United States Patent [19]

Hajdu et al.

[11] **3,923,042**

[45] **Dec. 2, 1975**

[54] **ELECTRICAL DETECTOR/TRANSDUCER/APPLICABLE ON THE SKIN SURFACE FOR BIOMETRICAL OBSERVATIONS**

[75] Inventors: **László Hajdu; György Hegyessy; József Balla; Gábor Vitán,** all of Budapest, Hungary

[73] Assignee: **Medicor Muvek,** Budapest, Hungary

[22] Filed: **Sept. 30, 1974**

[21] Appl. No.: **510,708**

[30] **Foreign Application Priority Data**

Oct. 15, 1973 Hungary ..... ME 1674

[52] **U.S. Cl.** ..... **128/2.06 E;** 128/2.1 E; 128/417; 128/DIG. 4; 252/514

[51] **Int. Cl.**[2] **A61B 5/04**

[58] **Field of Search** ..... 128/2.06 E, 2.1 E, DIG. 4, 128/417, 418, 404; 252/514

[56] **References Cited**

UNITED STATES PATENTS

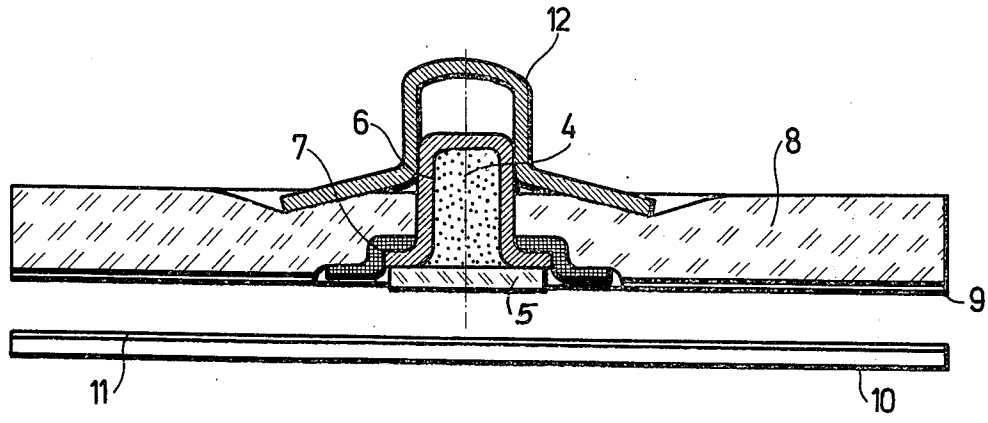
3,490,440	1/1970	Mosier et al.	128/2.1 E
3,496,929	2/1970	Domingues	128/2.06 E
3,574,305	4/1971	Muhl	128/2.1 E
3,685,645	8/1972	Kawaguchi	128/417
3,701,346	10/1972	Patrick, Jr. et al.	128/2.06 E
3,747,590	7/1973	Motley	128/DIG. 4
3,828,766	8/1974	Krasnow	128/2.1 E
3,834,373	9/1974	Sato	128/2.06 E

Primary Examiner—Robert W. Michell
Assistant Examiner—Lee S. Cohen
Attorney, Agent, or Firm—Young & Thompson

[57] **ABSTRACT**

Electrical detector to be fixed on the skin surface for biometrical observations, consisting of a silver silver-chloride electrode and outlet placed in a casing, further of a biologically harmless ion conducting gel placed between the skin surface and the electrode, the electrode having a porous structure containing silver grains of less than 800μ 82m linear size and its density falling between 2 and 8 g/cm^3, the surfaces of the individual silver grains being bound by cohesion to the surfaces of the adjacent silver grains, respectively to the surface of the outlet shaped from silver and the surfaces of the silver grains not participating at the cohesive binding being coated by a known silver-chloride layer.

8 Claims, 2 Drawing Figures



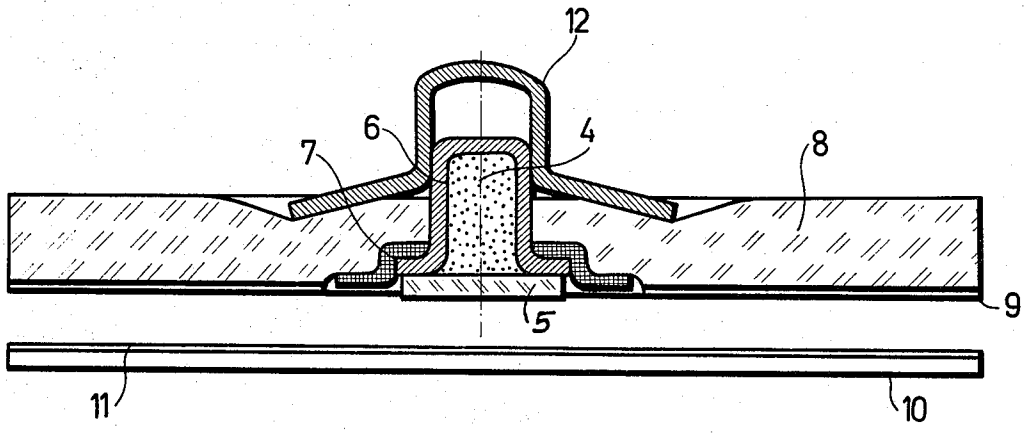


Fig. 2

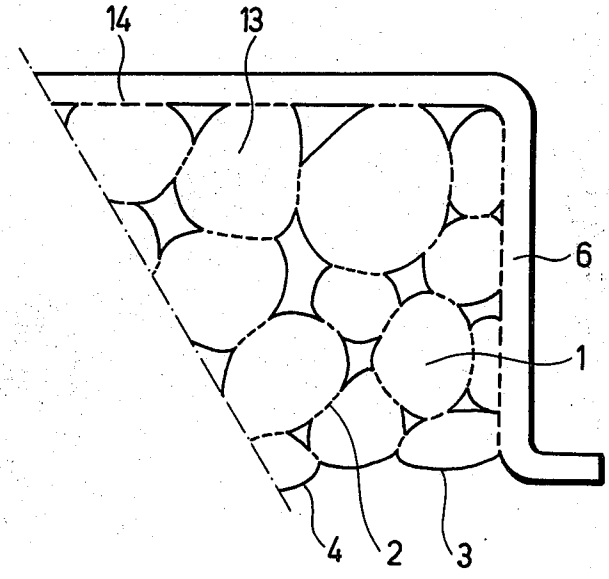


Fig.1

ELECTRICAL DETECTOR/TRANSDUCER/APPLICABLE ON THE SKIN SURFACE FOR BIOMETRICAL OBSERVATIONS

The invention relates to an electrical detector which can be fixed to the skin surface, to be used for biometrical observations and in particular for electrocardiographic, e.g. electroencephalographic examinations.

The electrode incorporated in the detector has the task of picking up and transferring the potential appearing on the skin surface without any change in it. Since in the body we can speak of the second kind-transfer that is of ion transfer, the electrode transforms substantially the transfer of the second kind to a transfer of the first kind (to electron transfer). The most important requirement for the electrodes is the stability over a period of time of the potential of the electrode, i.e. prevention of the substantial polarization of the electrode. This can be achieved, as is known, by means of silver silver-chloride electrodes in conjunction with an electrolyte containing Cl^-ions.

Besides the primary requirement, that is the stability of potential the electrode must possess between the electrolyte and the electron transferring outlet minimum contact resistance, the entire surface of the electrode must be equipolar. The electrolyte of Cl^-ion contents placed between the electrode surface and the skin surface must not irritate the skin surface even during extended use — e.g. 48 – 72 hours — and on the other hand it must preserve essentially its original concentration.

With the development of medical techniques, disposable medical appliances, including electrical detectors are gaining popularity at a steadily growing rate, due to their simple manoeuvrability and quick, hygienic applicability. Disposability sets another requirement for the electrical detectors. In the interests of quick and simple manipulation it is desirable that the electrode should be all ready for use with the electrolyte necessary for its proper functioning, and with means for ensuring its proper connection to the skin surface.

In a known type of electrode, the material of the electrode consists of fine-grained pressed silver silver-chloride mixture to which an electrical outlet is connected by soldering. The surface of the electrode formed this way will not be equipotential, since the individual silver grains are in contact with each other only through silver-chloride which is a bad electrical conductor. The currents flowing through the electrode which are of very low value produce voltage drops at different spots of the electrode surface which have a disturbing effect on the measurements. Leading out the current from a soldered joint can be the source additional problems, since in the presence of the electrolytic substance the soldering material may cause disturbing potentials, and the developing corrosion may disadvantageously influence the contact quality.

In another known construction of the silver silver-chloride electrode an electrolytic silver-chloride coating is applied on the surface of a silver plate. The disadvantage of this construction is that firstly the high specific resistance of the solid silver-chloride increases the resistance of the electrode, and secondly the silver-chloride does not adhere well on the surface of the silver and in aqueous substances, especially during extended examination periods particles of the silver-chloride may separate, thus causing fluctuations in the potential. A further disadvantage of the plainsurface electrode is the fact that in comparison with electrodes of porous surface it has a surface smaller by several orders, therefore it is not well suited for examinations over extended periods, e.g. of 48 – 72 hours. The constantly increasing popularity of disposable electrical detectors is mainly due to their simple and quick applicability. The special requirements necessitated by disposability and in particular the ease of manufacturing required could not have been met with the known electrical detectors.

According to the present invention, there is provided an electrical detector, which can be fixed to the skin for biometrical observations, consisting of the silver silver-chloride electrode housed in a casing with an outlet, and a biologically harmless ion conducting gel arranged between the skin surface and the electrode, the electrode having a porous structure containing silver grains of less than 800 μm linear size and with a density falling between 2 and 8 g/cm^3, the surfaces of the individual silver grains being bound by cohesion to the surface of adjacent silver grains and/or to the surface of the outlet which is also silver, the free surfaces of the silver grains being coated by the known silver-chloride layer.

The silver grains being bonded to each other provide for good conductivity of the electrode material and by this for the equipotential character. This formation of the electrode further maintains the very advantageous large homogenous surface, which reduces polarisation and ensures the stability of potential. Since the outlet is also made of silver, and the adjacent silver grains are bonded to it, a stable and safe electrical contact is obtained between the material of the electrode and the outlet.

The outlet can also be made of silver wire, which can be placed between the silver grains of the electrode.

Preferably, the outlet is a silver cup, which surrounds the electrode on three sides and there exists a cohesive bond between the inner surface of the cup and the silver grains of the electrode adjacent to the cup. The outlet can also form the housing of the electrode at the same time.

The ion transferring gel soaks into the pores of an elastic disc of porous structure and the disc extends from the electrode so that it is compressed when the electrode surface and the skin surface are in contact.

The cup with the electrode placed in it, and the disc soaked by the ion transferring gel may be surrounded by a disc of closed cell foam; a plastic annulus can be fastened to between the disc of the closed cell foam and the exterior of this cup. The surface of the closed cell foam disc in contact with the skin surface can be coated by a biologically harmless adhesive layer.

A bell can be fixed to the external surface of the silver cup and the disc of closed cell foam will be held between the bell and the plastic annulus.

When the detector is adapted to be used once only, the adhesive coated surface of the disc of closed cell foam is made suitably of polyethylene and covered by a protective paper of silicon lining. The protective paper hermetically seals the disc soaked by the conductive gel, thus protecting it from drying. Before use the paper cover must be removed from the surface of the disc.

The electrical detector may be placed in a hermetically sealed container containing saturated water vapour.

The invention will now be described in more detail. by way of example, with reference to the accompanying drawing, in which:

FIG. 1 represents the scheme of the electrode structure connected to the outlet,

FIG. 2 is a simplified sectional drawing of a disposable electrode.

In FIG. 1, the grain structure of the electrical detector (transducer) according to the invention is shown. Electrode 4 is formed by silver grains 1 connected to each other and silver grains 13 connected also to the outlet. Owing to the porous structure of the electrode, only specific parts of the surfaces of the silver grains 1, 13 are connected to each other. The silver grains 1 have edge portions 2 along which the silver grains are connected to each other by cohesive bonding. Silver grains 13 adjacent to the outlet are connected along edge portions 14, also by cohesive bonding, to the outlet made of silver. The size of silver grains 1, 13 is less than 800 μm and the density of the material of the electrode in this embodiment was 3.5 g/cm^3. The free surfaces of silver grains 1, 13 are coated by a silver-chloride layer.

In FIG. 2, an embodiment of the electrical detector according to the invention is shown, which has been designed to be used once and then discarded.

In this case the outlet of the electrode 4 is a cup 6 made of silver, which surrounds the electrode 4 on three sides. The external flange of cup 6 joins to the inner surface of a plastic annulus 7 and this annulus 7 also forms the seat for a disc 5 made of porous plastic foam. A metallic bell 12 is attached by solid binding to the outside of cup 6. In the space between bell 12 and annulus 7 a plastic foam disc 8 of closed cell structure is situated. On the surface of plastic foam disc 8 which will be in contact with the skin, a known adhesive coat 9, which will not dissolve in water, is put on so that the electrode can be attached to the skin. In this embodiment plastic foam disc 8 of closed cell structure has been made of polyurethane with a diameter of 50 mm and a thickness of 3 mm. The adhesive coating 9 applied to the disc can be any glue not harmful to the human organism and non-soluble in water, for instance glue of poly-isobutylene base.

A plastic foam disc 5 is placed in the interior of annulus 7 and its thickness exceeds the depth of the recess in annulus 7 and consequently the external surface of disc 5 protrudes beyond the external flange of annulus 7. Disc 5 is soaked in a gel containing Cl^- ions and is harmless to the human organism. The gel utilized can contain, for example, 1% of Cl^-, 6% of glycerine, and 1% of carboxy-methyl-cellulose. The other components of the gel can be various perfume substances, e.g. lemon oil, further distilled water.

Before use, the surface coated by layer 9 of disc 8 is protected by a multi-layer protective paper 10, the surface of the paper in contact with the layer 9 being for instance a silicone lining, which will not adhere to the glue.

The electrode is placed in a hermetically sealed multilayer bag containing saturated water vapour and this bag has at least one polythene layer and one aluminum foil layer. The ion conducting gel contained in disc 5 and stored in the bag containing saturated water vapour does not dry out for a long time.

When the electrode is to be used, the bag is opened and protective paper 10 is removed from plastic foam disc 8, thereafter the electrical detector is placed on the skin surface to be examined, and is held there by the adhesive layer 9. When placed on the skin, plastic foam disc 5 is compressed and the ion conducting gel stored in it establishes a safe electrical contact between the skin surface and the electrode 4. Since the ion conducting gel is encircled by a hermetically sealed surface it cannot evaporate and, once in place, the electrode provides for an excellent connection for several days.

Electrical connection between the detector according to the invention and the examining device can be established by a contactor of suitable design attached to the external surface of bell 12, for instance by the connector as detailed in our Hungarian Patent Application with base no. ME-1673. Due to its advantageous properties the electrode according to the invention is outstanding among the detectors of known designs: its stability of potential, contact resistance, stability in time is remarkably better than those of the electrodes known up to now. From the simple design it is also evident, that the production costs of the detector are moderate too.

What we claim is:

1. An electrical detector to fix to the skin for biometrical observations, comprising an electrically conductive housing defining a cavity having an open side and having a silver inner surface, a coherent porous body of silver grains compressed in said housing substantially filling the cavity and having cohesive bonds between contacting silver surfaces of said grains and between said grains and said housing surface, and a coating of silver chloride on the surfaces of substantially all of said grains other than said contacting surfaces.

2. A detector as claimed in claim 1, said housing comprising a silver cup that encompasses said grains on three sides.

3. A detector as claimed in claim 2, and an elastic disc of open cell porous structure soaked with an ion-conducting gel and closing the open side of said housing and projecting beyond said housing to contact the surface of the skin.

4. A detector as claimed in claim 2, and a plastic annulus encircling the cup, and a closed cell foam disc having a surface secured to and extending beyond said annulus said foam disc including means for attaching the disc surface to the skin.

5. A detector as claimed in claim 4, and a metallic bell secured to the external surface of said cup, said form disc being gripped between the bell and the annulus.

6. A detector as claimed in claim 4, said attaching means including a protective paper layer covering the surface of the foam disc, and an adhesive releaseably securing said paper to said foam disc.

7. A detector as claimed in claim 1, said grains being of less than 800 μm linear size and having a density from 2 to 8 g/cm^3.

8. A detector as claimed in claim 1, and a biologically harmless ion conducting gel being disposed on the open side of the housing and in contact with the silver grains.

* * * * *