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.

A. B. COUCH

CHAPEL HILL, N. C.

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

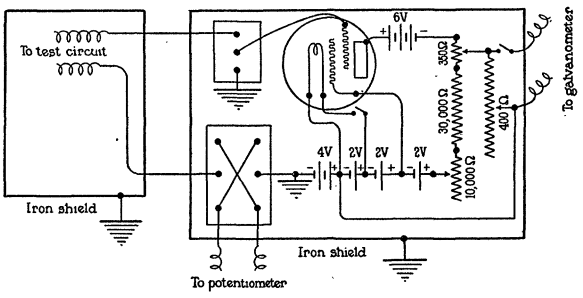

FIG. 1. Circuit for measuring D.C. potentials in high resistance circuits with the General Electric Pliotron FP 54. Batteries are lead storage cells. Resistances are wire-wound. Shielding is galvanized iron.

[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.

galvanometer. The sensitivity of the instrument depends largely upon the galvanometer. For measuring to one tenth millivolt the writer has found adequate a galvanometer with a sensitivity of 0.01 micro ampere per millimeter. In use, the grid is grounded, and the plate resistance adjusted until the galvanometer reads zero. The grid is then connected to the circuit under test and the potentiometer adjusted until the galvanometer again reads zero. The potentiometer reading, of course, gives the E.M.F. and polarity of the test circuit.

Some of the earlier papers upon glass electrode circuits lay unnecessary emphasis upon insulation difficulties. Only ordinary care need be used except in the grid circuit of the tube. The potentiometer reversing switch is in the low resistance portion of the grid circuit and may be of almost any material and may be outside the shield with the potentiometer. In the high resistance part of the grid circuit extraordinary care must be taken that there are no insulation leaks to shunt the tube. The wire leading from the glass electrode to the grid should be shielded (a flexible copper shielded wire has been found excellent) and the single pole double throw switch for grounding or charging the grid should be the best available. The writer used a telephone "anti-capacity" switch, in which the manufacturer's black bakelite mounting was replaced by transparent bakelite, which was used also for the roller. It was found necessary to bake this transparent bakelite for two days at 115° C. in order to make its insulation good enough. Amber might, of course, be used but is more expensive. The handle of this switch was grounded in order to avoid any body charge from the operator. When glass electrodes of extremely high resistance are used, there is an initial deflection of the galvanometer on closing the switch, due to the capacity of the test circuit. The charge due to this capacity difference leaks off in a few seconds. The 400 ohm shunt resistance for the galvanometer reduces the initial deflection, and the shunt is then opened to secure full sensitivity.

The shield for the external circuit was a cage of ¼ inch mesh iron wire, which was found adequate. Inside the iron cage, the electrodes and other apparatus were held in iron clamps attached to ½ inch bakelite rods screwed into laboratory tripods. No special treatment was needed for the bakelite rods if the clamps holding the electrodes were as much as six inches apart. The bakelite rods were occasionally cleaned with alcohol and ether. In general, greater care should be taken with the insulation and shielding of the grid circuit than with an electrometer circuit, since this is a more sensitive instrument. This vacuum tube circuit is cheaper and more portable than the Compton electrometer. The Lindeman electrometer, which is portable, has the disadvantage of a low sensitivity, and must be read with a microscope. For those unaccustomed to the use of vacuum tube amplifiers, the small amount of time required to master this simple circuit will be more than compensated for by its superiority to any other method of measuring potentials in high resistance circuits.

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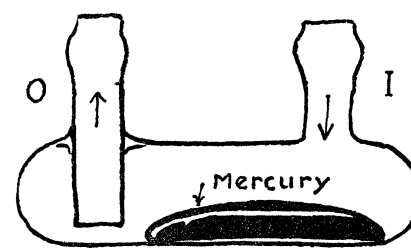
A TILTING STOPCOCK

I HAVE made and used for some time a simple stopcock which corresponds exactly to the convenient mercury switch for electric current, and which can be used in the same way for cutting positively a flow of gas under small pressure, without any danger of leak and without friction. It can be mounted like the mercury switch, that is, well balanced on a light axis, so that the slightest effort will cut off the supply of one or more Bunsen burners. I found it a great help



whenever automatic regulation of gas supply was needed. The accompanying sketch will make its construction and functioning clear. One must always connect the tubes in such a way as to have the gas enter the stopcock through inlet I. As soon as the stopcock is tilted, the mercury obstructs the outlet O, and the flow is cut off. On coming back to horizontal position, the gas resumes its flow.

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SPECIAL ARTICLES

A MOTTLED-EYED DROSOPHILA

EARLY last December a gray red-eyed female fly was found that had notched wings and an area of white facets covering the lower fourth of the left eye. The fly appeared in the F_1 generation from a cross of a treated Theta male to an untreated female