covers the entire range of meteorology, except the optical phenomena, about as fully, perhaps, as the average person cares to know it. There are no mathematical equations, and no attempt to discuss things that require for their elucidation this type of formal logic. Nevertheless, Dr. Brunt evidently assumes that his readers already have some knowledge and want more, for he writes as one scholar to another, and not, as so many authors of popular science do, as a romancer to blockheads.

Each of the eleven chapters is excellent, but the one that treats of that most difficult subject, the "Origin of Cyclonic Depressions," is so exceptionally good as to deserve especial mention.

In speaking of humidity Dr. Brunt refers, as does nearly every one else, to "the maximum amount of water-vapor which air can take up." Perhaps he might be willing to explain, in some future edition, that the only merits of this expression are its hoary age, general usage and convenience; that really the air is not a sort of sponge nor in any way essential to evaporation, and that after all it is the space and not the air that becomes saturated.

There is no book on meteorology that one could recommend more heartily than this to the general reader.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

APPARATUS FOR THE DETECTION OF SUBSTRATUM COMMUNICATION AMONG TERMITES

THE theory that termites might communicate with each other by means of substratum vibrations usually not audible to the human ear led to the construction of the apparatus described below. A more extensive paper on the subject of termite communication will appear later, but it is thought that an account of the method of detection of substratum vibrations of termites might have a more general interest at this time.

The inside of a telephone transmitter, consisting of the carbon cup and screw to which the diaphragm is attached, was connected to four dry cells. The primary of a ten to one ratio audio transformer was connected to the microphone and batteries, while the secondary of the transformer was connected to the input terminals of an audio amplifier such as is used in radio work. An RCA Uni-Rectron AP-935 amplifier was used in this case, and an ordinary pair of head phones was connected to the output terminals

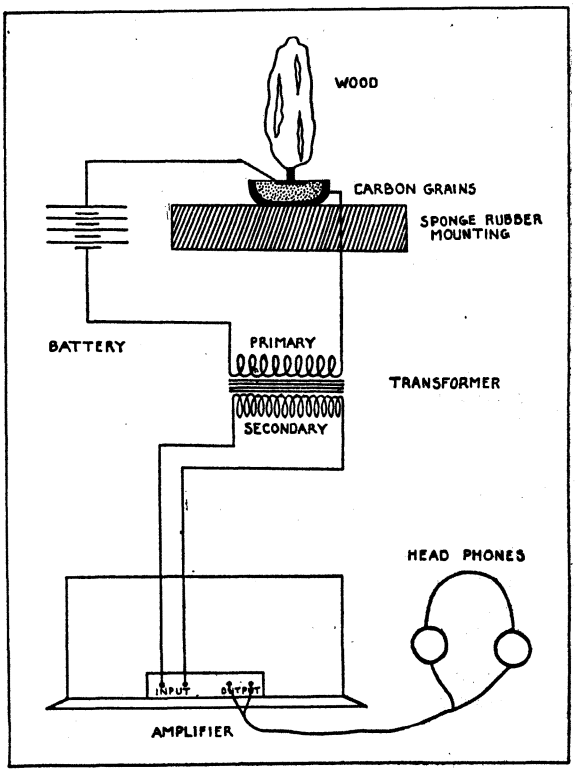

FIG. 1. Showing cross section of microphone and its base.

of the amplifier. The diaphragm was removed from the telephone transmitter and a piece of the wood inhabited by the termites was threaded on the diaphragm screw.

The termites crawling upon the wood jarred the carbon grains, thus altering the current from the dry cells. This produced a sound which was amplified to the extent that a termite walking on the wood could be heard through the head phones. It was found best to mount the microphone button and attached wood on a piece of sponge rubber in order that outside vibrations jarring the table or floor would not register on the apparatus.

After several hours of observation, some soldiers of *Reticulitermes flavipes* (Kollar) became disturbed and were thus stimulated to hammer their heads upon the wood. This performance could be plainly seen at the same time that the amplified noise produced was easily heard through the head phones. This action on the part of soldiers of *Reticulitermes flavipes* has never before been recorded to our knowledge, and we imagine that the sound would be almost impossible to hear under natural conditions.

Audible sounds made in a similar manner have been detected among several genera of *Kalotermitidae, Rhinotermitidae* and *Termitidae* before, but there has been some confusion in the literature as to whether the sounds were caused by hammer-

ing the head or by some stridulatory apparatus. Experiments conducted by the senior author, however, seem to indicate that termites hear air vibrations very poorly if at all, while at the same time they are very sensitive to substratum vibrations. This fact together with the definite proof that the head hammering produces a distinct substratum vibration tends to support the idea that these insects communicate with each other through the nest material. Probably the asymmetrical mandibles of *Capritermes* and allied genera are modified for making a substratum vibration by snapping the mandibles. As these substratum sounds are generally associated with disturbance, it is thought likely that they are utilized as symbols of danger.

The jerking motion of termites commonly observed did not register enough vibration through the substratum to be detected in the apparatus, and there seems to be no indication that this action is a method of communication by sound, although evidence points to the strong possibility that termites communicate by means of this jerking motion, possibly by means of an odor stimulation.

There is some indication reported by Dr. T. E. Snyder, of the U. S. Bureau of Entomology, that excessive substratum vibration frequently produced will deter termites from occupying certain situations. Crossties of railroads with heavy traffic and buildings occupied by cotton machinery in motion seem to be immune to attack, and the above experiments indicate the reason.

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AN ACCURATE DROP RECORDER

SOME time ago in a brief review of the various existing drop recorders I described one model of Hainke's suction electrode type.[1] Recently at the request of a former colleague I constructed an instrument in which certain important changes were made. The resulting device was so much better than the one previously described that it may be of interest to others whose problems demand a high order of accuracy in the measurement of small flows. As will be seen by a reference to the figure[2] the instrument consists of three parts. *A* consists of the usual condom displacement chamber already described; in place, however, of the long inlet tube, I now fit a fine glass rod *R* which supports the condom thus insuring more complete emptying. *B* is the sulphate reservoir and also vacuum chamber combined, made from a

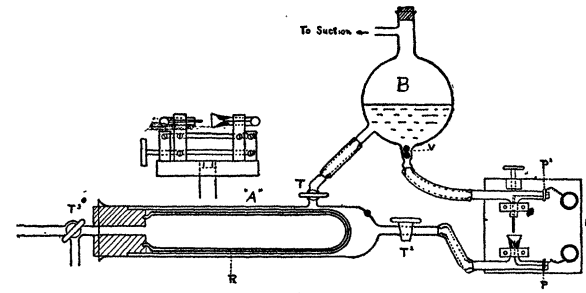

FIG. 1

250 cc pyrex flask. In the bottom tube which connects to the upper electrode is a bead valve *V* to prevent back-flow should the suction fail. When the instrument is not in use the tube leading to the electrode should be clipped off. *C* illustrates the electrodes. The top or cup of the lower one should be on a level with the middle of the displacement chamber to which it is connected. Electrical connection is made by means of a platinum wire running from the base of the cup to the binding post *P*. The upper movable or suction electrode consists of a fine platinum tube connected to its binding post P^2. To use the instrument the displacement chamber is filled with 10 per cent. sodium sulphate solution from the reservoir through the tap *T*, the exit tap T^2 being closed. In order to avoid disconnecting the animal or other source of inflow, use is made of the three-way tap T^3. Suction is now turned on, and for this purpose I personally use a filter-pump on the recorder stand worked from the laboratory compressed air. The clip is removed from the upper electrode tube and air bubbles freely in the vacuum-tube. T^2 must, of course, be closed. As the displaced fluid wells up in the cup it comes in contact with the suction electrode, momentarily making contact, which is recorded in the usual way.

Variation of the size of the drop is obtained in three ways. Firstly, by the size of the suction electrode tube; secondly, by the type of surface it takes its drop from, the larger the surface the larger the drop, hence the funnel shape of the lower electrode; thirdly, by the amount of suction used, the greater the suction, naturally, the smaller the drop. This latter, however, can not be too great unless extremely sensitive electrical recorders are used, as the contact time is correspondingly shortened.

The apparatus as demonstrated will easily give an accuracy of 600 drops per cc, using an ordinary thousand ohm telephone relay and simple signal connected through a 45-volt wireless battery. Using such a sensitive instrument as a string galvanometer with a finer electrode probably well over a thousand drops per cc could be readily recorded. Movement of the electrodes alone gives about 500 per cent. variation.

[1] O. S. Gibbs, "Drop Recorders," *Jour. Lab. and Clin. Med.*, 12: 686, 1927.

[2] I am indebted to Mr. J. G. Allen, of the cableship *John W. Mackay*, for the drawing of this instrument.