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slide within it, so that by gentle pressure against a hard plane surface the edges of the convolutions can at any time be very accurately adjusted to the same plane. Other forms might doubtless be given to the multiplier, but the cylindrical coil is the most compact and requires for its use the smallest amount of liquid. The labour of double-threading the long strip of beads is considerable, and I have tried to avoid it by substituting a strip of asbestos cardboard, which would allow the coil to be cleansed by the action of the flame as before. But though in other respects satisfactory, the asbestos very rapidly gains in weight through the absorption of the vapour of many liquids, and cannot therefore be used unless wrapped in very thin platinum foil; but when so wrapped it is troublesome to coil, and does not allow the same ready adjustment of the edges of the coil to one plane.

Clifton College, Bristol,
October 16, 1884.

IV. *Note on a Point in the Theory of Pendent Drops.* *By* A. M. Worthington, *M.A.* *

[Plate I. figs. 3–5.]

IN a paper on Pendent Drops (Proc. Roy. Soc. no. 214, 1881) I explained how, from a tracing of the outline of a drop pendent from a circular base, the value of the surface-tension of the liquid could be deduced with an accuracy that compared favourably with that of any other method.

The most difficult part of the process is the measurement at various levels of the inclination of the tangent of the curve to the axis; and I find that this difficulty does not disappear, as I hoped it might, when a photograph of the magnified image of the drop is substituted for a tracing made by hand.

It is essential to the success of the method to measure this inclination at levels where the horizontal sectional area of the drop is widely different. Thus in a drop shaped as in fig. 3 Plate I. it would be desirable to measure the inclination, say, at the level AB and again at the level CD. Now at AB, where the inclination changes very slowly, its value may be very accurately determined; but at CD the change of inclination is rapid and its determination difficult.

It has lately occurred to me that the necessity of finding the value of the inclination at more than one level may be

* Communicated by the Physical Society: read November 22, 1884 (communicated by J. H. Poynting).

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avoided, while that level may be so chosen that the tangent is there vertical or changes its inclination very slowly.

Let ADCE (fig. 4) represent a horizontal circular section of the pendent drop taken at any level; ABC the generating curve in the plane of the paper; DBE the same curve in a plane at right angles to the paper. Consider first the equilibrium as regards vertical forces of the mass of liquid below the plane section. We may equate the vertical component of the surface-tension (T) round the circumference ADCE, to the weight (W) of the liquid below the section + the pressure on the area ADCE; so that, signifying by x the unknown distance of this section from the level of the free surface of the liquid, and by Δ the weight of unit volume of the liquid, we have

$$\mathrm{T}\cos\theta\times\pi\overline{\mathrm{AC}}=\mathrm{W}+\pi\overline{\mathrm{AO}}^2x\Delta\,. \quad . \quad . \quad . \quad \text{(i.)}$$

Again, if we consider the equilibrium, as regards horizontal forces parallel to the plane of the paper, of the mass ABDOE, we see that the surface-tension acting horizontally round the periphery DBE is equal to the hydrostatic pressure on the area DBE + the sum of the tensions across each element of the semicircumference DAE, each resolved first horizontally and then normally to DE. Now the hydrostatic pressure is equal to the area DBE × density of liquid × depth of the centre of gravity G of the area below the level of the free surface, and this depth $=\mathrm{OG}+x$; and I have found that OG can be determined with great accuracy by cutting the figure out of carefully selected writing-paper, and balancing; again the sum of the horizontal tensions across the semicircumference resolved normally to $\mathrm{DE}=\mathrm{T}\sin\theta\overline{\mathrm{DE}}$; so that

$$\mathrm{T}\times\text{length DBE}=\mathrm{T}\sin\theta\overline{\mathrm{DE}}+\text{area DBE }(\mathrm{OG}+x)\,\Delta,$$

or

$$\mathrm{T}(\text{length ABC}-\mathrm{AC}\sin\theta)=\text{area ABC }(\mathrm{OG}+x)\Delta\,; \quad \text{(ii.)}$$

and from these two equations x can be eliminated and T found.

Now the section can be chosen at a place of contrary flexure, where the value of $\cos\theta$ can be obtained with very great accuracy; or, again, if the circular base from which the drop depends be small enough the drop will assume the form shown in fig. 5, in which at a certain level MN the curve is vertical, and $\sin\theta=0$. When this is the case equation (i.) becomes

$$\mathrm{T}\times\pi\mathrm{AC}=\mathrm{W}+\pi\mathrm{AO}^2x\Delta, \quad . \quad . \quad . \quad . \quad \text{(iii.)}$$

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while (ii.) becomes

$$T \times ABC = \text{area } ABC(OG + x)\Delta. \quad . \quad . \quad \text{(iv.)}$$

The method here shown of considering separately the equilibrium first of vertical and then of horizontal forces is equally applicable to sessile drops and to portions of liquid raised by adhesion to a base, and brings out very clearly many results which have hitherto usually been obtained as special cases by rather complicated processes of integration.

Clifton College, Oct. 27, 1884.

V. *On a new Form of Monochord.* *By* Dr. A. Elsass *of Marburg**.

THE monochord has been employed from time immemorial to demonstrate the laws of transverse vibrations. It is used to show that, in producing its fundamental note, a string vibrates in its whole length, but that, in producing the higher partial tones, nodes are formed; and by its means the law of Mersenne can be demonstrated, according to which the fundamental note of a string depends upon its length, its tension, and its mass. In recent times Melde's apparatus has also been employed to show the mode of vibration of the string, which by its means may be made evident to a large audience.

The essential parts of this apparatus are a tuning-fork and a stretched yielding thread, one end of which is attached to the tuning-fork. If the tuning-fork is made to sound, its vibratory motion induces a transversal vibration of the thread, both when the motion of the tuning-fork takes place at right angles to the thread and when it takes place in the direction of its length and the magnitude of the vibrations of the thread is so great that they can be observed from some distance off. The present communication describes a new form of vibration-apparatus which combines the advantages of the monochord and of Melde's apparatus.

In Melde's apparatus the thread is made to assume different forms of vibration by altering its tension, and with it the ratio of its oscillation-period to that of the body which produces the motion; but the oscillation-period itself, which depends upon the period of the exciting body, is not subject to variation.

In the arrangement to be described, however, all variations can be obtained with the same thread by altering the period of the exciting body, so that the law connecting the normal

* Translated from the *Zeitschrift für Instrumentenkunde* for October 1884, from a separate impression communicated by the Author.

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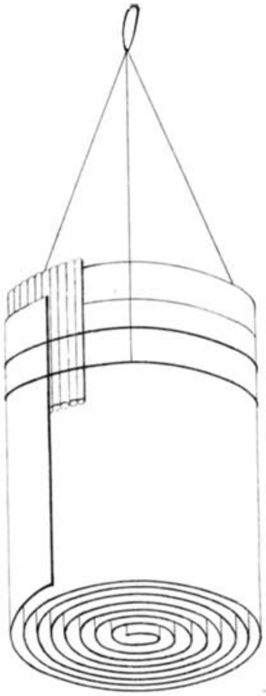
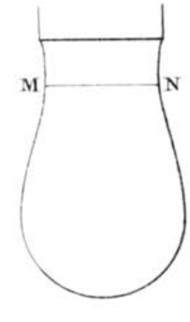


Fig. 1.

Fig. 5.



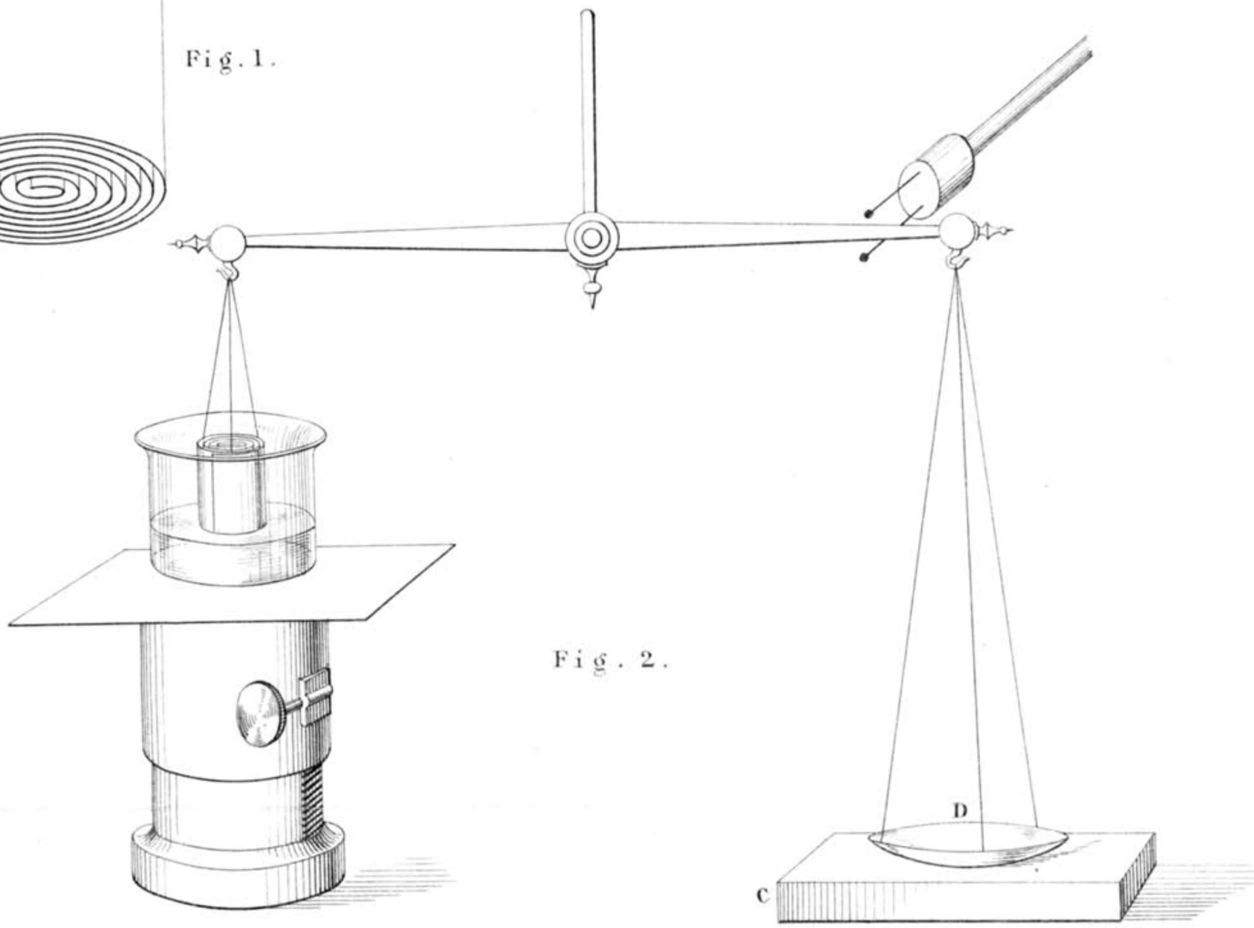


Fig. 2.

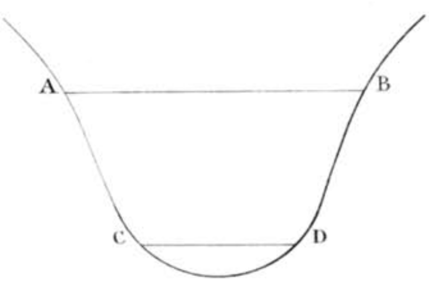


Fig. 3.

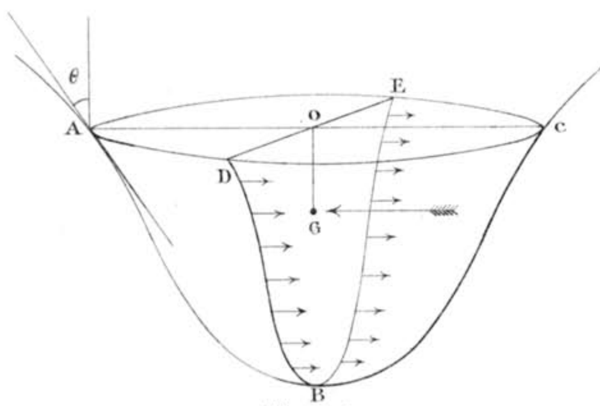


Fig. 4.

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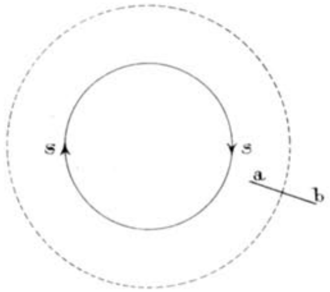


Fig. 1.

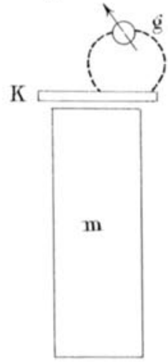


Fig. 2.

Fig. 3.

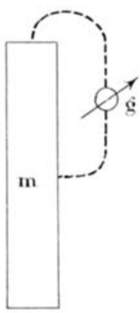


Fig. 4.

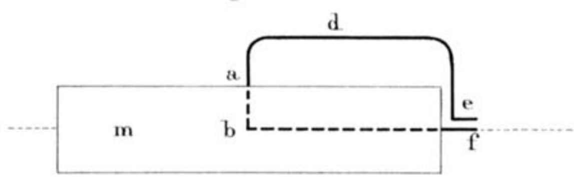
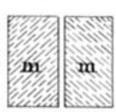


Fig. 4. (bis).



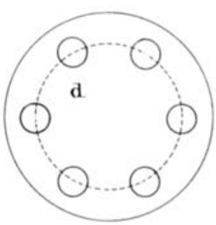


Fig. 5.

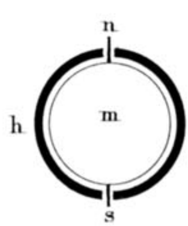


Fig. 6.

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