degeneration in the nucleus reticularis pontis oralis of split brain stem cats. The increase of W and D and the decrease of SS did not reach statistically significant values. Our experiments, therefore, support the hypothesis that the ventrolateral portion of nucleus reticularis pontis oralis has a hypnogenic function and, as was previously reported[2,3], this nucleus has an activating function on EEG.
Results show the importance of controlling exactly the lesions placed at the level of the pons, because little changes in the location and extent of lesions produce quite different modifications of SWC. Variations of SWC due to lesions in the ventrolateral area of nucleus reticularis pontis oralis are different from modifications found after destruction of its dorsomedial part[10]; also modifications are different from those found when the nucleus reticularis pontis caudalis is affected[11] or when there are wider lesions at this level[4]. It is imprecise, therefore, to speak of findings after lesion in the pontine tegmentum without determining the structures involved in the lesion.

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Construction of a thin film P_{O_2}-electrode using gold paste

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Summary. A thin film gold electrode for biological oxygen measurement was constructed using gold paste. This electrode is easy to construct, has high sensitivity and is disturbed only slightly by bubbling of the surrounding fluid. As an application, the electrode was used to measure oxygen consumption of the skin and yielded a reasonable value.

In the measurement of biological oxygen tension, 3 fundamental performances are required for the polarographic oxygen electrode; i.e. high sensitivity, rapid response and resistance to the effects by movements of surrounding fluid. These requirements oppose one another and can hardly be realized in 1 electrode: High sensitivity needs a large surface area of the active electrode, rapid response and resistance to fluid movements require a small electrode surface. To effect a compromise of these requirements, Saito and Mochizuki[3], Saito[4] introduced a ultra-thin film ring electrode of sputtered platinum. The construction of this electrode needs careful control of the sputtering apparatus, but the elaborately constructed electrode often becomes unstable, probably because the heat expansion of insulated platinum film is markedly larger than that of the insulating glass. To avoid such difficulties, Kimmich and Kreuzer[5] recommended to insulate a ring of a platinum foil of about 3 µm thick by means of polyvinyl chloride. The oxygen current of their electrode, however, is still affected by fluid movements, when utilized without covering. Therefore, it seems worthwhile to examine another method of construction of the thinner film ring electrode. In the present study, we investigated the applicability of gold paste, which is used for the painting of china, to the construction of oxygen electrode.

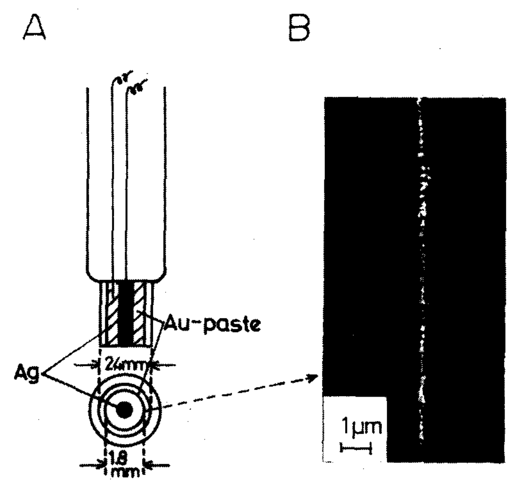

Fig. 1, *A* Schematic illustration of the gold paste electrode. *B* A microscopic photograph of a part of the gold paste active surface immersed in oil (n= 1.515) and illuminated with a light beam having a suitable incident angle. Olympus oil objective Hi M 100× and occular 10× were used.

Construction of the electrode. The structure of the electrode is schematically shown in figure 1, A. A thin glass tube (OD 2 mm) is painted with diluted gold paste and heated for 60 min at a temperature of 400 °C. This tube is then inserted in another glass tube which serves as insulation. Air is then removed from the tubes with a vacuum pump. The tube is heated while the vacuum pump is still running, which causes the outer tube to melt and shrink onto the inner glass tube and insulate the gold film. The tip of this glass tube, having an insulated gold film in it, is cut off and polished gently on artificial leather with cerium oxide powder, so that a smooth thin ring of gold film is exposed on the surface flush with the polished cut end of the glass tube. Then a silver wire coated with silver chloride is inserted into the glass tube and mounted in a suitable position at the cut end by means of epoxiresin. This Ag-AgCl wire serves as the reference electrode against the gold film, which is charged at –0.7 V.
Characteristics and testing of the electrode. The sensitivity and reproducibility of oxygen current of this electrode was tested in a saline solution bubbled with air and nitrogen. The oxygen current is of the order of 10^{-11} A/Torr and its response to alternate bubbling with air and nitrogen was reproducible within a relative error of 6% over 7 h. When air bubbling was stopped, the oxygen current quickly decreased by 5% of total current and remained at that level. This means that the disturbance

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of the diffusion layer by the water movement is very small. The C-V curve shows a plateau over the range of −0.3 to −0.8 V. The temperature dependency of the current was 4×10^{-14} A/Torr · °C over the temperature range of 30 to 45 °C, which was a reasonable change in view of the changes of O_2 absorption and diffusion coefficients of saline solution.

Figure 1, B shows a part of the electrode surface at a high magnification by means of a microscope. The exposed gold-ring can safely be regarded as a straight narrow band having the width of 0.2 µm. The O_2 diffusion layer which develops on this electrode surface can be expressed by a 2 dimensional partial derivative equation having its X and Y axes at right angles to the gold film surface as shown in figure 2. Then the final solution for the oxygen diffusion layer at infinite time is given by;

$$P = P_0 \cdot (1 - k),$$

where $k = \tan^{-1}(X+a)/Y - \tan^{-1}(X-a)/Y$ and 2a is the width of narrow band of the gold film ring. By putting $k' = \tan^{-1}k$, the iso-P_{O_2} line is given by the equation;

$$X^2 + (Y - a/k')^2 = (1 + 1/k'^2) \cdot a^2.$$

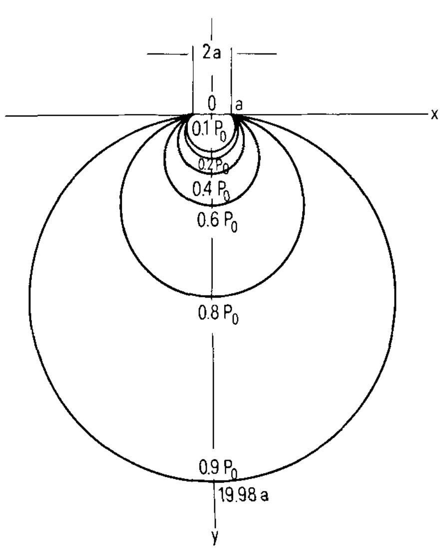

Fig. 2. Iso-P_{O_2} line in a region close to the gold paste surface.

The numerical plotting of this solution is given in figure 2. The farthest point from the electrode surface for $P = 0.9 \cdot P_0$ is $19.98 \cdot a$, which for the present electrode is 2 µm.

Application. This electrode may be used to measure the oxygen tension of the skin. The electrode tip is dipped in a solution (10% in acetone) of cemedine-C® (cellulose solved in acetone-ethanol-isopropanol mixture, Cemedine Co, Tokyo) and is dried in the room air, so that the electrode surface is coated with a thin coating (5 µm thick), which serves as a saline container when placed on the skin surface. The electrode so treated is passed through a cylindrical water bath, so that the electrode tip is situated flush with the bottom of the bath. The skin P_{O_2} was 0 to 2.5 mmHg during both air and oxygen breathing when the temperature of the water bath was at room temperature. An example of a recording under various conditions is shown in figure 3. The results were: 1. When the temperature was raised to 46 °C, the skin P_{O_2} increased to 48 mm Hg. 2. After blood flow was stopped by an inflated cuff placed around the arm, the skin P_{O_2} fell to nearly zero. 3. On releasing the cuff, the P_{O_2} recovered to the original value. 4. After the gas for breathing was changed from air to oxygen, the P_{O_2} rose rapidly to 230 mm Hg in 150 sec. 5. At this point the cuff was inflated again and the P_{O_2} decreased to nearly zero. 6. On releasing the cuff and changing the gas from oxygen to air the P_{O_2} attained a level near the initial value.

Since the oxygen diffusion layer on the electrode is estimated to be only 2 µm and the epidermis of this area is about 80 µm thick, the present electrode measures the P_{O_2} of the epidermis. According to Huch et al.[6], The skin oxygen consumption can be estimated by the following equation when skin P_{O_2} is sufficiently high and blood supply to the skin is interrupted by cuff inflation;

$$\dot{V}_{O_2} = \alpha/760 \cdot \Delta P/\Delta t,$$

where α is the oxygen absorption coefficient of skin tissue (= 0.0169 at 46 °C). In figure 3 the linear decrease of P_{O_2} is 184 mm Hg over the time range of 1.75 min. Putting these values into the above equation gives a $\dot{V}_{O_2}$ of 0.00233 ml O_2/ml tissue · min. This value is slightly higher than 0.002 by Ohara[7] and 0.0018 by Evans and Naylor[8]. This difference is probably due to the high temperature at which the present measurement was carried out. These results indicate a wide applicability of the present electrode to the investigation of tissue oxygen tension.

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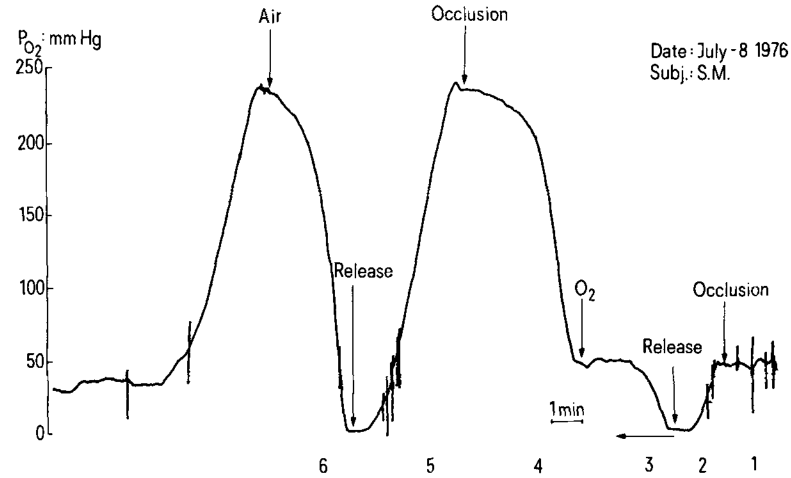

Fig. 3. An example of skin P_{O_2} recording during several experimental conditions. The numbers below the recording refer to successive experimental conditions. Read right to left.