount which flows through the galvanometer circuit.

Although I have described in detail one device embodying my invention, I do not wish to be limited to the exact construction shown, as obviously many features of the invention may be embodied in other types of galvanometers than that herein illustrated.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. In a galvanometer, the combination with a vertical horseshoe magnet, of a plate overlying one side of said magnet and detachable from the magnet, and a vertically-arranged coil sustained by and removable with the plate and situated between the poles of the magnet.

2. In a galvanometer, the combination with a base, of a vertically-arranged magnet supported thereby, a backing plate overlying one side of the magnet and detachably secured thereto, and a vertically-arranged coil situated between the poles of the magnet and sustained by and removable with said backing plate.

3. In a galvanometer, the combination with a base, of a vertically-arranged magnet permanently sustained thereby, a backing plate detachably secured to the magnet, a coil supported by the backing plate and situated between the poles of the magnet, and a mirror associated with the coil, said backing plate having an opening in line with the mirror.

4. In a galvanometer, the combination with a vertical horseshoe magnet having an open slot in the yoke thereof, of a backing plate overlying one side of said magnet and removably secured thereto, said backing plate having an arm extending over the yoke of the magnet, a suspension ribbon sustained

by said arm and extending through said slot, and a coil carried by the ribbon.

5. In a galvanometer, the combination with a base, of a magnet fixedly sustained thereby, a coil, a member detachable from the magnet and the base, means to suspend the coil from said member, a movable device carried by the member for rigidly clamping the coil thereto, said coil and device being removable from the base and magnet with said member.

6. In a galvanometer, the combination with a base, of a magnet fixedly secured thereto, a member detachable from the magnet and base, a suspension ribbon sustained by the member, a coil secured to said suspension ribbon, and means carried by said member for raising the coil and taking the weight thereof from the ribbon and firmly clamping the coil to said member.

7. In a galvanometer, in combination, a magnet, supporting means therefor, a backing-plate overlying one side of the magnet and detachably secured thereto, a suspension ribbon sustained by the backing-plate, and a coil suspended from the suspension ribbon, said ribbon and coil being removable with the backing-plate.

8. In a galvanometer, in combination, a magnet, a backing-plate overlying one side of the magnet and detachably secured thereto, a coil sustained from said backing-plate and removable therewith, and means carried by the backing-plate to relieve the ribbon from the weight of the coil and to clamp the coil in fixed position.

9. In a galvanometer, in combination, a vertically-arranged magnet, supporting means therefor, a backing-plate detachable from said magnet and its supporting means, a suspension rod sustained by the backing-plate, a suspension ribbon secured to the suspension rod, and a coil hung from said ribbon, said coil and ribbon being removable with the backing-plate.

10. In a galvanometer, the combination with a magnet, of a transparent plate overlying one side thereof, a backing plate overlying the other side thereof, said plates and magnet forming a coil-receiving chamber, and a coil carried by the backing plate and situated within said chamber.

11. In a galvanometer, the combination with a magnet, of a transparent plate overlying one side thereof, a backing plate overlying the other side thereof, said plates and magnet forming a coil-receiving chamber, and a coil carried by the backing plate and situated within said chamber, said backing plate and coil being removable bodily from the magnet.

12. In a galvanometer, the combination with a magnet, of a transparent plate overlying one side thereof, a backing plate overlying the other side thereof and removably secured thereto, said plates and magnet forming a coil-receiving chamber, a suspension ribbon sustained by said backing plate, and a coil carried by the suspension ribbon, said suspension ribbon and coil being bodily removable from the base with said backing plate.

13. In a galvanometer, the combination with a magnet, of a suspended coil, a spiral electrically connected to the lower end of said coil, and a protecting case surrounding the spiral.

14. In a galvanometer, the combination with a magnet, of a suspended coil, a spiral electrically connected to the lower end of the coil, and a tube surrounding the spiral to protect the same.

15. In a galvanometer, the combination with a magnet, a suspension coil, and a spiral connected to the coil, of a backing piece removable from the magnet and constructed to sustain the coil, and means carried by and removable with the backing piece to protect the spiral from injury.

16. In a galvanometer, in combination, a magnet, a backing piece removable from the magnet, a suspension coil sustained thereby, a spiral connected to the coil, and a protecting tube supported by the backing piece removable therewith and inclosing the spiral.

17. In a galvanometer, the combination with a magnet, of a transparent plate overlying one side thereof, a backing plate overlying the other side thereof and detachable from the magnet, a suspension ribbon sustained by said backing plate, a coil carried by the ribbon, a spiral also secured to the backing plate and connected to the coil, and a protecting case rigidly secured to the backing plate and surrounding the spiral, said suspension ribbon, coil, spiral and case being bodily removable from the magnet with the backing plate.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

LOUIE E. KNOTT.

Witnesses:
LOUIS C. SMITH,
MARGARET A. DUNN.