

The blood changes were similar to those observed in the preceding group, namely, a rise in the arterial CO_2 and in the CO_2 curve level, a rise in arterial oxygen saturation, decrease in pulmonary ventilation and in basal metabolic rate and, in one case, an increase in the vital capacity. The arterial serum pH was not altered.

The striking features of these 2 cases were the occurrence of diuresis and the consequent disappearance of edema while in an atmosphere rich in oxygen. In both cases, a return to ordinary room air was followed by diminution in urinary output and return of edema. A second period of residence in 45% oxygen again resulted in diuresis and disappearance of edema. The direct relationship between the oxygen percentage in the atmosphere and the water balance, as measured by fluid intake and output, seemed clearly established. No such constant and parallel relation was apparent between diuresis and the changes in other measurements, such as vital capacity, metabolic rate, pulmonary ventilation, CO_2 level and hydrogen ion concentration. Probably there was a fairly close association between the amount of urinary output and the degree of arterial oxygen unsaturation, but the data were not sufficiently complete to determine this point. The temperature and humidity of the atmosphere were not deciding factors, because the same sequence of events occurred whether the patient was transferred from the oxygen chamber to the ward, or was kept in the oxygen chamber while the oxygen in its atmosphere was changed from 45 to 21%.

Electrocardiograms were taken at frequent intervals on all 5 patients. No changes were observed in the form of the complexes or in conduction which could be ascribed to variations in the oxygen content of the inspired air.

Citations to literature will be given in the complete report.

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A New Type of Microelectrode.

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Several types of microelectrodes have already been devised by different investigators.¹ In all these electrodes the conducting me-

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¹ Bose, J. C., *Trans. Bose Institute*, 1919, ii; Taylor, C. V., *Proc. Soc. Exp.*

dium, whether of metal or of KCl-agar, is enclosed in a micropipette of glass or quartz. It is possible to make electrodes of similar fineness from metallic wires, but they are too flexible for use.

In the new type of microelectrodes described here, the conducting medium is a continuous film of silver, gold or platinum for stimulating electrodes and silver-silver chloride for non-polarizable electrodes, on the outer surface of glass or quartz micro-needles. The advantages are: (1) they can be easily made and in large numbers at one time, (2) many pure metals can be used, (3) electric contacts of any geometrical shape and fineness can be easily made, (4) the non-polarizable electrode can be made sterile, and (5) their electric resistance is low.

The best way to deposit films of metal on glass and quartz is by sputtering, *i. e.*, by placing them in the dark space of high voltage vacuum discharge. But for the deposit of silver films on glass needles, Brashear's² method of silvering glass has been found very satisfactory; for bright platinum films Meillere's method³ is used.

The desired number of micro-needles is drawn in the way described in detail by Chambers.⁴ The shank ends of the needles are warmed in a microflame and embedded vertically up in a block of paraffin and are then cleaned by immersing the needles vertically down in a beaker of cleaning fluid. After a few hours in the cleaning fluid the needles are thoroughly washed in running water and then kept immersed in a large beaker of distilled water till they are to be placed in the silvering solution. The silvered needles are washed thoroughly and dried in a hot oven.

Electric contacts with these silvered needles are made by inserting them in the electrode holder (Fig. 1). Woods metal previously placed in the tapering end of the holder is melted by gentle heat and

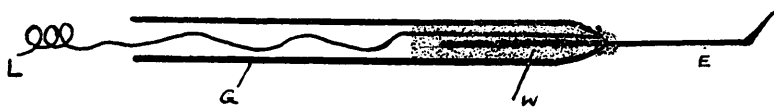


FIG. 1.

Electrode Holder. G, glass tube 4 mm. diameter. W, Woods metal. E, microelectrode. L, copper wire lead.

BIOL. AND MED., 1925, xxiii; Ettisch, G., and Peterfi, T., *Pfluger Arch. f. d. ges. Physiol.*, 1925, cexiii; Gelfan, S., *PROC. SOC. EXP. BIOL. AND MED.*, 1926, xxiii; Taylor, C. V., and Whitaker, D. M., *Protoplasma*, 1927, iii.

² *Scientific American Cyclopedia of Formulae*, 1925, 502.

³ Clark, W. M., "The Determination of Hydrogen Ions," 1928, 283.

⁴ Chambers, R., in McClung's "Test Book of Microscopical Technique," Hoeber, 1929.

the needle thrust in. On cooling of the metal a good contact is secured. Any defect in the rigidity at the contact is overcome by pouring minute drops of melted Woods metal with a fine glass pipette. After mounting the coated needles in this way thicker coats of silver or of any other metal can be deposited electrolytically. For non-polarizable electrodes a thicker coat of silver is desirable. The film of silver chloride is deposited electrolytically by making the electrodes the anode in a 5% KCl bath, the cathode being another piece of silver. With 0.5 volts across the terminals, and keeping the current on only for 30 to 40 seconds a good continuous coat of silver chloride film is obtained. The electrodes are washed and kept in distilled water for a few hours before use. Electrodes when broken are easily replaced by fresh ones by warming the Woods metal of the electrode holder.

When necessary the metallic film of the shank can be insulated by applying shellac solution with a fine brush. The insulation of the micro-tip end is done under a microscope. The tip pointed upward is illuminated in the dark field of the microscope and its shank is gradually lowered by rack and pinion into a small cup of shellac solution. By this method it is easy to insulate up to 10μ from the micro-tip. With care and by using a thicker shellac solution, insulation up to within 5μ can be obtained. The resistance of a pair of electrodes with a micro-tip less than 3μ in diameter has been found to be only 35 ohms. We have been using these electrodes for the last 6 months and they are found to be very satisfactory alike for measuring resistances, by the method previously described,⁵ and currents in single living cells and for stimulating single nerves and muscle fibers.

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Effect of Cathode Rays Upon Certain Bacteria.

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The following experiments, which are intended as preliminary steps in a study of some of the effects of cathode rays upon cells,

⁵ Sen, B., *Roy. Soc. Proc.*, 1923, xciv, 216.