

NOTE ON A STRING GALVANOMETER FOR USE ON BOARD SHIP.

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The Department of Terrestrial Magnetism in connection with its ocean work and special duties assigned to it in 1917 has had occasion to design, with the assistance of Dr. W. F. G. Swann, a special form of string galvanometer, which was constructed in the instrument shop of the Department.

The galvanometer is of the string type originally developed by Prof. Einthoven. It is of the permanent-magnet, air-damped pattern. The magnetic field is produced by a laminated magnet consisting of five permanent horseshoe-magnets. These magnets are of the permanent magnet-steel supplied by the Crucible Steel Company of America, and were made following the methods used by the Department of Terrestrial Magnetism for the manufacture of magnetometer magnets.¹ To insure maximum flux-density in the gap, two pole pieces, *P*, of soft iron are attached as shown in the Section *AB* of Fig. 1; the gap for the fiber is 2 mm. wide.

The string element consists of a fine quartz fiber coated with silver or platinum; it is soldered to two cylindrical copper lugs which may be clamped in the standards *S* and *S'* (see Fig. 1). These standards are mounted on the plate *K* which in turn is mounted on the plate *L* by four adjusting sleeves and screws by which the plate *K* may be adjusted to center exactly the fiber in the gap. The tension of the fiber is regulated by means of the milled head *Q* which may be clamped in the screw sleeve *R*. The pitch of the latter is slightly different from that of the screw *E* which is mounted in the second standard *S'*. Because of the slight difference in the two pitches, it is possible to effect readily a fine adjustment of the fiber for tension. It should be noted that the standard *S* is fixed with reference to the plate *K* and that the standard *S'* is attached to a slide mounted between suitable clamps on the plate *K*. It is possible to alter quickly the distance between the two standards *S* and *S'* by unclamping the milled head *Q* and sliding the bar *G* with the standard *S'* one way or the other in the screw sleeve *R*. When the distance desired between the two standards is secured, the milled head *Q* is clamped and the final

¹ Cf. J. A. FLEMING, "Two new types of magnetometers," *Terr. Mag.* vol. 16, pp. 2-3, 1911.

adjustment made. It is thus possible to use a fiber of any length between 93 mm. and 120 mm. In the present instrument the rod *G* is made of phosphor-bronze because invar-steel of proper size could not be obtained. For future instruments it is intended to use invar-steel in order to eliminate any possible effects due to the difference in temperature coefficients for the bronze rod and for the quartz fiber. Suitable cover plates and caps (see Fig. 2) are provided to exclude dust and air currents.

The small deflection of the fiber produced at right angles to the magnetic field by the passage of a current through the galvanometer is observed by projecting the image of the fiber on a glass scale by means of a beam of light passing through the microscopes *M* and *M'* and suitably mounted prisms (see Fig. 2 showing the microscopes but not the attachments for the prisms and scale). One of the microscopes serves as the optical condenser. The microscopes are mounted on adjustable carriers on either side of the central magnet-section, holes of suitable size being drilled through the section to permit the necessary adjustments of the objectives by the fine focusing arrangements. The diameter of these holes is 2 mm. greater than the diameter of the tube containing the objectives to permit centering of the microscope on the fiber; the free spaces about the objective tubes are packed with cotton when the instrument is in use.

The galvanometer is mounted in a frame (see Fig. 2) so arranged that it may be set up with the fiber either in a horizontal or a vertical position. The bearings of the axles supporting the magnets with their appurtenances are provided with two clamping screws so that the instrument may be clamped in any position in its bearings.

When used aboard ship it was found that vibrations, for example those from the engine, could be practically eliminated by suspending the galvanometer from the beams in the cabin with strong rubber bands.

The fibers are coated by the method described by Prof. H. B. Williams,² and the resistances range from 2000 ohms upward. Fibers of diameter 0.001 to 0.002 mm. are, on the whole, the most convenient.

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²On the silvering of quartz fibers by the cathode spray, *Physic. Rev. ser. 2*, vol. 4, No. 6, pp. 517-521, 1914.

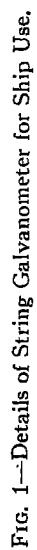


FIG. 1—Details of String Galvanometer for Ship Use.

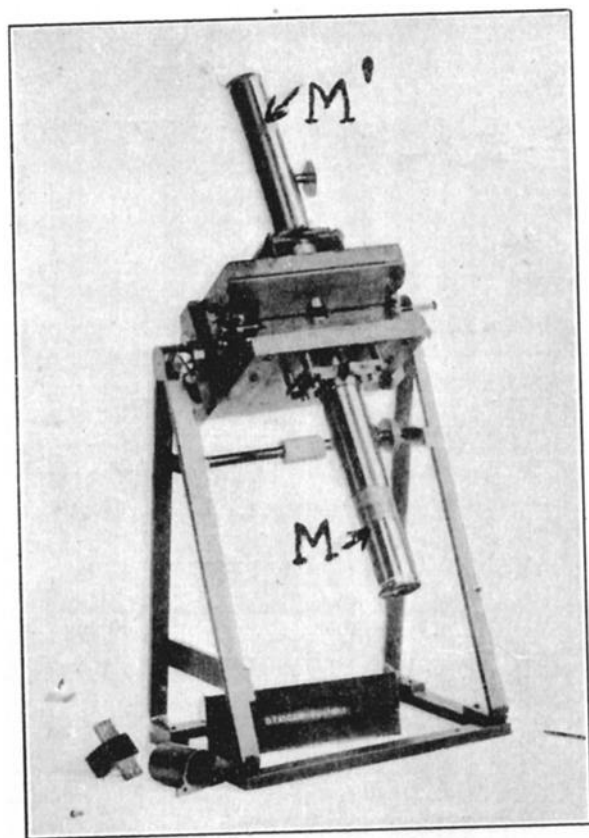


FIG. 2.—String Galvanometer.