mentation constant $s_{20} = 582 \times 10^{-13}$ cm dynes^{-1} sec^{-1} has been calculated. On the assumption that the particles possess spherical shape, which is supported by the absence of flow double refraction and by the low relative viscosity of their dilute solutions (1.09), the average diameter of the individual particles, as derived from the sedimentation constant with the aid of Stokes's equation, is 72 mμ. Using the value of 1.22 for the density of the material (kindly determined for us by Mr. P. H. Barbour, Jr., by the falling drop method of Barbour and Hamilton) an average particle weight of 2.6×10^{-16} gm and a "molecular weight" of 146×10^6 is obtained.

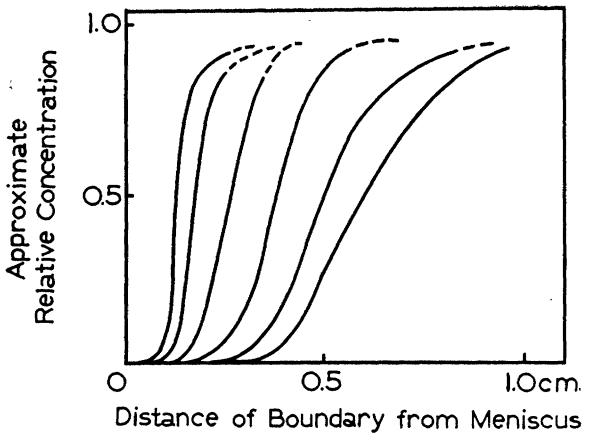


FIG. 1. Tracings made from the microphotometer curves of the sedimenting boundary of macromolecular material isolated from bone marrow of leucotic chickens. Material purified by four alternate high-speed (30,000 r.p.m.) and low-speed (2,600 r.p.m.) centrifuge runs; concentration, 0.5 per cent., in 0.005 M. phosphate (pH 7.4); mean gravitational force during analytical run, 3,500 g (7,200 r.p.m.); interval between exposures, 6 min.; $\lambda = 2{,}480 - 3{,}600$ Å; photographic magnification, 1.5; magnification ratio during recording, 1: 6.

With respect to its chemical and physical properties the material described above resembles the causative agent of the Rous chicken tumor I[3] and also the macromolecular material isolated by Claude[4] from normal chick embryos. In contrast to the virus proteins isolated by Stanley and others from plants, these materials do not represent pure nucleoproteins but much more complex chemical structures of the type encountered in the analysis of protoplasm.

KURT G. STERN
ARTHUR KIRSCHBAUM
LABORATORY OF PHYSIOLOGICAL CHEMISTRY
AND DEPARTMENT OF ANATOMY,
YALE UNIVERSITY SCHOOL OF MEDICINE

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE SIMPLEST TRANSPARENT ULTRACENTRIFUGE

WE have developed a form of transparent ultracentrifuge which permits of photographic recording of the contents of a glass or quartz tube while spinning at 110,000 times gravity. It is so simple that it dispenses entirely with accessories, not even a camera being required. The complete equipment can be made in fifty to sixty hours of a mechanician's time. Nevertheless, it gives useful results of fair accuracy.

The device is a development of ideas previously used by Elford, McIntosh and Selbie, and Ford, but applied to obtaining a record without stopping the rotor. This consists, Figs. 1 and 2, of a solid piece of duralumin, 7 cm in diameter, and directly air-driven. In the upper surface two channels are milled on the same diameter; one carries a dummy to balance the cell. In the other is placed first a piece of photographic film and upon it a block of hard rubber with a horizontal hole to hold a tube of 1.5 mm internal and 7 mm external diameter, containing the solution to be measured. The rubber block is sawn nearly in two, giving a radial vertical slit 0.6 mm wide. The tube is sealed at the outer end and closed at the other end with a piece of gummed paper with a piece of cork pressing against it to assist insulation. The length of column of liquid we have used is 8 mm, but may readily be longer. It therefore has ample resolving power for the smallest proteins. The rotor has a cover screwed on with a central screw. In the cover is a window, set in with Duco or similar

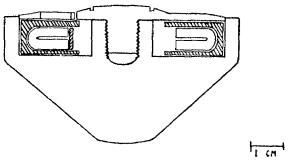


FIG. 1. Cross section through assembled rotor.

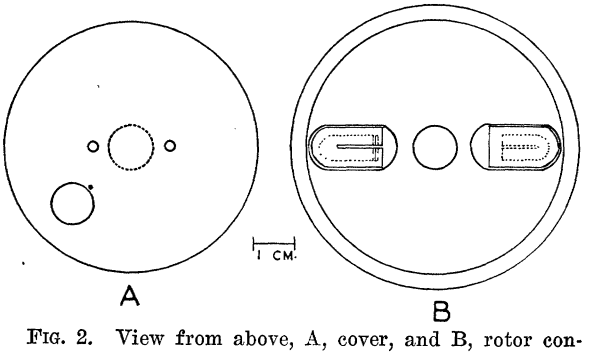


FIG. 2. View from above, A, cover, and B, rotor containing cell and dummy.

[3] K. G. Stern and F. Duran-Reynals, SCIENCE, 89: 2322, 609, 1939.

[4] A. Claude, *Proc. Soc. Exp. Biol. and Med.*, 39: 398, 1938.

nitrocellulose cement. There is also a hole 0.5 mm in diameter just next to the window nearer the axis of the rotor to serve as reference point. About 30 cubic feet of air are required per minute if the pressure is 100 pounds per square inch. The stator should also be 7 cm in diameter.

The run is made in dim light or with a cover placed over the guard around the rotor until the record is desired, whereupon a distant light or a collimated beam is flashed on for about one second. This places upon the photographic film a spot representing the reference point, a boundary for the top of the tube or edge of the window, another for the liquid meniscus and a graduated image showing any boundary or optical inequality in the liquid from top to bottom. Only one record has been made for each run, but it should be easy to arrange a slit or opening which can be moved outwards to successive positions, and exposed in each.

This was developed for the study of petroleum products in non-aqueous solution, but we quote here some test runs on sedimentation velocity in earthworm blood diluted 10:1 with 1 per cent. potassium chloride solution. These can be made at the rate of several an hour, owing to the fact that the direct air-drive brings the rotor to full speed almost immediately, so that zero time can be taken when the air is full on. Instead of one tube, two to six can be measured simultaneously in the same rotor.

The duration of each sedimentation was 5 minutes. The values of sedimentation constant $s \times 10^{13}$ were successively 58.2, 57.7, 58.9, 55.5, 57.6, 53.7, 60.8; which, reduced to 20° C., become 59.2, 60.0, 61.0, 57.9, 60.0, 55.9 and 63.4. The mean is 59.6. Svedberg's values for $s_{20°}$ were from 56.4 to 64.3, mean 60.9.

The cylindrical tube is of course not radial, but this is of very minor importance. There is a controlled convection outwards, confined to within a few particle diameters of the periphery of the tube with the correspondingly small upward movement of all the remaining volume, thus giving a sedimentation velocity very slightly too small, as in the example given. If desired, the usual type of radial sectorial cell may be used. A detailed description of the rotor and stator will be published elsewhere.

It would appear that the ultracentrifuge in this form could now be made available for undergraduate classes in biochemisty and colloids.

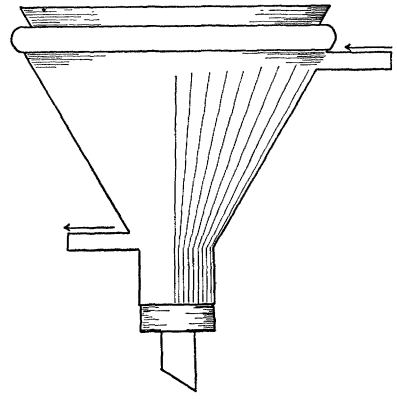
J. W. McBAIN
A. H. LEWIS

STANFORD UNIVERSITY

FUNNEL-HEATING DEVICE

WITH the necessity for frequently conducting hot filtrations has arisen the need for more efficient and practical means of keeping funnel contents hot than is afforded by older forms of funnel-heating devices. These forms, whether of coils or double-wall jackets, lack satisfactory heat transfer, making it difficult to keep alcoholic solutions boiling. There is also a serious fire hazard where gas heat has to be applied to maintain the temperature.

The present device, a front view of which is illustrated, consists of a single-wall metal jacket, which fits around the bell of a funnel and makes steam-tight connections by means of a rubber gasket at the top and a bored rubber stopper on the stem. The compressive stress in the rubber keeps the device locked tightly against the glass so that no leakage of steam occurs. Inlet and outlet nipples are provided for the steam. Since the steam impinges directly against the outer surface of the glass funnel, the heat transfer is at its maximum efficiency, and alcoholic solutions can be kept at the boiling point. If a steam line is not available, the device can be operated satisfactorily with steam generated in a flask on the laboratory table. Among other desirable features are the transferability from funnel to funnel, use with funnels considerably larger than the device itself and rugged construction. The device is patented and is now on the market.



FUNNEL-HEATING DEVICE

FIG. 1

L. N. MARKWOOD

BUREAU OF ENTOMOLOGY AND
PLANT QUARANTINE,
U. S. DEPARTMENT OF AGRICULTURE

BOOKS RECEIVED

CHILDE, V. GORDON. *Man Makes Himself.* Pp. xii + 275. 11 figures. Oxford University Press. $2.50.

LEE, OLIVER J. *Beyond Yonder.* Pp. 169. Illustrated. Chapman and Grimes. $2.50.

LONGWELL, CHESTER R., ADOLPH KNOPF and RICHARD F. FLINT. *A Textbook of Geology; Part I, Physical Geology.* Second edition, revised. Pp. xi + 543. 340 figures. Wiley. $3.75.

WELLS, GEORGE R. *The Art of Being a Person.* Pp. vii + 300. Appleton-Century. $2.50.