radius of 0.88–0.98 μ. The mean radius of cellulose diaphragms was found to be independent of the electrolyte concentration, whereas the values for finely ground quartz rose with increasing salt concentration to a constant value at 4×10^{-4} N NaCl. These data illustrate the use of this simple method, which should prove of value in other investigations of this character. A more detailed discussion of these results has been presented in a later paper.[5]

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE APPARATUS TO FACILITATE THE PREPARATION OF BACTERIAL VACCINES[1]

ONE of the main problems in preparing bacterial vaccines on a large scale is to prevent contaminations during the process of preparation. Since a large number of bottles are used in preparing vaccines and each bottle must be opened several times, it is frequently difficult to avoid contamination. The usual procedure in collecting the bacterial growth from the inoculated bottles is to add saline to each bottle and collect the bacterial suspension into a sterile bottle by means of volumetric pipettes. This is of necessity a slow procedure and the vaccine is exposed to contaminations repeatedly; because the collecting bottle must be opened a number of times to discharge the contents of the pipette.

A simple apparatus has been devised which eliminates the use of pipettes and reduces the risk of contaminations to a minimum. The apparatus consists of a special burette for adding saline to the bottles containing the bacterial growth, as illustrated in Fig. 1, and a tube for collecting the vaccine, as shown in Fig. 2. The burette is connected serially by means of rubber tubing to a bottle of sterile saline, an empty sterile bottle and a bottle of 5 per cent. phenol. These bottles have two-hole rubber stoppers, glass tubes and rubber-tube connections (see illustrations, Fig. 1). The burette, collecting tube and the connections are sterilized separately and are assembled aseptically before use. All parts of the apparatus are protected against contamination. The top of the burette is plugged with cotton, which is wrapped in cheese-cloth and after plugging is covered with a paper cap. The delivery point of the burette is protected by a glass bell, which is also covered with a paper cap. The open end of the rubber tube on its side arm is placed in a glass tube, which is plugged with cheese-cloth. Similarly, all open parts of the connections for the bottles (Fig. 1) and the collecting tube (Fig. 2) are protected by glass tubes. They are then wrapped in paper separately and are sterilized in the autoclave for one hour at 15 pounds pressure. After the apparatus is assembled, as shown in Figure 1, the bottle containing the phenol is connected with a pressure pump. The metal clamps "h" are opened and air is forced through the phenol which sterilizes it before it reaches the saline. The intermediate empty bottle serves as a safety valve in case too much pressure should force the carbolic into the adjoining bottle. The burette is filled by opening cock "a" on the side-arm, which is closed when the saline reaches the zero mark. The desired amount of saline is then added to the bottles containing the bacterial growth by opening and closing cock "b" on the delivery tube. Both the mouth of the bottle and the delivery point of the burette are protected by the glass bell. During the entire operation all parts of the apparatus are completely protected against contamination.

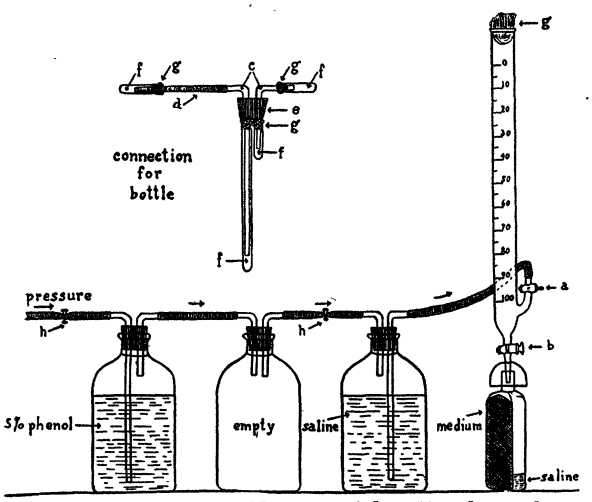

FIG. 1. a—cock or side arm of burette; b—cock or delivering tube of burette; c—glass tubes of connection; d—rubber tube; e—two-hole rubber stopper; f—glass tubes; g—plugs; h—metal clamp.

When the saline is added to all the bottles the burette is replaced by a sterile collecting tube, as illustrated in Fig. 2. This consists of a glass tube that has a constricted and slightly bent point. This tube is protected from contamination by an outer glass tube whose diameter is the same size as the neck of the bottle containing the bacterial suspension. The collecting tube is held in place by a perforated rubber cap and it slides back and forth in the outer tube. The outer tube serves a two-fold purpose—it protects the collect-

[1] From the Bureau of Laboratories, New York City Department of Health; Director, W. H. Park, M.D.

[5] H. B. Bull and L. S. Moyer, *Jour. Phys. Chem.*, 40: 9, 1936.

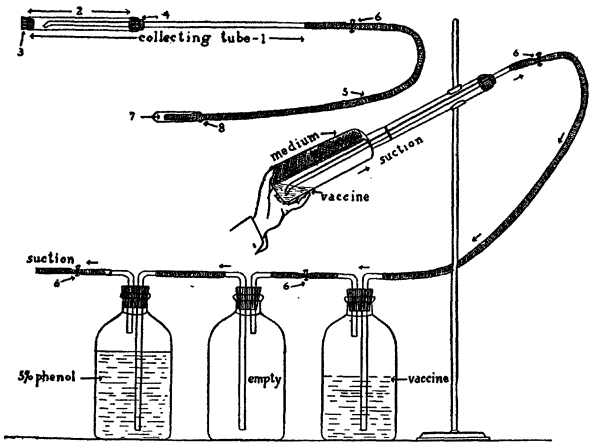

FIG. 2. Collective tube. (1)—glass tube; (2)—outer glass tube; (3)—solid rubber stopper; (4)—perforated rubber cap; (5)—rubber tube; (6)—metal clamp; (7)—glass tube; (8)—cheese-cloth plug.

ing pipette from contamination as well as the mouth of the bottle during the process of collecting the vaccine. The collecting tube is connected serially by means of a rubber tube with two sterile bottles and a bottle of 5 per cent. phenol (see Fig. 2). The bottle of phenol is connected with a suction pump, and the bacterial suspension is collected by means of suction. A clamp (6) at the top of the collecting tube stops the suction as soon as the growth of the individual bottle is delivered into the vaccine-bottle and the collecting tube is withdrawn from the bottle into the outer glass tube. Thus the tip of the tube is protected and no air is allowed to be drawn into the vaccine bottle.

When the growth from all the bottles is collected, the suction pump is stopped, and air is allowed to flow through the phenol. This sterilizes the air before it enters the bottle of vaccine and fills the vacuum there. The collecting pipette is then disconnected, and the two-hole stopper in the vaccine bottle is replaced by a sterile solid rubber stopper.

This apparatus has been used successfully in our laboratory for the past year. It facilitates the preparation of bacterial vaccines in that it saves time and labor and reduces contaminations to a minimum.

I wish to express my appreciation to Miss Mildred Melman for making the drawings from the model.

LUCY MISHULOW

THE PRODUCTION OF HIGH VELOCITY IONS FOR THE DISINTEGRATION OF ATOMIC NUCLEI

LAWRENCE has been able to give in the cyclotron a multiple acceleration to positive ions in a uniform magnetic field and has obtained very high velocities of the particles. Thus energies of the order of seven million electron volts have been attained, and an increase to ten million should be accomplished soon. In the cyclotron the ion is accelerated twice by the high frequency electrical field during each (approximately) circular orbit.

In experiments on a small apparatus it is proposed to endeavor to apply the use of a three-phase oscillator system to give either three or six accelerations per revolution of the positive ion in its orbit. If successful this should make it possible to attain much higher equivalent voltages. The principal difficulty involved is that of getting a satisfactory high-frequency, high-voltage, three-phase oscillator system.

Consideration of the simplest and least effective application of a three-phase potential, such as that in which it is connected to a trisector electrode cyclotron, for example, as compared with a duant cyclotron, leads to the following results: An ion is accelerated three times instead of two times per circuit. The ion density is reduced 50 per cent. The capacity of the electrode is reduced 33 per cent. The proper sequence of accelerating voltages in a forward direction occurs every 120 electrical degrees. In the reverse direction the proper sequence occurs only half as often, *i.e.*, every 240 electrical degrees. Resonance is preferred in the forward direction. In the duant type the accelerating potential in both the forward and reverse directions occurs 180° apart. The magnetic field frequency of the oscillating potential and the root mean square high frequency potential are the same in both cases. The use of six electrodes instead of three would be much more efficient.

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BOOKS RECEIVED

ADAMS, ORVILLE. *Elements of Diesel Engineering.* Pp. xvi + 478. 240 figures. Henley. $4.00.

CROWTHER, J. G. *Men of Science.* Pp. xiii + 332. Illustrated. Norton. $3.50.

HOBBIE, JOHN R. *Introduction to College Physics.* Pp. ix + 756. 458 figures. Farrar and Rinehart. $3.50.

KUBIE, LAWRENCE. *Practical Aspects of Psychoanalysis.* Pp. xiv + 223. Norton. $2.00.

MURPHY, ROBERT C. *Oceanic Birds of South America.* Volumes I and II. Pp. xxii + 1245. 80 figures. 88 plates. American Museum of Natural History, New York.

Osiris: Studies on the History and Philosophy of Science, and on the History of Learning and Culture. Vol. I, January, 1936. GEORGE SARTON, Editor. The David Eugene Smith Presentation Volume. Pp. 777. Illustrated. Saint Catherine Press, Bruges, Belgium.

ROBB, ALFRED A. *Geometry of Time and Space.* Pp. vii + 408. 57 figures. Macmillan, The Cambridge University Press. $7.50.

WATMOUGH, W. *The Cult of the Budgerigar.* Pp. viii + 296. Illustrated. Cage Birds, London. 6/6d.