A NEW APPARATUS FOR MEASURING SURFACE TENSION.

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Surface tension is probably one of the most difficult phenomena to measure. Although a great deal of ingenuity has been spent for almost a century in devising accurate techniques, the figures obtained deviate more from each other for the same substance, according to different authors, than any other constant characterizing the substance. It is well known that the two classes of methods of measurement, the static and the dynamic give entirely different results when applied to the same liquid. The following figures illustrate these differences.

	Dynamic.	Static.
Water	73	73
Sodium oleate	26	79
Heptylic acid	54	68

The static values were obtained by the capillary tube method, and the dynamic values by the oscillating jet method. Nevertheless, under given conditions, all the methods give practically concordant values in the case of pure liquids, but not in the case of solutions.

With the static methods (among which are weight of hanging drops, rise in a capillary tube, adhesion of a disc to the surface, excess of pressure in a spheric bubble produced in a liquid, direct measurement of curvature of the surface), the following figures are obtained for the surface tension of water.

	Dynes. cm.
Method of pulling off a ring	81.0
" " capillary tube (air)	75.5
" " " " (water vapor)	73.0

Some authors give 82 for the first method, others, 80, and for the third, some give 68.

Temperature plays an important part. It may be represented by the simple formula:

$$A = A_o\ (1-\alpha t)$$

The cleanliness of the apparatus containing the liquids and of the measuring devices is extremely important, for a minute trace of greasy substance spoils the results.

The importance of the action of surface tension in biological phenomena is well known, but all the techniques of measurement are either complicated (static methods: capillary undulations, drop rebounding, capillary jets, rebounding jets), or long (drop method), and it is desirable to have a simple apparatus by means of which the surface tension, and especially the variation of surface tension of a given liquid, could be readily measured, with sufficient accuracy. For this reason the apparatus to be described has been designed (Fig. 1). There is no new principle in it; it is based upon adherence of a ring, or of any other design, to the liquid (Weinberg). It is simply a torsion balance, but instead of measuring the tension by means of weights (which is time-consuming, and makes two readings necessary), the torsion of the wire is used to counteract the tension of the liquid film and to break it. A single reading on a dial indicating the degree of torsion of the wire gives a figure, which, if the apparatus has been previously standardized with water, gives the surface tension of the liquid by a simple proportion. According to the fact that the torsion of the wire for water, which has the highest surface tension, is only 72°, we can assume that, within these limits, the strain of the wire is proportional to the angle of torsion, so that no table of correction is needed (see Fig. 2). Of course, the apparatus may be used for standard measurements also, by simply forcing the lever to come back to its former position by means of weights after the tearing of the membrane has taken place. By using the comparison method, the figures are reliable and constant, and the time necessary to make one measurement does not exceed 15 to 30 seconds. A very small quantity of the liquid is required,—about 1 cc. in a watch-glass,—but the apparatus could be fixed in such a way that it would need only 0.5 cc.

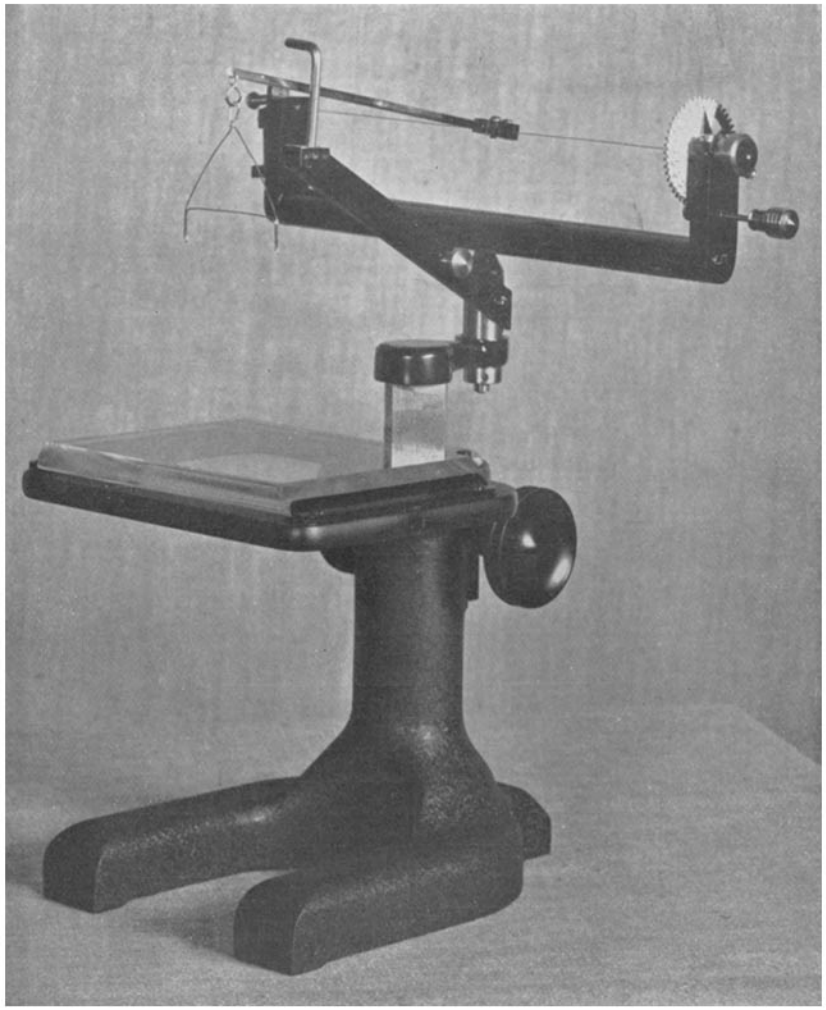

FIG. 1.

The tension of the wire can be adjusted. The torsion is controlled by a gear, which moves very slowly. The dial shown in Fig. 1 is attached to the wire and turns with it. A fixed needle indicates the angle of torsion. The apparatus described is homemade, and would be greatly improved by using a large dial and a worm-gear for controlling the torsion.

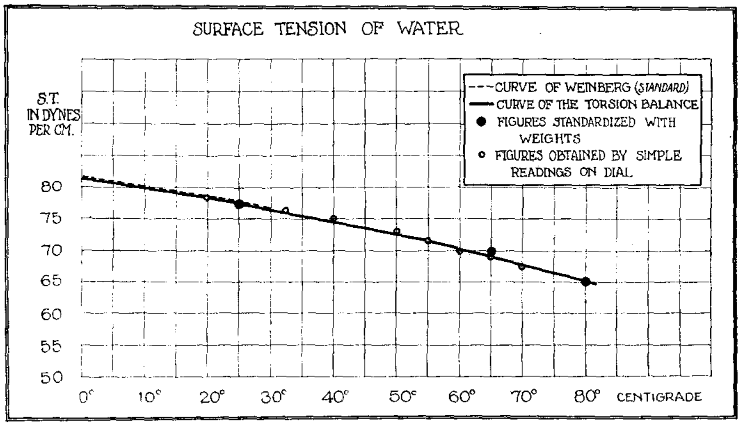

FIG. 2.

With the apparatus described above, with a platinum ring, the circumference of which is equal to 4 cm., 77 dynes per cm. were found for the surface tension of ordinary distilled water, at 25°C., 81 dynes at 0°, and 65 dynes at 80° (see Fig. 3).

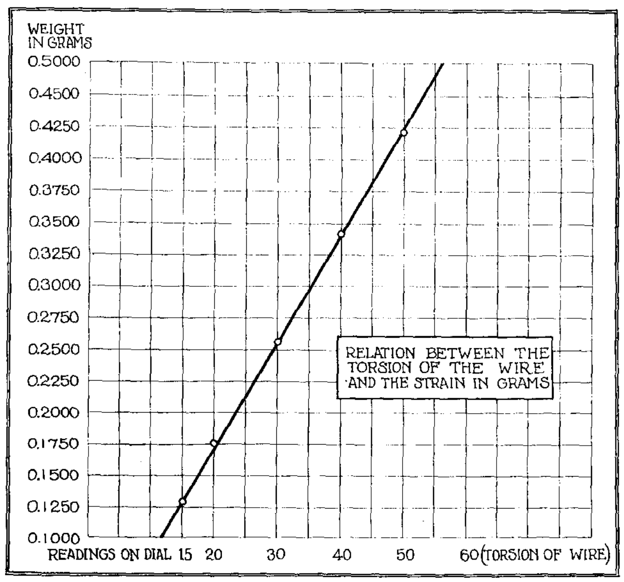

FIG. 3.