XII. On a method of determining the sensibility of a balance

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become more penetrating than the radiation characteristic of the absorber, this increase in the absorption being intimately connected with the emission of tertiary radiation by the absorber in these circumstances (see paper on "The Absorption of X-Rays," Barkla & Sadler, *Phil. Mag.* May 1909).

The fraction of this increase in the absorption of the energy of the secondary beam, which is re-emitted as tertiary radiation, is not constant, but decreases as the secondary beam becomes more penetrating, slowly at first, and then more rapidly when a very penetrating secondary beam is used.

In conclusion I wish to thank Dr. Barkla for the interest he has shown throughout this research, and especially for his kindly criticism and advice during the writing of this paper.

George Holt Physics Laboratory,
University of Liverpool,
24th March, 1909.

XII. *On a Method of Determining the Sensibility of a Balance.*
By J. H. POYNTING, *Sc.D.*, *F.R.S.*, and G. W. TODD,
*M.Sc.**

IN the method, as we have arranged it, a small frame (fig. 1, end view) is fixed at the centre of the beam of a 16-inch Oertling balance. This carries two Vs about 2 cm.

Fig. 1.

End view of V frame fixed to balance-beam.

apart, and in the Vs lies a straight wire or fibre about $3\frac{1}{2}$ cm. long, parallel to the beam and level with the central knife-edge. This wire takes the place of the ordinary rider, and

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we shall call it "the rider." Its weight is determined before use as accurately as possible by weighing on an assay balance. The sensibility is determined by moving the rider either to right or left a measured distance. If this distance is d , if the half length of beam is b , and if the weight of the rider is R , the movement is equivalent to an addition of weight to one pan, Rd/b .

In order to move the rider a definite distance a stout horizontal rod (fig. 2) passes through the balance-case from side to side without contact with the case, and is supported at its ends outside, and independent of, the case. It is parallel to the beam and a little lower than the V frame. On the rod are fixed horizontally two Brown & Sharp micrometer-screws divided to $\cdot 01$ mm. and allowing an estimate of $\cdot 001$ mm.

Fig. 2.

Arrangement of right-hand micrometer-screw.

Their axes are in one line coinciding with the axis of the rider, and they are fixed so that one can bear against one end and the other against the other end of the rider. Their ends are plane and the ends of the rider are bluntly pointed. Each micrometer screw-head has a cross piece fixed on it, and a fork which can be rotated about an axis in the continuation of the axis of the screw by a pulley outside the case, can engage with the cross piece, and so advance or withdraw the screw. The pulley is worked by an endless string passing to a pulley at the side of the observer, who is about 2 metres in front of the balance. The micrometer divisions are illuminated and each micrometer is viewed by its own telescope. The position of the balance-beam is read by a double-suspension mirror, telescope and scale. The scale is divided to millimetres and is about 3 metres from the

mirror. The double-suspension mirror is fully described in the Phil. Trans. A, 1891, p. 572. It is of course not essential to the method, but was chosen because of the great magnification of the deflexion which it gives.

Let us suppose that the value of the scale-divisions of the deflexion is to be determined by a movement of the rider from right to left. The two micrometer-screws are withdrawn so that neither is in contact with the rider, that on the left so far that the rider will not touch it in its subsequent travel. The beam is lowered and allowed to swing. Then the right-hand screw is advanced till it bears against the end of the rider and pushes it some small distance. The contact is seen to have occurred by the interference with freedom of swing, as watched in the telescope. The micrometer is then read. Let its reading be m_1 . It is then withdrawn a little so as to leave the rider free, and the centre of swing C_1 is determined in the usual way from three successive turning points. Then the micrometer is advanced again so as to push the rod a little further, and its reading m_2 is taken. It is then withdrawn and the new centre of swing C_2 is taken. If $m_1 - m_2 = d$, $C_1 - C_2$ divisions deflexion are due to an addition of Rd/b to the left pan.

The right-hand micrometer may then be withdrawn and the left-hand micrometer may be brought into action in a similar manner, and so on, the two screws being used alternately.

The balance-case was fixed on a shelf and was enclosed in a tin-foiled wood box with wool loosely packed between box and case. The case and box were provided with plate-glass windows to view the mirror and the micrometer divisions. The following abstract of some determinations of sensibility will serve to show what accuracy may be attained :—

I. Rider German silver wire, 7.35 mgm.

Half length of beam, 20.272 cm.

10 determinations alternately left and right.

Mean travel of rider 2.4850 mm

Mean deflexion 21.26 divisions.

Mean value for 20 divisions ... 0.0848 mgm.

The separate determinations range between

20 divisions = 0.0877

and 20 „ = 0.0824.

II. The same rider.

10 determinations alternately left and right.
 Mean travel of rider ... 5.2713 mm.
 Mean deflexion 45.47 divisions.
 Mean value for 40 divisions ... 0.1681 mgm.
 The separate determinations range between
 40 divisions = 0.1722
 and 40 ,, = 0.1632.

III. Rider German silver wire, 189.05 mgm.

7 determinations alternately left and right.
 Mean travel of rider 0.1764 mm.
 Mean deflexion 38.70 divisions.
 Mean value for 40 divisions ... 0.1691 mgm.
 The separate determinations range between
 40 divisions = 0.1709
 and 40 ,, = 0.1654.

IV. The same rider.

7 determinations alternately left and right.
 Mean travel of rider 0.3004 mm.
 Mean deflexion 64.84 divisions.
 Mean value for 60 divisions ... 0.2578 mgm.
 The separate determinations range between
 60 divisions = 0.2612
 and 60 ,, = 0.2518.

XIII. *The Balance as a Sensitive Barometer.*

*By G. W. TODD, M.Sc.**

IT occurred to the author while testing with Professor Poynting the accuracy of a new method of determining the sensibility of a balance, described on p. 132, in which a thin rod or fibre is used instead of the usual rider, that a balance might with proper precautions be converted into a very delicate barometer.

A difference in volume on the opposite sides of a balance will give rise to motions of the pointer when the density of the surrounding air changes. Small oscillations of the pointer, due chiefly to convection currents, become negligible if this difference in volume is sufficiently large. Alterations in the density of the air are produced by changes in pressure, in temperature, and in the percentage of aqueous vapour in

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