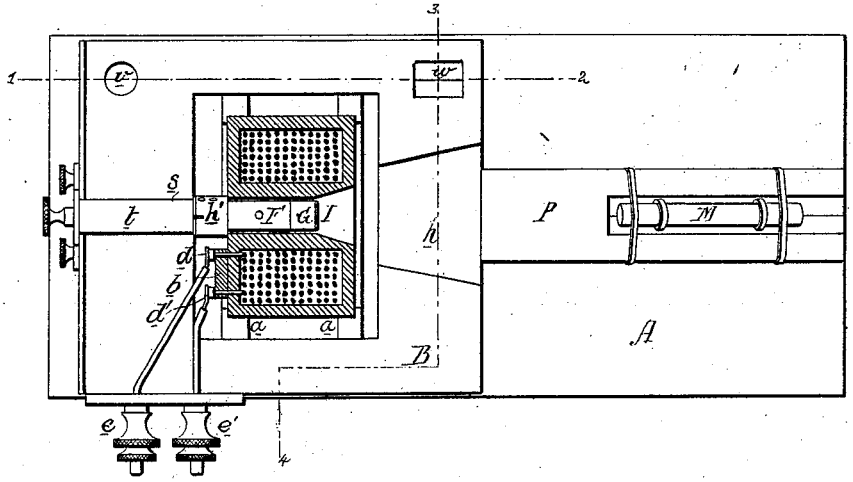
W. THOMSON.

Reflecting Galvanometer.

No. 209,942. Patented Nov. 12, 1878.

FIG. 2.



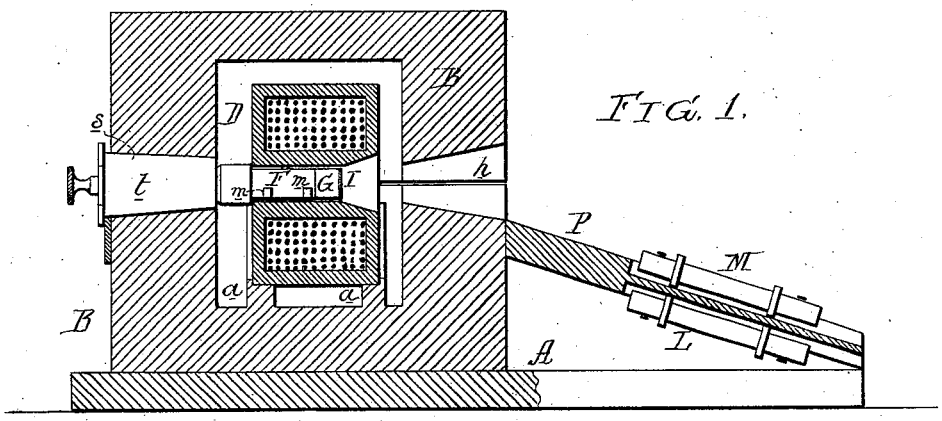




FIG. 1.

FIG. 3.

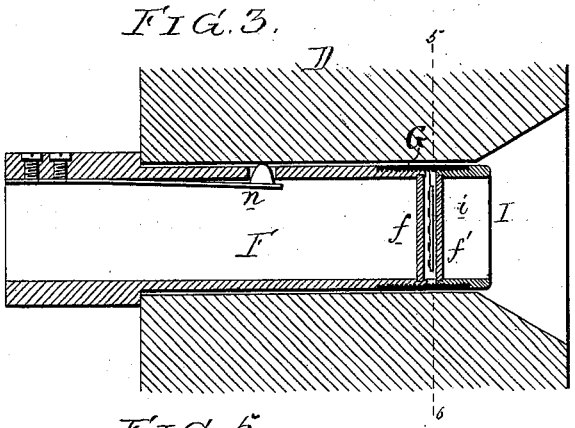



FIG. 4.

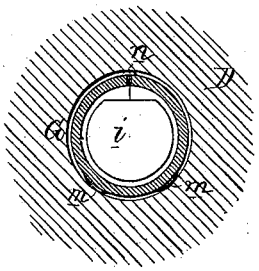



FIG. 5.

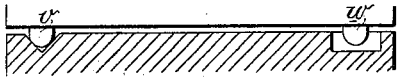
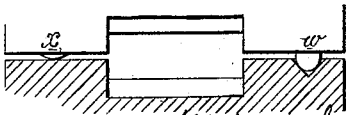



FIG. 6.




Witnesses. Harry Smith
Thomas McIlvain

Inventor: William Thomson
by his Attorneys
Howson and Son

# UNITED STATES PATENT OFFICE.

WILLIAM THOMSON, OF GLASGOW, SCOTLAND.

## IMPROVEMENT IN REFLECTING-GALVANOMETERS.

Specification forming part of Letters Patent No. **209,942**, dated November 12, 1878; application filed January 7, 1878.

*To all whom it may concern:*

Be it known that I, WILLIAM THOMSON, of Glasgow, Scotland, Kingdom of Great Britain and Ireland, have invented a new and useful Improvement in Reflecting-Galvanometers, of which the following is a specification:

My invention relates to certain improvements in the reflecting-galvanometer for which Letters Patent of the United States No. 92,228 were granted to me on the 6th day of July, 1869, the main object of my present improvements being, first, to so construct the instrument that a greater number of observations can be made in a given time than with the former instrument; and, second, to render the needle less sensitive to disturbing influences without making it less delicate in its action.

These objects I attain in the manner which I will now proceed to describe, reference being had to the accompanying drawing, in which—

Figure 1 is a vertical section of my improved reflecting-galvanometer; Fig. 2, a plan view of the same, with a portion of the casing removed and the galvonometer-coil shown in section; Figs. 3 and 4, detached views, drawn to an enlarged scale, and illustrating parts of the apparatus; Fig. 5, a part section on the line 1 2, Fig. 2; and Fig. 6, a part section on the line 3 4, Fig. 2.

A is the wooden base of the instrument, on which, near one end, is placed a cast or malleable iron box or sheath, B, the latter being divided on a horizontal plane at or about midway between top and bottom, so as to form a lower half or base and an upper half or cover. In both the upper and lower halves of the box or sheath B are formed semi-cylindrical recesses, which coincide with each other when the two halves of the sheath are in position, so as to form a cylindrical chamber, in which is contained the galvanometer-coil D, the latter resting on recessed blocks *a* in the under half of the sheath B.

The opposite ends of the wire forming the galvanometer-coil communicate with a block, *b*, against which block spring-plates *d d'* bear when the said coil is in position, the said spring-plates *d d'* being in communication with the binding-posts *e e'*, so that the latter constitute in effect the terminals of the galvanometer-coil D. To the central opening of this coil D is adapted a tube, F, which is open at the rear end, but closed at the front by a glass plate, *f*. The front end of the tube F is threaded, for receiving a threaded ring, G, to which is adapted another threaded ring, I, having at the inner end a glass plate, *f'*, similar to the plate *f* of the tube F. (See Fig. 3.) Within the ring G, about midway between its opposite ends, is hung, by means of a fine fiber, the mirrored needle, consisting of a mirror, *i*, with four small steel magnets secured to its rear face, as described in my former patent. (See Figs. 3 and 4.) This mirror is of such a diameter that it will hang freely, but so that it can have no material lateral vibration, within the ring G.

The extent to which the mirrored needle is at liberty to swing around on its suspension-fiber, under the influence of the electric current passing through the coil D, will depend upon the distance between the glazed ends of the tube F and ring I, which form the ends of the chamber in which the mirror *i* is suspended. It will thus be seen that by screwing in the tube F into the ring G until the range of the mirror begins to be limited in one direction, and by screwing in the ring I into the ring G until the range of the mirror begins to be limited in the other direction, the chamber in which the needle hangs can be so contracted that the resistance of the air to the motion of the needle may cause a rapid extinction of the oscillations due to any sudden commencement or variation or annulment of deflecting force of the coil upon the needles, thus securing what I term a "deat-beat" action. In other words, the limited size of the chamber prevents the oscillation of the mirror beyond the points where the lines of reflection reach the opposite ends of the screen.

The opening *h* in the front of the sheath B, through which the ray of light passes from the lamp to the mirror and is reflected back to the screen, is formed by recessing the faces of both the upper and lower halves of the sheath.

The tube F is maintained in a central position within the coil D by means of four very small projecting knobs, *m*, and a spring-pin, *n*, by which the said knobs are pressed against the

concave sides of the external tube. The rear end of the tube is slotted at *h'*, Fig. 2, for the reception of a suitable instrument, by which it can be turned so as to bring the point of suspension of the mirror *i* uppermost, when it is desired to do this, without lifting off the upper half of the iron sheath. It can be seen whether this adjustment is needed by looking through the tube from the rear end; and, in order to permit such observation of the mirror without necessitating the raising of the upper half of the sheath B or the removal of the coil D, I form in the rear portion of the sheath, directly in line with the tube F, an opening, *s*, which is closed under ordinary circumstances by a soft-iron plug, *t*, so that the continuity of the iron sheath will not be interrupted.

The upper half of the sheath B is not screwed or clamped to the lower half, but merely rests upon the same; and, in order to insure the accurate adjustment of the said upper half to the lower half, and its maintenance in the position to which it is adjusted, I form in the top of the lower half of the sheath, near one side of the same, two recesses, *v* and *w*, the former of which is conical and the latter a V-shaped slot, with its length in a direction through the center of the conical hollow.

On the under face of the upper portion of the sheath, near one side of the same, are two semi-spherical projections, *v' w'*; and near the opposite side of the sheath, about midway between each end, is a projection, *x*, with slightly-curved face. When this latter projection rests on the top of the lower half of the sheath, and the projections *v' w'* in the recesses *v* and *w*, the upper half of the sheath will be accurately centered and leveled in respect to the lower half, and cannot be easily disturbed.

In front of the sheath B is an inclined table, P, which carries two permanent magnets, L and M, the former of which is fixed and the latter adjustable. These magnets have their poles turned in opposite directions, with their axes in a vertical plane passing through the center of the galvanometer-needle, and perpendicular to the front of the instrument. The two magnets being of equal or nearly equal strength, they will not, when exactly opposite each other, tend to deflect the mirrored needle; but if, when the magnet M is adjusted to a position nearer to the sheath than the magnet L, there is a tendency to produce a movement of the zero toward the right, the adjustment of said magnet M to a position farther away than the magnet L will produce a movement of the zero toward the left. These magnets therefore afford a ready means of adjusting the zero of the instrument.

The degree of sensibility of the instrument may be varied in the following manner, assuming, as an example, that the true north-seeking pole of the needle is toward the left side of the sheath and its true south pole toward the right: In order to diminish the sensibility, a powerful bar-magnet is held on the left side of the sheath, with its length parallel to or in the same direction as that of the needle, and with its true north pole near the iron of the sheath.

The action of the magnet while in this position will be to diminish the directive force of the needle, but after it is withdrawn to leave a permanent increase of directive force due to magnetism induced and retained in the iron sheath of the instrument. The same may be done or the effect increased by holding the magnet similarly on the right side of the sheath, with the true south pole close to the iron of the same. The effect is most symmetrically produced by holding simultaneously two magnets, one on each side of the case of the instrument, with their opposite poles close to the iron of the same, as described above. To increase the sensibility the directive force must be permanently diminished by performing the same operation with the other poles of the magnets.

The needle, having been disturbed by the presence of the inducing-magnet, will, after the magnet is withdrawn, probably assume a position of equilibrium not corresponding with its former position, thus changing the zero of the scale. If it is not convenient to read the deflections from the new zero, it may be changed, as above described, by adjusting the sliding magnet; or the position of the zero may be changed without perceptibly altering the sensibility by holding the true north pole or the true south pole of a magnet toward the center of the front or back of the case of the instrument, with its axis parallel to the side of the case.

The operation of the reflecting-galvanometer having been described in my former patent, it will not be necessary to explain it here.

The advantages of my improved galvanometer may be summarized as follows:

First, the dead-beat arrangement of the mirror, which, by checking the oscillations of the spot of light and bringing it speedily to rest, enables four or five observations to be taken in the length of time hitherto required in obtaining one. This feature also greatly increases the usefulness of the galvanometer as a submarine or land telegraph instrument by rendering it comparatively free from disturbance by earth-currents.

Second, the inclosing of the instrument in an iron box or sheath. When a galvanometer not inclosed in an iron case is set to be very sensitive, unless it is on the astatic system, with two needles, the zero keeps constantly changing. If by a fixed magnet or magnets in the neighborhood of the instrument the directive force is made considerably less than the horizontal component of the earth's magnetic force, then the natural daily changes of the terrestrial magnetic force, and the greater changes which take place on days of magnetic storms, make the instrument so unsteady as to be almost unmanageable. When, however, the instrument is inclosed in an iron sheath, the needle is not sensibly influenced by varia-

tions of the earth's magnetic force, or by disturbances produced by masses of iron or magnets in the neighborhood. The iron sheath offers another advantage by obviating the necessity for the astatic arrangement of needles, thus allowing the dead-beat and the great rapidity of operation thereby secured to be made available for all purposes. Still another advantage of the iron sheath is the very convenient method, above described, of varying the sensibility and adjusting the zero of the instrument by means of magnetism induced in the iron case.

Third, the method of supporting the upper half of the sheath, whereby accuracy in the setting of the same and steadiness in retaining it in its place are insured.

Fourth, the movable magnets, for adjusting the zero of the instrument.

I claim as my invention—

1. A galvanometer-instrument in which the mirrored needle is hung in a chamber for restricting its movement beyond the extreme lines of reflection onto the screen, substantially in the manner described.

2. The combination of the mirrored needle *i* with the tube F and ring I, adjustable, so as to limit the swing of the needle.

3. The combination of the ring G and its mirrored needle with the adjustable glazed ring I.

4. The combination of the ring G and its mirrored needle with the adjustable tube F.

5. The combination of the ring G and its mirrored needle with the tube F, having a glazed end.

6. The combination of the galvanometer-coil, the tube F, its four projecting knobs *m*, and spring-pin *n*.

7. The combination of the galvanometer-coil with an inclosing box or sheath of iron, whereby the terrestrial and other external magnetism is cut off from the said coil.

8. The combination of the galvanometer-coil D and its inclosed mirrored needle *i* with the iron box or sheath.

9. The combination of the mirrored needle with an iron sheath having an opening, *h*.

10. The combination of the galvanometer-coil, having a central opening, in which the mirrored needle is hung, with a box or sheath having an opening, *s*, in line with the central opening of the coil.

11. The combination of the iron sheath having an opening, *s*, with the soft-iron plug *t*.

12. The sheath B, divided on a horizontal plane passing centrally through the openings *h* and *s*.

13. The combination of the upper half of the sheath and its projections *v'*, *w'*, and *x* with the lower half of the sheath and its recesses *v* and *w*.

14. The combination of the iron casing containing the coil and its mirrored needle with an adjustable magnet.

15. The combination of the iron casing containing the coil and its mirrored needle with a fixed magnet, L, and adjustable magnet M.

16. The within-described method of varying the sensibility of the instrument by diminishing or increasing the magnetism of the iron sheath, as set forth.

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

WILLIAM THOMSON.

Witnesses:

JOHN MACGOWAN,

SAMUEL F. COOPER.