(even though for only a little way) into matters psychological scattered through several of the chapters. And in this, as in several other respects, the book is a distinct improvement on many another production of recent date in the same general field. For example, the chapters entitled "The Dawn of Civilization" and "The Rise of Personality" are exhilarating promises of how vast and how vital the drama of human life upon the earth will be seen to be, even by persons of ordinary education, when once a few biologists competent to tell well the material side of the story shall have become sufficiently educated to tell its spiritual side also.

Wm. E. Ritter

LABORATORY APPARATUS AND METHODS

AN EFFECTIVE ABSORPTION APPARATUS[1]

During an investigation which aimed to determine qualitatively and quantitatively the gaseous evolutions from flowers of sulphur and from ground sulphur when freely exposed to the atmosphere and to bright sunlight different types of absorption apparatus were tried out in an endeavor to find one suitable for the purpose to which it was to be applied. Owing to the fact that the gases to be absorbed were very small in quantity and distributed through relatively large volumes of air it was quite essential that the absorbing apparatus should be efficient and capable of continuous operation for a considerable period of time. In examining the various types of apparatus such points as efficiency, compactness, rigidity, ease of sampling, ease of refilling, and cleaning were considered. To meet the particular experimental requirements it was necessary to devise and construct a special type of apparatus.

The essential features of the apparatus which was finally adopted and constructed are shown in longitudinal section in figure 1. The apparatus consists of a heavy walled bacteriological culture tube A about 25 mm. outside diameter and 150 mm. long to which is sealed near its lower end a side arm tube B 4 mm, in diameter. The lower end of the side arm tube is drawn out to a narrow tip which is directed downward toward the bottom of the tube A. The opening through this tip is quite small to permit the formation of only very small bubbles coming at regular intervals when the apparatus is in operation, the bubbles being released near the side wall at the bottom of the tube A.

The central tube E is about 12 mm. outside diameter and 125 mm. long around which 60 cm. or

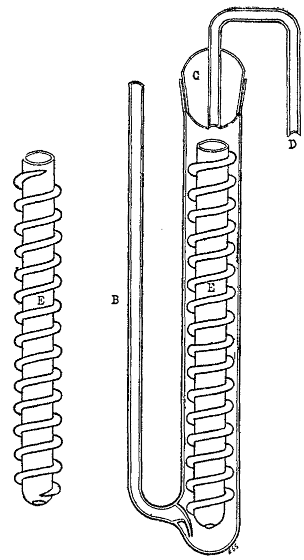

Fig. 1

more of 4 mm. glass tubing is wound to form the spiral which is sealed off at both ends to prevent the entrance of liquids. The central tube E is open at both ends the opening at the upper end having the full diameter of the tube while that at the lower end is somewhat smaller; the tube, being rounded at this end, serves as a guide to direct the escaping bubbles against the spiral. The spiral with the central tube E slides freely into the tube A but fits snugly enough to prevent the bubbles from escaping between the spiral and the walls of the tube A. The spiral with the tube upon which it is wound, being movable, can be adjusted in the tube A in any position with respect to the tip of the side arm upon which it rests. It can be removed readily from the tube A for the purpose of cleaning which is an important matter to be considered.

The tube A is closed with an air tight seal by means of the ground glass stopper C which holds the outlet tube D. A rubber stopper holding the outlet tube may be substituted, of course, for the ground glass stopper if experimental conditions permit.

In operating the apparatus the tube A containing the spiral and central tube E is partially filled with the absorbing liquid after which the stopper holding the outlet tube D is put in place. The apparatus is then adjusted to receive the air containing the gases to be absorbed, these entering through the tube B when suction is applied at D. Suction may be applied continuously by the use of an ordinary small aspirating pump attached to a constant level reservoir to insure steady action.

Air and the gases to be absorbed, entering the apparatus, are delivered into the absorbing solution at the lower tip of the side arm tube B in the form of small bubbles which are caught by the spiral, passed

[1] Paper No. 140 of the Journal Series, New Jersey Agricultural Experiment Station, Department of Plant Physiology.

many times around the tube E in their upward course between the walls of the tubes A and E and are turned over and over in the absorbing solution during the process, thus giving ample opportunity for the removal of the last trace of soluble gases.

This apparatus has been found quite efficient and has given entire satisfaction when applied to the purpose for which it was intended. It is entirely probable that with modifications, in regard to size and minor details, it might find quite general application in various types of work in which the thorough washing or complete absorption of gases is an essential feature.

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SPECIAL ARTICLES

AIR-EARTH CURRENTS AND OTHERS

IN SCIENCE of July 27, 1923, pp. 67–68, Dr. L. A. Bauer has criticised my article in SCIENCE of May 25 on the ground that my data was insufficient. I can only reply that I used the data upon which practically all the generalizations upon atmospheric potential gradient have been made. My Figure 1 represented the data from *Observatorio del Ebro* for the six years, 1914–1919, and seems to me to contradict Dr. Bauer's statement that the annual variation of atmospheric potential gradient "does not vary according to the sine of the sun's zenith distance at apparent noon at any given place."

In general, the annual variation which I described in my paper applies to the published data for the following stations besides Tortosa, as may be seen from the table on page 889 of Arrhenius's *Lehrbuch der kosmischen Physik:* Brussels, Kreuznach, St. Louis, Melbourne, Moncalieri, Paris, Ghent, Wolfenbüttel, Helsingfors, Sonnblick, Batavia, Kief and Stuttgart. Arrhenius says that the annual variation at Cape Horn, like that at Melbourne, is opposite to that in the Northern Hemisphere, but I have not seen a tabulation of Cape Horn data. Neither have I seen any data from Helwan, Egypt.[1a]

[1a] In his article on "Atmospheric Electricity," in the Dictionary of Applied Physics, C. T. R. Wilson says: "Such evidence as is available goes to show that the annual variation is of the same character with a maximum in midwinter and a minimum in midsummer throughout middle latitudes in both hemispheres, *i.e.*, everywhere outside the tropics and the polar regions. The records of potential obtained at Helwan (Egypt) are exceptional, showing a maximum in midsummer and a minimum in midwinter."

Also, while Dr. Bauer says the average annual variation of potential gradient varies by but 60 per cent., Arrhenius[1] says the average potential gradient over Europe is about 4.6 times as great in winter as in summer. The same is true for the St. Louis data.

In the article which Dr. Bauer criticized, I called attention to the importance of correcting the observed potential gradient for the conductivity of the air at the time of observation. This was done in the case of the data from Ebro Observatory, but no data on atmospheric conductivity was available for other stations. It was mentioned that this corrected potential gradient is what has usually been defined as an air-earth current. This current, as computed from the atmospheric potential gradient and the atmospheric conductivity amounts, according to Dr. Bauer's estimate,[2] to about 3×10^{-6} ampere per sq. km over the whole earth. This would give a total current of about 1500 amperes continually flowing into the earth, which would raise the electric potential of the earth at the rate of 2,400,000 volts per second. This change in potential, impossible as it seems, fades into insignificance in comparison with that which would accompany some of Dr. Bauer's hypothetical air-earth currents.

My paper of May 25 dealt only with the seasonal variation of atmospheric potential gradient; but there is likewise a diurnal variation of atmospheric potential gradient which must, if the phenomenon is one of induction by a charged earth, vary with the diurnal variation of the earth's potential at the place of observation. For the purpose of showing that such a relation is indicated, I am fortunately able to refer to data which have already been approved by Dr. Bauer. In *Terrestrial Magnetism,* XXV, page 161, Dr. Bauer gives two curves which show what he calls the summer diurnal variation of air-earth current density. One of these curves is there said to represent Dr. Dorno's observations at the Alpine station Davos, and the other is said to represent observations made at the Potsdam Observatory. In Figure 1, below, Dr. Bauer's Davos curve, as scaled from the one in *Terrestrial Magnetism,* is compared with a curve showing the diurnal variation of the electrical potential of the earth at my Palo Alto observatory for the year August, 1920–July, 1921, and in Figure 2, the Potsdam curve is compared with the curve of diurnal variation of earth potential at Palo Alto for the year September, 1921 to August, 1922. In both figures the broken line represents the Palo Alto curves. It will be seen that the air-earth current curves agree with the curves of earth potential variation as closely as they do with each other.

[1] "Kosmische Physik," p. 888.

[2] *Terr. Mag.*, XXV, 156 (Dec., 1920).