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 [32] Priority **Sept. 9, 1967**  
 [33] **Germany**  
 [31] **P 15 66 089.6**

[56] **References Cited**  
**UNITED STATES PATENTS**  
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 3,085,577 4/1963 Berman et al. .... 128/418  
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[54] **ELECTRODE SERVING FOR THE DETECTION OF  
 ELECTROPHYSIOLOGICAL POTENTIALS OR  
 CURRENTS**

**7 Claims, 2 Drawing Figs.**

[52] U.S. Cl. .... **128/2.1R,**  
**128/DIG. 4, 252/514**  
 [51] Int. Cl. .... **A61b 5/04**  
 [50] Field of Search .... **128/2.06,**  
**2.1, 404, 411, 417, 418, (Pickup Electrode**  
**Digest); 252/514, 518**

**ABSTRACT:** A diagnostic device for facilitating the measurement of electrophysiological potentials or currents. An electrode of sintered construction and of disc configuration is retained within a holding member of the diagnostic device. The electrode is a mixture of silver powder and silver salt at defined ratios, and the silver salt being within a preferred solubility level. The holding member has a plurality of radial ribs adapted to provide free space wherein an electrolytically conductive paste may be placed so as to prevent direct contact between the electrode and the skin surface of the patient.

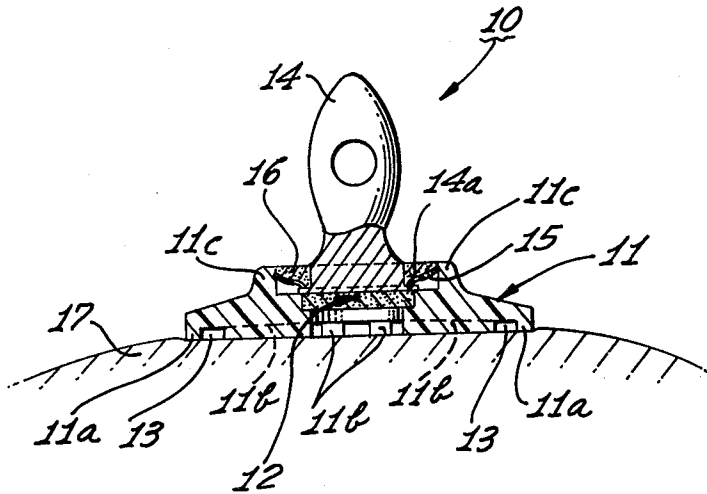


Fig. 1

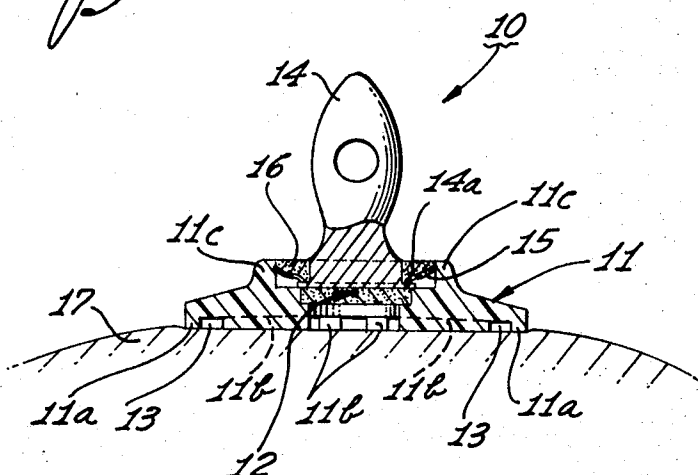
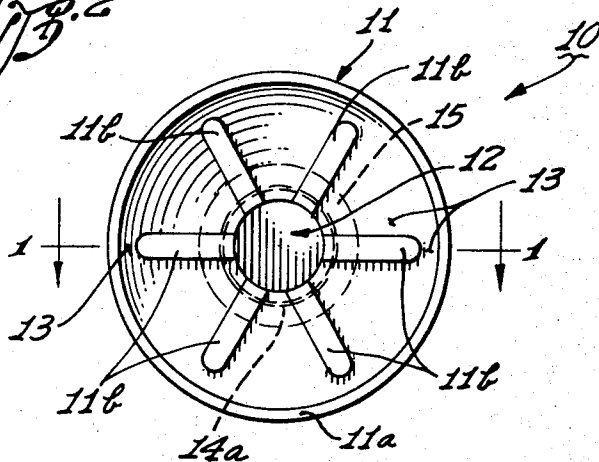


Fig. 2



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# ELECTRODE SERVING FOR THE DETECTION OF ELECTROPHYSIOLOGICAL POTENTIALS OR CURRENTS

## FIELD OF THE INVENTION

This invention relates to an electrode utilized with diagnostic equipment and more particularly to an electrode of a sintered body construction.

## DESCRIPTION OF THE PRIOR ART

Electrodes for facilitating the measurement of electrophysiological potentials or currents are well known. Various structural arrangements and various compositions of electrodes have been utilized depending upon the subject to be tested or the environment in which the tests are to be conducted. Electrodes have been press fabricated of selected ratios of silver and silver halides, however, this approach has produced light sensitive surfaces owing to the decomposition of the silver chloride when it is exposed to light. The contact surface of the electrodes becomes black and unsightly so that they are no longer suited for a number of applications. In addition, the simple pressing procedure does not produce electrodes having a high degree of conductivity. Other electrodes have included a synthetic resin as a binding agent. In general, the electrodes which include such a binding agent are of poor quality due to insufficient conductivity.

Accordingly, it is an object of the present invention to provide a diagnostic device having a novel electrode of a sintered construction.

It is a further object of the present invention to provide a novel electrode that maintains its original composition and may be used repeatedly.

It is a still further object of the present invention to provide a novel electrode having high conductivity.

It is another object of the present invention to provide a novel electrode that substantially reduces polarization voltages and is not sensitive to light.

## SUMMARY OF THE INVENTION

In accordance with the objects set forth above, the present invention provides an electrode of sintered construction having high conductivity that may be used repeatedly. The electrode is held within a diagnostic device having radial ribs which are adapted to provide free space wherein an electrolytically conductive paste may be placed so as to prevent direct contact between the electrode and the skin surface of a patient. The electrode comprises a mixture of silver powder and silver salt at defined ratios, and the silver salt being within a preferred solubility level.

## BRIEF DESCRIPTION OF THE DRAWINGS

Additional objects, advantages, and characteristic features of the present invention will become readily apparent from the following detailed description of preferred embodiments of the invention when taken in conjunction with the accompanying drawings in which:

FIG. 1 is a sectional side view of a diagnostic device disclosed in FIG. 2 taken along lines 1-1 in accordance with the present invention; and

FIG. 2 is a bottom view of a diagnostic device in accordance with the present invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, there is shown a sectional side view of a diagnostic device 10 in accordance with the principles of the present invention. The diagnostic device 10 includes a holding member 11, which may be constructed of any suitable rigid nonconductive material, for example, plastic. The holding member 11 comprises an outer rim 11a, six radial ribs 11b, and a mounting portion 11c. Further included in the diagnostic device 10 is a terminal pin 14 having a bottom ridge 14a which may be constructed of any suitable conductive

material. The terminal pin 14 may be connected to diagnostic equipment (not shown) via suitable conductive leads (not shown). The terminal pin 14 is retained within the holding member 11 by a snapping 15 which is adapted to fit against the bottom ridge 14a. A cover member 16 which may be of any suitable insulating material may be utilized to ensure proper covering of the snapping 15. The diagnostic device 10 is shown placed upon a skin surface 17 of a patient (not shown).

An electrode 12 is shown inserted within the holding member 11 and underneath the terminal pin 14. The electrode 12 is of a sintered construction, i.e., the electrode 12 is constructed of desired powders which have been cold-pressed into a desired shape then heated to form a strong cohesive body. The composition of the electrode 12 is preferably a mixture of silver powder with one or several of the following silver salts: silver cyanide, silver rhodanide, silver iodide or silver bromide. In the practice of this invention, the most favorable results have occurred by utilizing silver salts which have a solubility of below  $100 \cdot 10^{-16}$  g. in 100 ml.  $H_2O$ . For example, the preferred solubility for the four above-mentioned silver salts would be as follows:

|            |                                            |
|------------|--------------------------------------------|
| for Ag Br  | : $12 \cdot 10^{-16}$ g./ 100 ml. $H_2O$   |
| for Ag I   | : $0.25 \cdot 10^{-16}$ g./ 100 ml. $H_2O$ |
| for Ag CN  | : $2.8 \cdot 10^{-16}$ g./ 100 ml. $H_2O$  |
| for Ag SCN | : $14 \cdot 10^{-16}$ g./ 100 ml. $H_2O$   |

From experimentation, it has been found that the material most suited to form the electrode 2 is a sintered body consisting of a mixture of silver powder and silver salt with a solubility of less than  $100 \cdot 10^{-16}$  g./ 100 ml.  $H_2O$ , at a ratio of between 30:70 and 50:50, preferably in the ratio 40:60. The sintering process at sufficiently high temperatures and sufficiently high pressure creates conductive bridges of very low resistance in the sintered body. The absence of a synthetic resin as a binding agent further reduces the electrode resistance. With Ag CN, for instance, the light sensitivity of such a contact body is lowered by more than one order of magnitude than it is for materials with silver chloride as the second component. As far as the suppressing of polarization voltages is concerned, at least the same conditions as for silver chloride apply. If Ag Br is used, no deterioration due to light sensitivity occurs when the contact body is placed against electrolytically conductive pastes containing ammonia ions. The material composition suggested in accordance with the principles of this invention provides an electrode of superior quality since the silver salts especially selected are characterized by low sensitivity and low solubility. The solubility also has an influence on the light sensitivity because the latter would go up considerably with the salt in a dissolved condition. Thus, these advantages guarantee clean handling and trouble-free functioning of the electrodes during the detection of electrophysiological potentials or currents or during the application of electrical stimulating currents or voltages.

Referring now to FIG. 2 there is shown a bottom view of the diagnostic device 10 in accordance with the principles of the present invention. The radial ribs 11b are shown along with the accompanying free space 13. The radial ribs 11b extend from the opening in the holding member 11 to approximately the outer rim 11a and provide the free space 13b of the diagnostic device 10. The free space 13 may be filled with an electrolytically conductive paste for facilitating proper electrical contact between the skin surface 17 and the electrode 12, the electrode 12 being of a disc configuration. The arrangement of the radial ribs 11b prevents direct contact between the skin surface 17 and the electrode 2, thus, ensuring that the contact resistance cannot change during measurement.

Thus although the present invention has been shown and described with reference to particular embodiments, for example, electrodes of a disc configuration and being a mixture of silver powder and silver salt at defined ratios and the silver salt being within a preferred solubility level, nevertheless, various changes and modifications obvious to a

person skilled in the art to which the invention pertains, for example, electrodes of a wedge configuration, are deemed to lie within the spirit, scope, and contemplation of the invention as set forth in the appended claims.

I claim:

1. A diagnostic device comprising:

a rigid nonconductive holding member having an opening from the top to the bottom thereof and further having a plurality of radial ribs adapted to hold an electrolytically conductive paste;

electrode means inserted within said opening of said holding member for detecting potentials and currents;

terminal means located within said opening of said rigid nonconductive holding member for maintaining said potentials and transferring currents between said electrode means and said terminal means; and

clamping means wedged between said terminal means and said opening of said rigid nonconductive holding member for retaining said terminal means against said electrode means.

2. A diagnostic device as recited in claim 1 wherein said opening is located in proximity of the center of said holding

member and said radial ribs extend outwardly from said opening to approximately the outer rim of said holding member.

3. A diagnostic device as recited in claim 2 wherein said opening is of circular construction and said electrode means is of a disc construction.

4. A diagnostic device as recited in claim 1 wherein said terminal means has a bottom ridge of a larger diameter than the major portion of said terminal means and said clamping means is a snapping.

5. A diagnostic device as recited in claim 3 wherein said electrode means is of sintered construction comprising a mixture of silver powder and silver salt, said silver salt having a solubility of less than  $100 \cdot 10^{-6}$  g./100 ml.  $H_2O$ .

6. A diagnostic device as recited in claim 5 wherein said mixture includes said silver powder and said silver salt at a ratio of between 30:70 and 50:50.

7. A diagnostic device as recited in claim 5 wherein said mixture includes said silver powder and said silver salt at a ratio of 40:60.

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UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,574,305

Dated April 13, 1971

Inventor(s) Gerhard L. Muhl

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 2, line 19:  $100.10^{16}$ g in 100 ml  $H_2$   
should be:  $100.10^{-6}$ g in 100 ml  $H_2O$

Col. 2, line 23:  $12.10^{16}$ g should be  $12.10^{-6}$ g

Col. 2, line 24:  $0.25.10^{16}$ g should be  $0.25.10^{-6}$ g

Col. 2, line 25:  $2.8.10^{16}$ g should be  $2.8.10^{-6}$ g

Col. 2, line 26:  $14.10^{16}$ g should be  $14.10^{-6}$ g

Col. 2, line 30:  $100.10^{16}$ g should be  $100.10^{-6}$ g

Col. 4, line 14:  $100.10^{16}$ g should be  $100.10^{-6}$ g

Signed and sealed this 31st day of August 1971.

(SEAL)

Attest:

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Attesting Officer

WILLIAM E. SCHUYLER, JR.  
Commissioner of Patents

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