with, but even so a considerable number, including the citrus fruits, have been omitted. In the opinion of this reviewer the value of the book would have been considerably enhanced if it had been restricted in scope to the flowering and ornamental plants, or the vegetable and salad plants, or the fruits, thus permitting a more comprehensive review of a relatively limited field.

The chapters dealing with incompatibility and sterility are of great interest to both the geneticist and practical plant breeder. They show clearly the important progress which has been made in this field in recent years.

The final chapter outlines the modes of origin of new and improved forms of garden plants. A number of interesting cases of constant hybrids are given. Among other problems brief mention of breeding for disease resistance is included. This subject is receiving increasing attention and represents one of the most promising fields open to the plant breeder at the present time, so it might well have been given greater emphasis.

The book includes a glossary, bibliography and index. It is written in a clear and interesting way, and will doubtless be favorably received by both geneticists and plant breeders.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

SAND AND WATER PARADOX

AT the March meeting of the Central Ohio Physics Club, Dr. G. E. Owen presented a startling experiment which apparently has not been completely explained. The apparatus consisted of a rubber bulb about 50 cc capacity with a glass tube, in which one could observe the water level at about half the length of the tube. When the bulb was squeezed, instead of an expected rise in level, the water was rapidly drawn into the bulb!

If the position of the level in the tube is to be considered as the indication of the pressure within the rubber bulb, then we have an interesting working model for that hypothetical part of van der Waals' equation where, indeed, a decrease in volume causes also a decrease in pressure.

The construction of the apparatus is made clear in Fig. 1, a, in its vertical cross section. The rubber bulb is tightly packed with sand up to the lower end of the glass tube, which is flared. A silk bolting cloth is stretched across the mouth of the tube to prevent sand from entering into the tube. Under ordinary conditions the grains of sand are so packed as to occupy the state of lowest potential energy which leaves the least volume between them. When the bulb is compressed, the spheres separate and the increased interstices draw in the water from the vertical tube. In a two-dimensional idealized diagram, Fig. 1, b, the

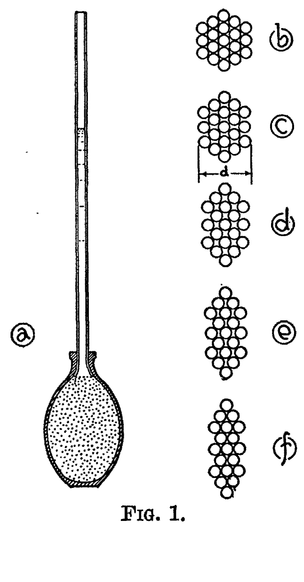

FIG. 1.

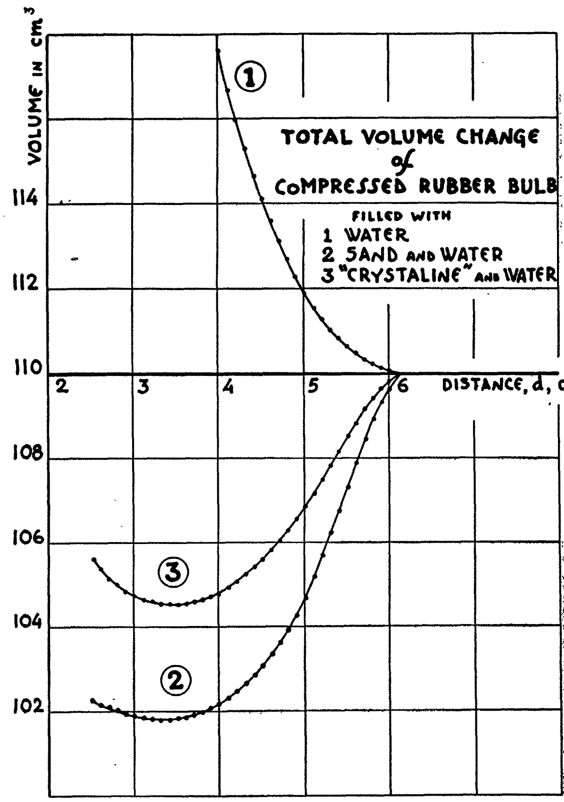

FIG. 2.

circles of equal diameters represent their original positions. The area between the circles will reach a maximum when the circles are rearranged, as in d; on further compression the area will start to decrease, shown in e, returning finally to its original value, as in f, equal to that of b.

To verify the above explanation an experimental set-up was made with a 100 cc rubber bulb between the parallel jaws of a milling machine vise. The height of the water level was measured by means of a meter stick arranged parallel to the vertical tubing. The tube was calibrated by measuring the volume of water that filled a certain length of the tube. The distance d, between the jaws, was determined from the pitch of the screw. The data are presented in form of three curves in Fig. 2. Curve 1 was obtained for a bulb filled with water only. Curve 2 shows how the water level changes with the distance d, when the bulb is tightly packed with the sand. In Curve 3, the bulb was filled with small glass spheres, ranging from .0215″ to .0224″ in diameter. These small spheres are produced by atomizing molten glass and are solidified in the air. Surface tension is responsible for their perfect sphericity. They are used for decorative purposes under the name of "Crystaline" or "Glasscherben." These curves definitely show the minimum volume for water and sand or glass spheres and an increase in volume on further decrease in d. As was expected, for the same change in d, the minimum is more pronounced with the glass spheres. Because of larger frictional forces between the irregular grains of sand the interspacial volume for sand increases more rapidly and reaches larger value than in the case of glass spheres. The limit of compression was set by the strength of the rubber bulb.

The phenomenon described here is a familiar experience to those at the seashore who have noticed how rapidly the water "dries up" around foot prints when walking on the wet sand.

Any of the readers who can give the reference to any publications concerning the described effect are kindly asked to communicate with the author.

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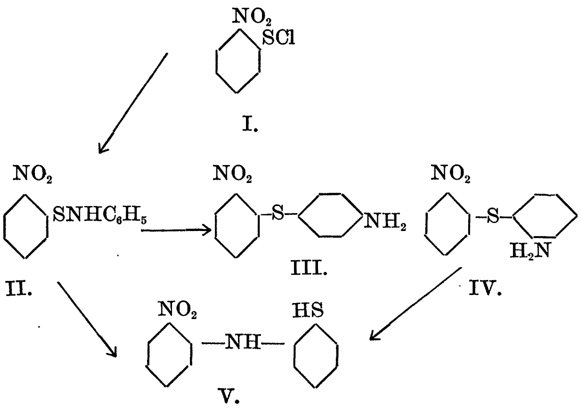
SPECIAL ARTICLES

MOLECULAR REARRANGEMENTS OF SULFANILIDES

DURING recent work in this laboratory on the development of improved methods for the synthesis of new sulphide phenol compounds possessing high antiseptic and germicidal power, it was discovered that certain sulphur compounds of the sulfanilide type are capable of undergoing profound molecular changes. Two types of transformations have thus far been revealed in the course of our researches, which may be illustrated by the following example: The starting point serving for our illustration is *o*-nitrophenylsul-



furchloride I, which is easily prepared by the action of chlorine on *o*-nitrophenyldisulphide. This sulfurchloride I interacts smoothly with aniline to form in good yield *o*-nitrophenylsulfanilide II. We find that this latter compound II undergoes two types of molecular change, depending upon the experimental conditions employed. (1) If the sulfanilide II is heated at a definite temperature, or if it is digested with its respective amine (aniline) at its boiling point, it is transformed into its isomeric 2-nitro-4′-aminodiphenylsulphide III. In some cases we have also observed a corresponding *ortho* rearrangement IV. (2) On the other hand, when the sulfanilide II is warmed in alcohol in the presence of sodium hydroxide it undergoes an entirely different type of change and is transformed smoothly into a mercapto-diphenylamine derivative corresponding to formula V. Regarding the mechanism of this last change we are not prepared to offer a decisive explanation. The simplest postulation, that we are dealing here with the intermediate formation of an *ortho*-aminosulphide (formula IV), which then rearranges to the isomeric diphenylamine V, does not satisfy as the correct explanation. The English chemist, Dr. Smiles, and his co-workers report[1] that *o*-aminosulphides of this type, studied by them, are unattacked by alcoholic sodium hydroxide, while the corresponding acetyl- and benzoyl-derivatives, for example, rearrange easily to diphenylamine derivatives under the same experimental conditions. Two types of reaction products, therefore, are possible of

[1] See Evans and Smiles, *Jour. Chem. Soc.* (London), p. 183, 1935.