CXXV. AN APPARATUS FOR VIEWING VARYING THICKNESSES OF A SOLUTION WITH A DIRECT-VISION SPECTROSCOPE

By GEOFFREY ARTHUR HARRISON

From the Laboratory of Chemical Pathology, St Bartholomew's Hospital

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THE principle of altering the thickness of a solution during spectroscopic examination is of course an old one, but the writer has not seen a published account of a simple and inexpensive apparatus. That described below can easily be made in the laboratory for a few shillings, and requires little skill mechanically or in glass-blowing. It has the great advantage that 5 ml. of solution can be examined in a layer 5 in. thick.

The apparatus

The four essential parts are a cup, a plunger, a spectroscope above and a light source below.

The spectroscope *S* and plunger *P* are mounted by means of bark corks in a long glass sleeve (*A*, in Fig. 1). The majority of spectroscopes will fit into the sleeve of the dimensions suggested, but should an unusually wide spectroscope have to be mounted, it is an easy matter to alter the dimensions of the mounting parts accordingly. One of the attractions of the apparatus is that a spectroscope already in one's possession can be utilized.

The glass sleeve *A* slides comfortably over a second *B* which carries the cup *C*.

The source of light *L* is a small frosted¹ electric bulb run from the mains supply—a 25 W. standard tubular lamp of appropriate voltage is suitable—but in the absence of a mains supply a motor-car tubular lamp and a battery could be used. The lamp-socket is fixed on a baseboard and connected by the usual flex and plug.

A wooden housing *H* is divided into two parts by a diaphragm *D*. The lower part of the housing covers the lamp, is supplied with ample ventilation holes and fits snugly into the baseboard. The upper part of the housing acts as a sleeve in which slides the plunger-glass-sleeve *A*. The lower cork fixing the bottom of the cup into its glass-sleeve *B* rests on the diaphragm *D*, which is countersunk to receive it, and has a central hole to allow the light to pass.

¹ If the lamp is not frosted, a piece of frosted glass is inserted in the bottom of the lower cork fixing the cup, or is placed in the recess in diaphragm *D* (see Fig. 1).

Fig. 1. Apparatus for spectroscopic examination of varying thicknesses of a solution.

To measure the depth of the solution a mm. scale may be fixed to, or etched on, the outside of the glass sleeve *A*. The zero of the scale is situated in the horizontal plane defined by sighting across the top of the shoulder of the cup, when the bottom of the plunger is touching the bottom of the cup.

List of parts and dimensions thereof

A direct-vision spectroscope is mounted in sleeve *A* by two corks suitably drilled, and provided with a loose cap to protect from dust (see Fig. 1).

The plunger is made from glass tubing¹ with the bottom sealed as flat as possible: length, 7 in.: external diameter, 7 mm.: internal diameter about 5.5 mm. A bark cork is drilled exactly in the centre to hold the top of the plunger tightly; this cork fixes the plunger in its sleeve (see Fig. 1), and must fit the sleeve very tightly so that movement is difficult.

The plunger-glass-sleeve *A* must slide over sleeve *B* easily in all positions: it is made from selected glass tubing: length, 9½ in.: external diameter, about 25 mm. (1 in.): internal diameter, 23 mm.

The cup *C* consists of a shoulder and a stem (see Fig. 1): total length, 6½ in. Its stem is sealed at the bottom as flat as possible, length, 5 in.: internal diameter, 7.5 mm.: external diameter, about 9 mm. The shoulder is blown on to the stem: length, 1¼ in.: external diameter, 19 mm.: internal diameter, about 17 mm. The cup is fixed in its glass sleeve, *B*, by two indiarubber corks suitably drilled and of appropriate size (see Fig. 1). Dimensions of sleeve, *B*: length, 5½ in.: external diameter, 22 mm.: internal diameter, 20 mm. The outside of the stem of the cup is painted black. The space between the shoulder of the cup and sleeve *B* is sealed with paraffin wax to prevent fluid running in (see Fig. 1).

A convenient size for the wooden base is 6 × 6 × 1 in. On the top of it is fixed a wooden flange, which may be made out of ⅞ × ⅞ in. wood; into this flange fits closely the wooden housing *H* and in the centre is the lamp socket (see Fig. 1).

The 25 W. frosted tubular lamp is 92 mm. long and 25 mm. wide (approximately).

The wooden housing *H* may be made out of a block of wood 2 × 2 × 10½ in., with a circular hole drilled through its length, diameter 1⅞ or 1⅝ in. The diaphragm *D* is ⅝ in. thick and may be made out of wood or bark cork. It is fixed about 4½ in. from the bottom and 5 in. from the top of the housing. It is countersunk above to a depth of about ¼ in. to receive the lower cork fixing the cup in its sleeve (see Fig. 1), and has a centrally drilled hole ½ in. in diameter. Just below the diaphragm, the housing is perforated by a number of holes to provide good ventilation.

Notes on assembly

The diaphragm *D* is so arranged and countersunk that in actual use there is about 1 mm. clearance between the bottom of the plunger and the bottom of the cup. The final adjustment may be made by raising (or lowering) slightly the bark cork carrying the plunger in the sleeve *A*, before the spectroscope is fixed. This adjustment is important as it prevents the plunger being forced through or cracking the bottom of the cup.

This having been done, the plunger and cup, in their sleeves, are removed from the wooden housing. The plunger is allowed to rest on the bottom of the cup, and the zero position for the mm. scale is marked on the outside of sleeve *A* whilst carefully sighting across the top of the shoulder of the cup, as described above.

¹ If solid rod is used, it must not be tinted and itself give an absorption spectrum.

With the light on, and the operator looking down the instrument, the alignment of the spectroscope is checked so that good illumination and a clear field are obtained.

Instructions for use

The plunger plus spectroscope in sleeve *A* are lifted clear. The cup is filled with the solution to be examined up to the level of the bottom of the shoulder, not higher, lest fluid overflow when the plunger is in use.

The top part of the apparatus is then returned, the eye is applied and the plunger raised and lowered so as to observe thicknesses of solution varying from 5 in. to 1 mm. It is convenient to place one hand on the top of the wooden housing, making sleeve *A*, which is held by the other hand, slide up and down through the fingers: when the lower rim of sleeve *A* comes into contact with the resting fingers, the maximum depth of solution is being observed: this manoeuvre reduces the risk of damage by suddenly jerking the top part of the apparatus out of the lower.

A test-pipette may be required for transferring a viscous solution, but usually the cup may be filled and washed directly. The plunger may be cleaned without removal from its sleeve, by rinsing in a test tube of fluid.

When not in use the light should be switched off to avoid overheating.

Examples of the value of the apparatus

For teaching purposes the instrument has proved most instructive. The beginner usually obtains a much better view of a spectrum, appreciates quickly the effect of dilution, and soon learns the relative intensities when there are two or more absorption bands.

For clinical diagnostic work the apparatus is a real adjunct in spectroscopic examinations. Thus in reputed haemoglobinuria, a negative report may be given with absolute confidence after clearing by centrifuging and failing to observe the bands of oxyhaemoglobin in a layer of urine 5 in. thick. Similarly for practical purposes pathological porphyrinuria is absent if 5 in. of urine, after strong acidification with HCl, fail to show the spectrum of acid porphyrin.

The apparatus is valuable in following the progress of a case of methaemoglobinaemia or sulphaemoglobinaemia by examining at intervals the laked blood or serum (depending on the site of the pigment). Its small capacity, only 5 ml., makes it particularly attractive in the spectroscopic examination of serum or plasma, gastric contents, faecal extracts or other biological fluids of which only small volumes are available.

In special investigations the mm. scale enables the depth of the solution of a pigment to be measured. By defining a spectroscopical limit, e.g. when an absorption band is just visible to the operator with his particular setting of the spectroscope, and after calibration with known concentrations of the pigment, the operator can use the instrument for the approximate determination of the concentration of that pigment in solutions.

Clearly the design of the apparatus may easily be modified or elaborated. In its present simple form it can be purchased complete, with or without the scale, from Messrs T. O. Blake, Ltd., 57, Hatton Garden, London, E.C. 1.