lished by Randoin[2] on the antiscorbutic factor. They found that oysters contain this vitamin in abundance.

By means of feeding tests with rats, we have found that oysters are rich also in vitamins A and B. In order to obtain uniform samples, fresh oysters were ground in a frozen condition. Quantities of the frozen product equivalent to 0.5 gm., calculated on a dry basis, caused prompt resumption of growth when fed daily to rats that had declined in weight as a result of the lack of vitamin B in their basal ration. Experiments in progress indicate that smaller quantities are sufficient to meet the requirements of rats for this vitamin.

As little as 0.25 gm. of a product obtained by dehydrating fresh oysters at a temperature not exceeding 40° under reduced pressure, enabled rats to make a fair recovery from the results of vitamin A deficiency.

It was found that during the process of dehydrating the oysters a change took place which caused a partial destruction of vitamin B. Whether this process also impaired the vitamin A value of the oysters is being investigated. Work is also in progress to estimate the vitamin content of clams, shrimp and other articles of sea food.

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The photo-electric cell as a colorimeter.

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The photo-electric cell determines the intensity of illumination to which it responds, by means of varying amperage, which it allows to pass through under the stimulus of an E.M.F. Any change in the illumination can be determined by changes in this amperage. The variables in an apparatus set up for this determination are: (a) the voltage offered to the cell from "B" batteries or other source of current, such as a "B eliminator," or other

[2] Randoin, L., *Compt. Rend. Acad. Sci.*, (Paris), 1923, clxxvii, 498.

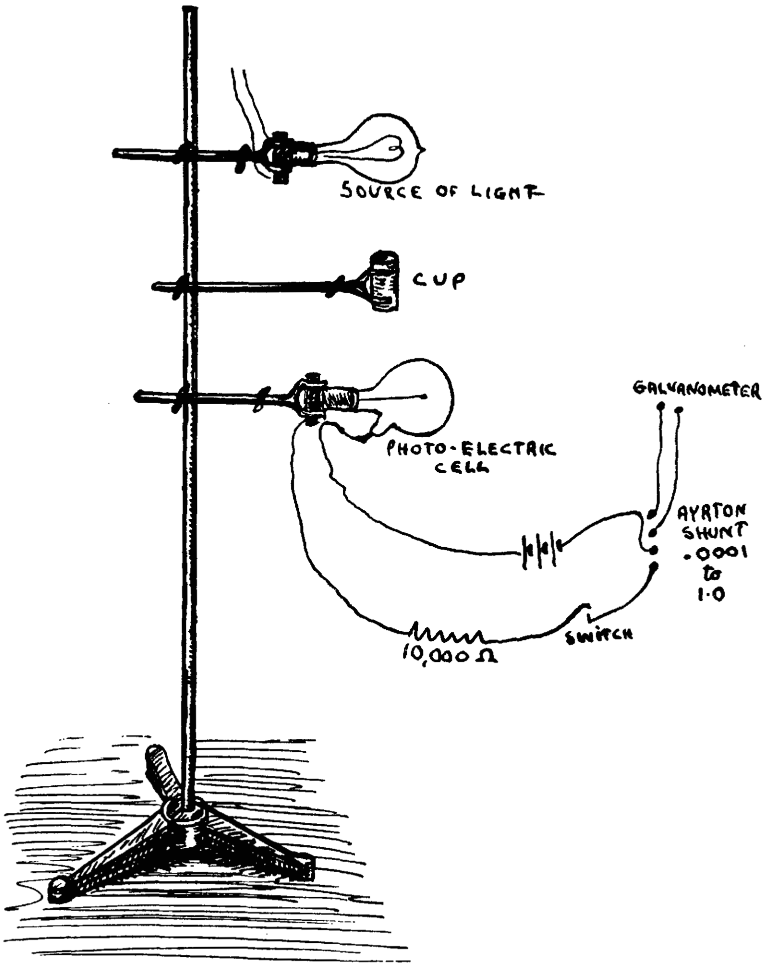
suitable control for voltage, (b) the distance of the light source from the cell, (c) the wattage of the light source, (d) the concentration of the solution to be analyzed, as, for example, standards of 100 or 200 milligrams of sugar, in which the blue color has been developed by the ordinary Folin-Wu procedure, (e) the height of the column of liquid through which the light passes, (f) the area of the cross section of the solution, etc.

All of these variables when plotted, do not give straight lines throughout wide ranges, but all do over certain distances. By adopting the straight line part of the curves in the actual use of the instrument it has been possible to obtain direct and indirect proportional results. Briefly, the apparatus consists of a source of illumination, an ordinary bulb of 25, 40, 75, 100, up to 250 watt power, depending upon the conditions adopted for the other variables; a source of constant voltage either from "B" batteries or from a "B eliminator" plugged into an A C house current; a cell to receive the solutions to be analyzed, for example, an ordinary cup as used in the Duboscqe colorimeter; the photo-electric cell; and an instrument to measure the current, either a galvanometer (type R, Leeds & Northrup) or a micro-ampere-meter (Weston). For further control of readings an Ayrton shunt is introduced into the galvanometer or micro-ampere-meter circuit.

There are several ways in which comparisons may be made between a known and unknown solution, for example, dextrose prepared according to Folin and Wu's method. The known can be placed in the apparatus and a reading obtained, say 40 micro-amperes. The unknown can then be placed in the apparatus and the distance of the source of light from the photo-electric cell varied until the reading of the unknown is also 40 micro amperes, whereupon, when suitable conditions are adopted, a direct proportion is established between the distance of the light when the known and unknown were read; this determines the amount of sugar in the unknown solution. Another way in which this can be accomplished is by varying the heights of the column of unknown solution until the same reading is obtained. A third way is to vary the voltage offered to the cell until the same reading is obtained. There are several other ways, but of five methods tried, that of varying the distance of the light source proved most convenient and satisfactory.

The method has been tried with colored substances from the red to the blue end of the spectrum; the comparative results between the unknown and known have been accurate in all ranges, so that the cell is useful throughout the entire range of the spectrum. As an example of its accuracy, it has been possible to determine the difference constantly, and by at least five separate individuals operating the apparatus independently, between 100 and 101 milligrams of sugar per 100 cc. of solution. Since only 5 cc. of solution are used for the actual determinations the accu-

FIG. 1.



One possible set-up and hook-up of the apparatus. Care must be taken by means of shields, etc., to exclude all extraneous light.

racy of the instrument seems quite as good as a chemical balance, that is, between 0.005 and 0.00505 milligrams.

To be emphasized is the fact that not only are the results consistent when one operator is at work, but at least five in our laboratory have checked analyses to the fifth decimal place. From other experiments at hand, it seems quite probable with suitable apparatus that this accuracy can be increased to an even greater extent. The personal factor of color comparisons is absolutely eliminated. A child can operate the instrument.

Further experiments have been made toward the reading of spectroscopic, spectro-photometric, polaroscopic and microscopic differences in color and illumination intensity. Furthermore, it has been used as an nephelometer with excellent results. Other fields of usefulness have suggested themselves and are steadily being investigated.

Full details, including curves, will be published shortly along with a detailed description of a convenient assembly of parts. Many pitfalls must be avoided and these will then be fully discussed.

SUMMARY.

Methods are described of using the photo-electric cell, in our case an argon filled bulb, whereby colorimetric and nephelometric determinations can be made with exceeding accuracy, thus threatening to displace the use of the ordinary Duboscqe and other similar colorimeters. The diagram indicates one possible set-up of the instrument and one possible hook-up whereby the measurements can be made. Others can be evolved, as we have determined; in fact, it is possible to measure color by sound after suitably treating the current obtained and passing it through amplifying devices into a loud speaker or a pair of ordinary radio head phones. This should give much finer readings than even by the use of the type R galvanometer which determines 0.000,00025 amperes.