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GLASS ELECTRODES
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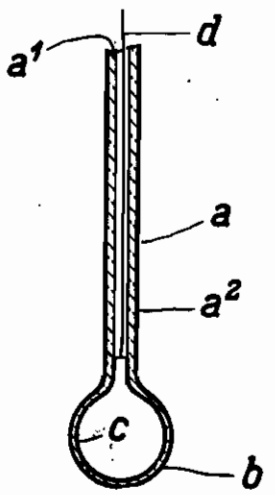

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GLASS ELECTRODES

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The present invention concerns glass electrodes for measuring the concentration of hydrogen ions. When using these electrodes it is generally necessary to employ voltmeters of special sensitivity, because the electrodes are highly resistant to the passage of electric current. With a view to keeping this resistance as low as possible, the electrodes are provided with an especially thin diaphragm-like part. The thickness of the layer in which the electric potential is formed belonging to the category 1μ, the wall thickness of the diaphragm would not, on principle, be required to be much greater. The manufacture of diaphragms of thicknesses smaller than 50μ is, however, difficult and would, on account of the fragility of such diaphragms, be disadvantageous. To further reduce the electric resistance, use is made, at least for the diaphragm, of glass of high electric conductivity. The conductivity can, however, be increased only at the expense of the chemical durability with respect to water, acids and alkalis by an increase of the alkali content in the glass. In the interest of a sufficient durability, the alkali content and, accordingly, the conductivity of the glass would have to remain within certain limits.

According to the invention, the electrodes can be, however, of glasses having a conductivity considerably higher than hitherto, if at least the diaphragm of the electrode consists of a plurality of layers, that is to say of a comparatively thick glass layer of high electric conductivity, though restricted chemical durability, and of one or a plurality of comparatively thin layers which cover at least the one side of and are of a greater chemical durability than the thick layer and whose electric conductivity need not in this case by particularly great. Whether a chemically resistant layer covers one side or both sides of the highly conductive glass layer depends on whether one or both sides of the electrode are to be in contact with the substance to be examined, for instance a liquid. The division of the glass wall into several layers has proved to be very practical in both these cases.

The manufacture of diaphragms according to the invention can be effected for instance by blowing small tubes of multi-layer glass whose principal part is of glass of high electric conductivity and whose thin layer is of glass of sufficient chemical durability. The proportion of the thicknesses of the different glass layers relative to each other is after the blowing the same as before.

Another possibility of making diaphragms consists in withdrawing chemically part of the alkali from the surface of the blown glass diaphragm of high conductivity, there being obtained, for instance by the action of acid or even water, a layer of silica gel which is swelled considerably. A process of this kind would take place by itself in the practical use of the electrodes for pH measurements. However, the gel layer thus obtained does, alone, not yet afford sufficient protection. This aim can be arrived at by carefully depriving the water from a thin gel layer having a thickness of approximately 1μ or less and then increasing the hardness of this layer by a suitable complementary treatment. This complementary treatment may consist, e. g., in one of the processes known in the manufacture of silica gel, for instance in driving at temperatures above 100 centigrade. The usefulness of such a protective layer produced by lixiviation and subsequent hardening depends on the absence of pores and cracks. This condition can be fulfilled by a suitable lixiviating liquid, for instance sulphuric acid of high percentage and suitable temperature and by correctly dimensioning the thickness of the layer, the best conditions depending in each particular case on the glass used.

Use can be made also of still further proceedings for the production of thin protective layers. It is known, for instance, that in the electrolysis of glass in mercury one of the glass surfaces is impoverished as regards alkali.

The accompanying drawing, which illustrates the invention, shows by way of example an electrode in a section through its axis.

The electrode is a tube *a* of multiple-layer glass having a thick interior glass layer a^1 of high electric conductivity and a thin glass layer A^2 of high chemical resistance, the lower end of the tube *a* terminating in a blown diaphragm-like sphere *b* which has the same, though much thinner, layers as the tube *a*. For convenience, the thicknesses are exaggerated in the drawing. The interior side of the sphere is covered by a thin layer *c* connected to a wire *d* leading to the outside. The illustrated electrode is meant for immersion into the substance to be examined.

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