

## AN APPARATUS FOR PRESSURE MEASUREMENTS OF SPREADING SUBSTANCES\*

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Results of measurements of the spreading of proteins have been reported in the previous article. The measurements were made with an apparatus differing in various ways from existing apparatus (Langmuir, Marcelin, and Adam).

It was essential in the construction of this apparatus to obtain an instrument by which it would be possible to make quick and accurate measurements.<sup>1</sup> Also we tried to make handling of the instrument as easy as possible. The latter feature is important for the use of the instrument in the clinical laboratory in, for instance, the estimation of spreading substances from the living organism such as proteins, lipoids, fats, and fatty acids.

The method by which measurements are made is essentially identical with that by which Langmuir got his well known results.

A free movable barrier *C* floats on the surface of the liquid in a shallow rectangular tray. The barrier is connected by very thin platinum strips  $P_1P_2$  ( $3\mu$  thick) to the edge of the tray (Fig. 1). A difference in tension of the surfaces at *A* and at *B* will cause a movement of the barrier *C*. This movement is prevented by the fork of the torsion balance, and forces acting on the barrier can be transmitted to the balance and compensated by the torsion of a spring *D*. The amount of torsion is read on the scale *S*. Movements of the balance are detected by an optical system *O* and mirror *M* on the axis of the balance.

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<sup>1</sup> The apparatus is constructed by the mechanic G. A. de Vries at Leyden and can be supplied by C. V. Eiga, Instrument Co., Leyden, Holland.

For accurate measurements the barrier cannot be rigidly attached to the fork. Therefore the legs of the fork fit loosely in two slightly larger holes in the barrier *C*. In this way only horizontal forces acting on the barrier will be transmitted to the torsion balance.

A more detailed description of the instrument will now be given. The steel axis of the balance turns between two agates. These agates are normal watch agates with small circular holes in which the fine cylindrical points of the axis accurately fit. The stones are fitted in two cylindrical axes. One of the axes is fixed rigidly to the frame of the balance. The other one—by means of which the agate is accurately centered—is also mounted on the frame but in such a way that it can rotate around its axis. The index with nonius is fixed to

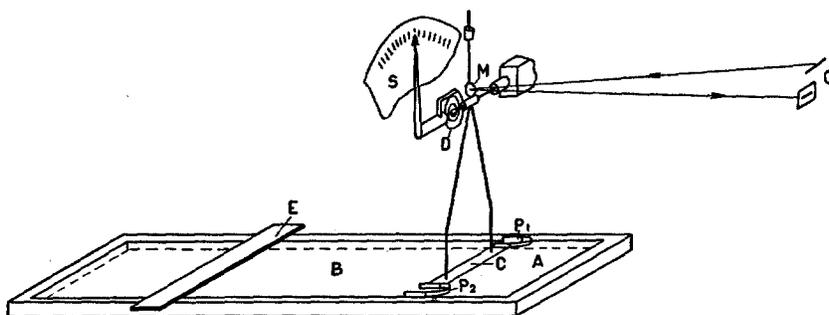


FIG. 1

this movable axis, to which the free end of the spring is also attached. The steel axis fits exactly in the center hole of the spiral spring,—an alarm-clock escapement spring. For sake of linearity of torsion forces two springs are mounted on the axis with the spiral-winding in opposite directions. The scale on which the torsion of the springs is read can rotate around its axis, to obtain an easy zero adjustment.

The next point to consider is the construction of the balance. Here it was tried to keep the balance system as light as possible without sacrificing rigidity. The vertical downward rods are tubes, obtained by drawing nickel-foil of 0.15 mm. around an axis of 2 mm. To prevent chemical action of the fluid in the tray with the nickel, and capillary rise of that fluid in the narrow tubes, short capillary glass tubes with one end closed are cemented over the ends. The barrier is a thin mica strip (thickness 0.2 mm., other dimensions 0.8 x 12 cm.).

At both ends are fixed two gilded brass holders for the platinum strips. They are bent from hard brass-foil, in such a way that a small spring is formed to clamp the platinum strip (Fig. 2).

The connection of the platinum strips with the sides of the tray is more complicated. For easy cleaning of the surface of the fluid in the tray it should be possible to lift the balance from the water; the platinum strips also have to be lifted. This is the reason why the strips are not fixed to the edges of the tray, but to a piece of gilded

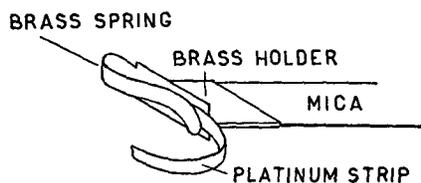


FIG. 2

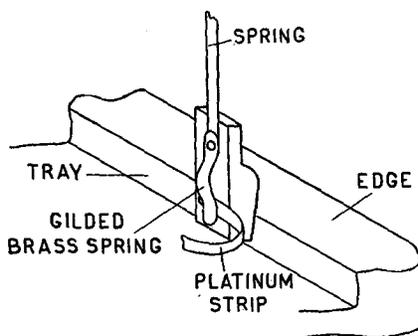


FIG. 3

brass. Here again a gilded brass spring is used to clamp the strip to the piece of brass. This piece of brass is attached by a steel spring to the frame of the balance in such a way that the pieces of brass are pressed against the edge of the tray (Fig. 3).

The frame of the balance can now slide up and down into two supports and can be lifted from the tray by a cog and pinion movement fitted to these supports. This will be clear from the photograph of the apparatus. The deviations of the balance are made visible by an optical system. On the axis of the balance a small mirror is fixed.

An optical system of the same construction as those in use for projection of galvanometer mirror movement is mounted to show movements of the axis of the balance. The sensitivity of this balance is 0.1 dyne/cm. per scale degree. Tenths of degrees can be read.

The next part to be described is the way in which the glass slide is moved over the tray. An arm in which the glass slides exactly fit can be moved by a long screw with a pitch of 1 cm. On a millimeter division fixed, parallel to the screw, on the support of the instrument the distance of the slide to the balance can be read (Fig. 4).

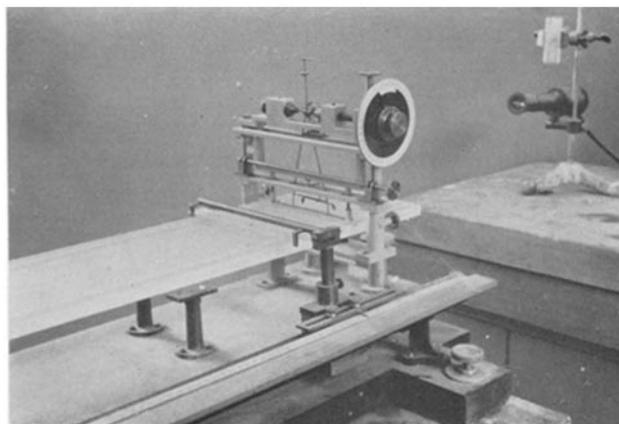


FIG. 4

The tray is made of glass. At first metal trays and trays of cemented glass were tried. The trays obtained in the following way, however, give satisfaction. A mirror glass plate (17 x 63 cm.) 10–12 mm. thick is hollowed out over a rectangular surface (14 x 60 cm.) by means of a sand-jet. The edges of this tray are slightly frosted. The use of glass has the advantage that it can easily be cleaned by a 1 per cent solution of hydrofluoric acid. All glass vessels used in our experiments are cleaned with this solution. The edges of the tray are paraffined by rubbing them with a piece of paraffin.

After the edges have been covered with a sheet of paraffin, they are rubbed vigorously with a clean towel so that the paraffin sticks firmly to the glass. Then the paraffin is shaved off with a razor blade, leaving a very thin layer. Once more this layer is rubbed with a clean towel. The edges obtained in this way will last for about a week.

Another method employed is the following. The tray is heated to about 80–100°C. By touching the edges with paraffin they are covered with a sheet of molten paraffin. This sheet is rubbed off with a clean towel. Again a very thin sheet of paraffin will remain on the edges, sufficient for spreading experiments.

The glass slides are treated in the same way. Balance and platinum strips are treated with a very diluted solution of paraffin in ether.

Salt solutions, etc., are obtained free from any spreading substances in the following way. The water used in the experiments is distilled in an all glass apparatus,—stops, corks, are all grease-free. For the experiments with proteins, it is important to have water completely free from carbon dioxide. To destroy the organic substances, some chalk and potassium permanganate are added to the water in the distilling flask. This flask is automatically filled. By the bend loss of warm water to the intake regulator is prevented for the difference in specific weight of hot water and the cold water that enters the apparatus prevents convection at this bend. Also the chalk and potassium permanganate will stay in the distilling flask. Salts are recrystallized in grease-free water—if possible they are heated to destroy organic material, and freed from contaminating substances, which lower surface tension.

#### LITERATURE

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