MOVING MAGNET GALVANOMETERS

Continued

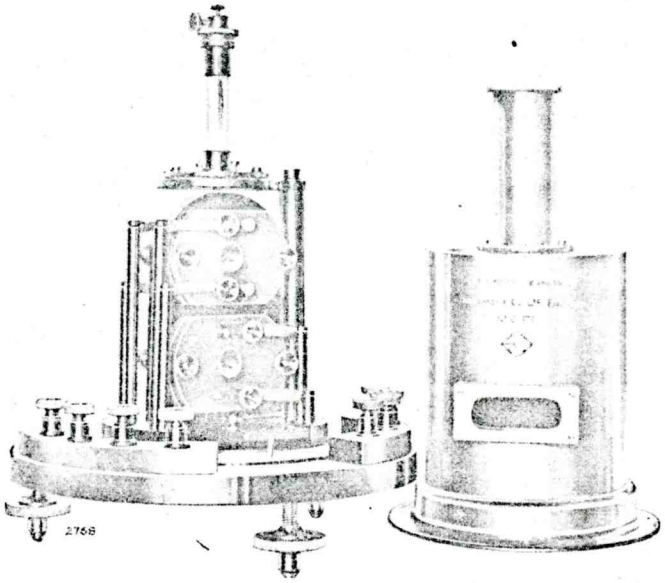

Fig. 16

23 × 23 × 32·5 cm. 7·7 kg.

Paschen Galvanometer.

The design of the galvanometer illustrated in Fig. 16 is the result of investigations carried out by Paschen,[1] Mendenhall and Waidner, and Abbott. It is characterised by its high sensitivity and factor of merit, a comparatively quick period corresponding to a given sensitivity. The resistance, sensitivity and period may be readily varied. Since the suspension is a quartz fibre, there is no instability of zero due to imperfect elasticity of the suspension. In conjunction with a thermopile, the galvanometer is frequently used to take measurements in calorimetry or radiometry.

The moving magnet system, which weighs about 30 milligrammes, consists of two groups, each with thirteen magnets, the magnets being arranged alternatively on opposite sides of a slender glass stem; a mirror is carried midway between the groups of magnets, and the whole is suspended by a quartz fibre 80 millimetres long and approximately 0·00075 millimetre diameter. These dimensions are such as have been found to give the greatest sensitivity consistent with other good qualities.

An outstanding feature of the galvanometer lies in the winding of the four coils, which are arranged in pairs and so designed that they produce a maximum field for a given resistance of copper. This effect is obtained by winding the coils with six sizes of wire, beginning at the centre with the smallest size and finishing with the largest. It has already been pointed out (see page 5) that the deflection of a galvanometer produced by one micro-volt varies approximately inversely as the square root of its resistance. By adopting this compound winding, the ideal conditions for maximum efficiency in this respect are obtained, seeing that, in spite of the large variation in length between the central and outside turns of the coil, the resistance per turn varies approximately inversely as its distance from the centre throughout the whole winding. The coils are shown in section in Figs. 17 and 18. The shape of the winding with each size of wire is such that it lies within a surface, the polar equation of which is $r^2 = d^2 \sin \theta$, where r is the length of radius making an angle θ with the axis of the coil, and d the value of r when $\theta = 90°$.[2] The inner coils are wound in an elliptical shape permitting the use of a greater number of magnets, and producing a field of more efficient shape than would otherwise be obtainable. The coils are fixed on a framework mounted on slides, enabling them to be readily moved apart or closed together; when the relative position of the coils has been adjusted, the framework may be clamped by operating a lever on the base of the instrument. This arrangement simplifies the removal or insertion of the moving system, and enables the sensitivity

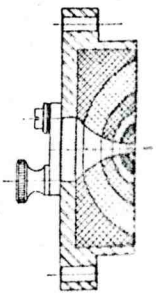

Fig. 17

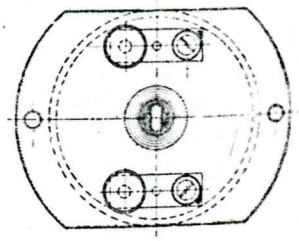

Fig. 18

[1] *Physikalische Zeitschrift*, 1913, p. 521.

[2] Maxwell, *Electricity and Magnetism*, II., 718.

MOVING MAGNET GALVANOMETERS

Continued

Paschen Galvanometer—*continued.*

of the instrument to be readily adjusted. Two terminals are provided for each coil, so that they may be connected in parallel, series parallel, or series without opening the case. To avoid thermo-electric errors, all terminals are made of copper. Standard coils have a resistance in series of about 12 ohms, in series-parallel of 3 ohms, and in parallel of 0·75 ohm respectively. When the galvanometer is to be used with high resistance thermo-piles, a set of coils, each having a resistance of 1000 ohms, can be supplied. These coils give a range of resistance on the galvanometer from 250 to 4000 ohms.

The standard optical system consists of a plane optically-worked mirror 2·5 millimetres square, and a lens of 1 metre focal length. Plane glass may be substituted for the lens when the galvanometer is used with a telescope and scale.

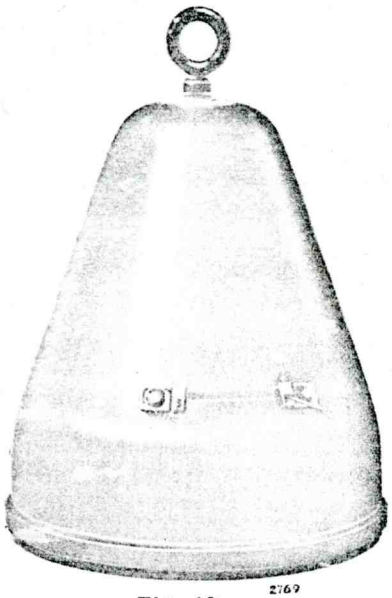

Fig. 19
35 × 35 × 39 cm. 46 kg.

Shields.

The moving system is liable to be influenced by external magnetic fields, and, when the galvanometer is to be used in a position where it is exposed to variable fields, it is necessary to enclose it in a soft iron shield, as illustrated in Fig. 19. Either double or single shields are made; in most cases, however, the single inner shield is found to protect the system sufficiently. The shields are conical in form, and differ only in size; when both are used, the latter encloses the smaller. Each stands on a circular soft iron base plate, the smaller of which carries the galvanometer. In each shield a slit-hole is provided to permit the passage of a beam of light to and from the galvanometer mirror. To enable the zero of the instrument to be set and to facilitate the alteration of sensitivity and period, two control magnets are carried on rods supported on brackets on either side of the slit-hole. To facilitate handling, a ring is fitted to the top of each shield. It has been found that protecting the galvanometer by a single shield reduces a deflection caused by any disturbance to about 5 per cent. of the deflection when the instrument was unshielded. By adding the second shield, the deflection is reduced to about 5 per cent. of that produced when only one shield is used.

By means of the magnetic control the period may be readily varied from 0·5 second to 6 seconds, and, if care is taken in adjustment, to 12 seconds; after this, the instrument becomes aperiodic. When the galvanometer is required for quick period work, as, for example, in conjunction with thermo-piles, a light damping vane may be fitted to the end of the moving system, this vane operating against the face of the lower coil at the back of the instrument. The damping may be roughly adjusted by altering the distance between each pair of coils, and the period by altering the position of the control magnet; fine adjustment is provided by tilting the instrument by means of the back levelling screw, and so bringing the damping vane nearer to or further away from the coil. This vane should not be fitted when the instrument is to be used for long period work.

Some approximate sensitivity data for galvanometers fitted with standard coils are given on page 11.

Cat. No.	Fig. No.	
41211	**16**	**Paschen Galvanometer, with standard coils.**
41212		**High Resistance Coils for above.**
41216	**19**	**Inner Shield.**
41217		**Outer Shield.**