There are irregularities, however, as in *Oenothera*, and haploid plates of seven and nine, instead of the usual eight, are not uncommon. At maturity there is always a large percentage of morphologically sterile pollen. The peculiar arrangement of chromosomes seems to be of special interest and so far has been noted in no other *Hypericum*.

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SOFTENING TISSUES

IN the paper, "A Method to Soften Tissue Already Imbedded in Paraffin," which appeared in SCIENCE on December 12, 1930, it should have been stated that the work was done entirely in Dr. Linford's laboratory, and that it was at his suggestion that I tried the water soaking to soften the pineapple leaf.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

USE OF AN IMPROVED NULL INSTRUMENT FOR GLASS ELECTRODE OR OTHER HIGH RESISTANCE CIRCUITS

SEVERAL authors have described vacuum tube amplifiers for use with glass electrodes, employing radio-type vacuum tubes in circuits arranged to secure stability and sensitivity. But in even the best of these the grid current of the tube is large enough to cause polarization of the glass membrane or there are other difficulties.

A new vacuum tube has recently been described by Metcalf and Thompson.[1] This tube, the General Electric Pliotron FP 54, was especially designed for the detection of minute D.C. currents and potentials, and its use for this purpose has been discussed by Du Bridge.[2] The grid current is so small (10^{-15} amperes) that it introduces negligible errors in the measurement of potentials of systems of very high resistance. For instance, the writer has found that glass electrodes with resistance as high as 100,000 megohms may be used in the grid circuit of the tube with no difficulty. The measured potential of a standard cell in series with this value is the same as when obtained directly. When an electrode of 10,000,000 megohms was used, and allowance was made for the IR drop across it, the correct value of the standard cell was obtained within one tenth of one per cent. Using a Compton electrometer, hitherto the best instrument available, no reading at all could be made in series with this 10,000,000 megohm resistance.[3, 4]

The usefulness of this vacuum tube is obvious. It makes possible the use of thick glass membranes of small area, simplifying the drop method of MacInnes and Dole[5] by permitting the use of thicker and more rugged glass membranes. For measurements where larger quantities of liquid are available, bulb electrodes may be blown with such thick walls that they can be handled almost as roughly as test-tubes, and their resistances will be entirely negligible for this measuring instrument. The validity of the glass electrode as a hydrogen electrode is discussed in the papers by MacInnes and Dole,[5] who also give the composition of a suitable glass.

A diagram of the circuit used is given in Fig. 1. The amplifier is entirely enclosed by a heavy sheet-iron shield, and the test circuit also is carefully shielded, all shields of course being grounded. The designers of the tube recommend large storage batteries for all potentials in order to avoid drift of the

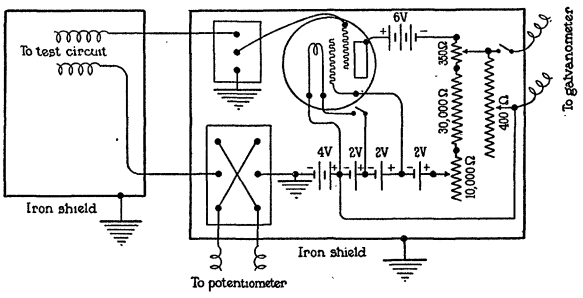

FIG. 1. Circuit for measuring D.C. potentials in high resistance circuits with the General Electric Pliotron FP 54. Batteries are lead storage cells. Resistances are wire-wound. Shielding is galvanized iron.

[1] G. F. Metcalf and B. J. Thompson, *Phys. Rev.*, 36: 1489, 1930.

[2] A. Du Bridge, *Phys. Rev.*, 37: 392, 1931.

[3] Mr. D. Belcher, of the Rockefeller Institute, kindly tried making measurements in series with these high resistances with the Compton electrometer.

[4] This vacuum tube is also a useful instrument for measuring extremely high resistances. The flow of the grid current (10^{-15} amperes) through a resistance placed in the grid circuit will cause a change in potential of the grid. From the simple equation $E = IR$, the value of the resistance may be determined. The grid current of the tube may thus be used for measuring resistance above 10^{11} ohms when the plate circuit galvanometer has a sensitivity of 0.01 micro-ampere per millimeter (permitting detection of one-tenth millivolt). Measurement of resistances below 10^{11} ohms of course calls for current from some external source, and is carried out in the usual manner.

[5] D. A. MacInnes and M. Dole, *Jour. Gen. Physiol.*, 12: 805, 1928–29. *Ind. and Eng. Chem.*, 1: 57, 1929; *Jour. Am. Chem. Soc.*, 52: 29, 1930.