United States Patent

[11] **3,565,059**

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[21] Appl. No. **735,394**
[22] Filed **June 7, 1968**
[45] Patented **Feb. 23, 1971**

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[54] **BIOLOGICAL ELECTRODE AND METHOD OF MAKING SAME**
11 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **128/2.06,** 128/418; 29/25.17
[51] **Int. Cl.** **A61b 5/04,** A61n/00, H01j 9/00
[50] **Field of Search** ..... 128/410 –418, 1.5, 303.13—303.19, (Pickup Electrode Digest), 404, 419, 419 (P), 419 (D); 128/(Pickup Digest), 2.06, 172.1, 418, 410—413; 29/(Inquired), 25.17; 128/303.1

[56] **References Cited**

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2,654,795	10/1953	Brill et al.	136/120
2,872,926	2/1959	Alderman	128/410
3,170,459	2/1965	Phipps et al.	128/2.06
3,387,608	6/1968	Figar	128/2.06
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FOREIGN PATENTS

90,273	10/1967	France	128/2.05

OTHER REFERENCES

Argyle; A. S. Aloe Company; 1831 Olive Street, St. Louis, Missouri; page 10

Primary Examiner—Richard A. Gaudet
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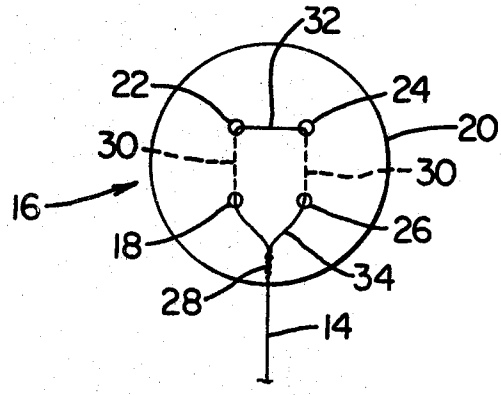
ABSTRACT: Electrode for application to the skin of the human anatomy for use with electromedical devices, such as electrocardiograph apparatus, which employs a normally dry electroconductive material, which, when wetted with a solvent, has adhesive properties for maintaining it firmly affixed to the skin. The electroconductive material is also bonded to a lead wire, minimizing electrical resistance between them in contradistinction to juncture contact between metallic electrical conductors.



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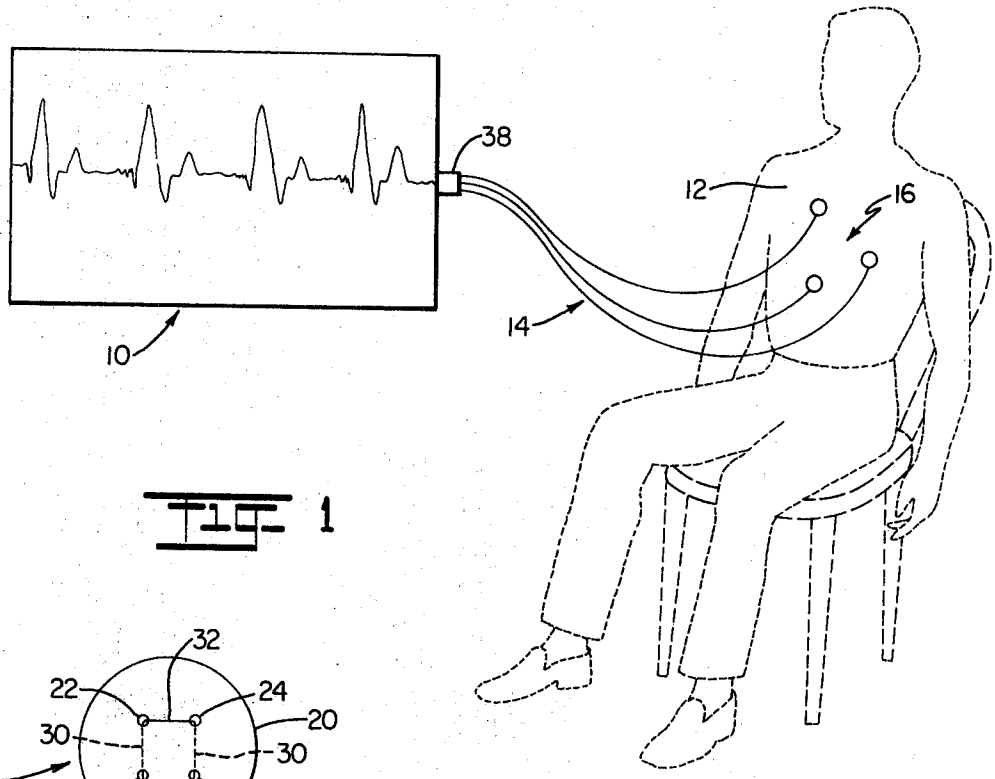

FIG. 1

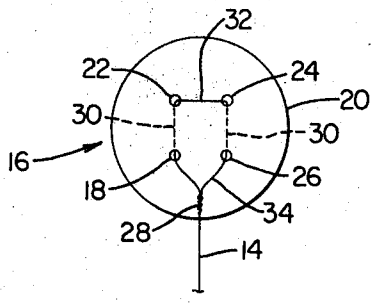

FIG. 2

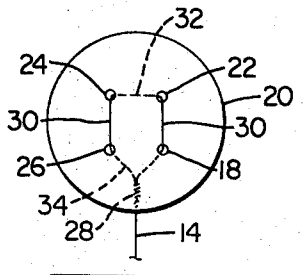

FIG. 3

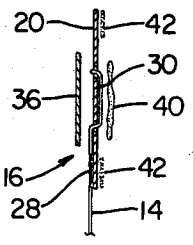

FIG. 4

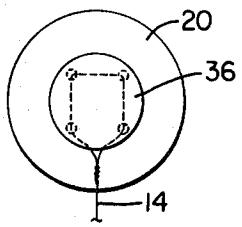

FIG. 5

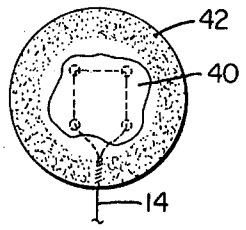

FIG. 6

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BIOLOGICAL ELECTRODE AND METHOD OF MAKING SAME

BACKGROUND OF THE INVENTION

In the prior medical art it has been well known practice to attach electrodes to the skin to provide contact and through which electrical signals are transmitted between the anatomy and electromedical apparatus. U.S. Pat. to Baum, No. 3,187,745 and Berman, No. 3,085,577 are exemplary of such electrodes, employed in the art of electrocardiography wherein electrical heart signals are received, and the U.S. Pat. to Alderman, No. 2,872,926, is exemplary of an electrode employed in the art of electroencephalography wherein electrical brain signals are received. The signals, in either event, are suitably recorded or charted and are a measure of a body function or functions under known conditions, such as rest, exercise, mental stress, intensive care, and the like. Also, with the advent of space travel and radio monitoring, or with the use of small portable electromedical recording devices, it is now possible to biologically monitor body functions of pilots under conditions encountered in fulfilling their missions. The importance of maintaining a low resistance contact with the anatomy is well recognized and the patents referred to are exemplary of obtaining the desired results by utilizing electroconductive pastes through which an electric signal is transmitted. The U.S. Pat. to Howell, No. 2,943,628 is exemplary of another approach wherein contact is made with metal foil surrounded by a pressure sensitive adhesive.

As the relatively recent art referred to has advanced, certain improvements appear desirable, including the need for more rapid and expedient application of the electrodes, simplification of their construction, together with its attendant reduction of cost, and elimination of protective coverings or the like previously employed with pressure sensitive adhesives or similar protective coverings for conductive pastes. Additionally, a light weight electrode is desirable to minimize or obviate inertial movement relative to a predetermined position on the skin. The principal objective of this invention is to fulfill such needs.

SUMMARY OF THE INVENTION

An uninsulated leg portion of an insulated lead wire is structurally connected to a flexible base member on its body facing side and coated with electroconductive adhesive, the adhesive embedding such portion and also bonding it to the base member. The opposite or exposed side of the base member may be provided with a color or otherwise coded insulating member, covering other uninsulated portions of the wire. When wetted with a solvent, the normally dry adhesive becomes sticky and will adhere to the skin. When it is desired to remove the electrode assembly, the base member may be engaged by human fingers or forceps and peeled from the skin, a solvent again being applied, if adhesion is unduly severe.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 depicts the general manner in which an electrocardiograph is recorded:

FIG. 2 is a side elevation, or exposed face, of the subject of the invention, an element being omitted;

FIG. 3 is a reverse side elevation, or body face, of FIG. 1, other elements being omitted;

FIG. 4 is a central cross section through FIG. 2 and 3, showing the omitted elements in exploded relationship;

FIG. 5 is an elevation, like FIG. 2, showing an omitted element superimposed thereon; and

FIG. 6 is an elevation, like FIG. 3, showing other omitted elements superimposed thereon.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, FIG. 1 depicts the well-known manner of recording a chart **10** on electrocardiograph

apparatus (not shown), the apparatus being connected to a subject **12**, by insulated lead wires **14**, terminating in electrodes **16** affixed to desired points on the skin of the subject.

Referring now to FIGS. **2** to **6**, the construction of each electrode can best be described by the manner in which it is fabricated. Starting with FIG. **2**, a suitable length of insulation is stripped from a lead wire **14** and its end threaded through aperture **18**, extending through disc **20**, thence in sequence through like apertures **22, 24, 26**, its end terminating in a twist **28** around the standing part of the lead wire. As will be apparent from FIGS. **2** and **3**, this now provides a pair of parallel spaced series connected uninsulated wire portions or legs **30** disposed adjacent the face of the disc which is to be in contact with the subject, an uninsulated connecting portion **32** adjacent the opposite or exposed face of the disc, and another uninsulated portion **34** adjacent the exposed face.

The uninsulated portions **32, 34** may be covered with an insulating disc **36**, FIGS. **4** and **5**, having an adhesive on one face of same, such disc being particularly desirable when these uninsulated portions might contact clothing of the subject and produce erroneous signals. Discs **36** of the various electrodes are preferably colored on their exposed surfaces, or otherwise coded, so that they may be applied to predetermined portions of the skin in order that chart **10** may be interpreted in accordance with the various signal sources. To attain this end, the remote ends of the conductors terminate at a multiple connector jack or plug **38**, which connects with the circuitry of the electromedical apparatus in a predetermined manner.

Referring now to FIGS. **4** and **6**, the body face of disc **20** is coated with an electroconductive adhesive **40** over an area sufficient to cover and embed at least the exposed portions **30** of the wire. If so desired, the surrounding area may be coated with an adhesive **42** of the same type to obtain a larger bonding area. Adhesives **40, 42** are preferably of a type which may be softened with readily available solvents, such as water or alcohol, when it is desired to remove the electrodes from the skin. It is not essential, however, that adhesive portion **42** be electroconductive since its principal function is to improve bonding to the skin rather than to transmit an electrical signal through it.

Discs **20** may be constructed from any suitable flexible material which will conform to the shape of the skin area to be covered, a paper, cloth or wire fabric material, being exemplary. It is preferably porous to obtain a strong structural bond with the applied adhesive. In one manner of fabrication, the entire disc may be coated with a liquid adhesive and allowed to dry to thus provide both faces with calenderlike surfaces. As previously referred to, this need not be an electroconductive material. The uninsulated end of the lead wire is then threaded through the various apertures, or stapled or soldered or otherwise attached and terminated to provide structural securement with the disc. Uninsulated portions **30** are then coated with an electroconductive adhesive embedding them within the adhesive which also bonds them to the disc, the adhesive then being allowed to dry, in which process its volatile solvent or solvents evaporate. Either prior or subsequent to this step, gummed insulating disc **36** is applied to the exposed face, thus insulating portions **32, 34**.

As will now be apparent, the adhesive of principal importance is adhesive **40**. This must have the characteristics of flexibility, electroconductivity, and strong adhesive affixity to the human skin when wetted with a solvent, as previously referred to, which may be applied with a sponge or the like, or the human tongue if water is the solvent.

Insulating disc **36** may be cut from conventional insulating paper, gum coated on one side and rewettable and having a colored opposite side. Rather than being colored, as just described, other coding may be employed.

An exemplary adhesive **40** comprises the following formulation proportions:

Polyvinylpyrollidone (Plasdone)	7.50 gr.
Camphor	0.75 gr.
Ethanol	8.00 gr.
Ether	6.00 gr.

12 percent Silvered polyethylene 15.00 gr.
Another example is:
Polyvinylpyrollidone (Plasdone) 7.5 gr.
Dimethylphthalate 0.75 gr.
Water 10.00 gr.
12 percent Silvered Polyethylene 10.00 gr.

Other examples of electroconductive materials include various plastic micro spheres coated with metals and forming inclusions in the adhesive to provide electrical conductive paths through their points of contact. A further example is disclosed in my copending application for Low Density Electrically Conductive Particulate Material, Ser. No. 639,530, filed May 18, 1967. In view of the various examples referred to, it is now believed apparent that the inventive concept is not dependent upon a specific electroconductive inclusion or material, but rather, upon the general characteristics as hereinbefore set forth.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

We claim:

1. In apparatus of the type for establishing an electrical connection between electromedical apparatus and the skin of the human anatomy, including an electrode adapted to be attached to the skin at a desired position thereon, and a lead wire extending between the electrode and the electromedical apparatus, the improvements wherein said electrode comprises:
   a. a flexible sheetlike base member having a body face and an exposed face;
   b. an uninsulated wire terminal portion having structural securement to the base member and having at least one leg portion disposed contiguous with the body face;
   c. a layer of normally dry electroconductive adhesive embedding said leg portion therein and bonding same to said body side; and
   d. said adhesive being of a type adapted to be wetted with a liquid solvent to render its exposed surface semiliquid and sticky, whereby it will adhere to the skin.

2. Apparatus in accordance with claim 1 wherein said terminal portion comprises a first portion extending through the base member from the exposed side to the body side, the leg portion aforesaid forming a continuation thereof, and another continuing portion extending from an end of the leg portion through the base member to the exposed face and therealong, thus forming said structural securement.

3. Apparatus in accordance with claim 2, including a sheetlike electrical insulating member adhesively secured to said exposed face and over the uninsulated wire lying adjacent thereof.

4. Apparatus in accordance with claim 3, including a plurality of electrodes, the electrical insulating members on the various electrodes being suitably coded to visually distinguish therebetween.

5. Apparatus in accordance with claim 4, wherein the exposed faces of said insulating members are of different color.

6. Apparatus in accordance with claim 1, including a plurality of series connected leg portions disposed contiguous with said body face.

7. Apparatus in accordance with claim 1, wherein said uninsulated wire terminal portion is an integral part of an insulated lead wire extending between the electrode and electromedical apparatus, thus forming a continuous electrical conductor, without junctures, between the electroconductive adhesive and the electromedical apparatus.

8. Apparatus in accordance with claim 7, wherein the terminal end of the uninsulated wire is twisted about the lead wire.

9. The method of making an electrode for use in transmitting an electrical signal between the skin of the human anatomy and electromedical apparatus, comprising the steps of:
   a. forming a base member from flexible sheet material to a desired flat shape, thus providing a body face and an opposite exposed face;
   b. forming at least two spaced apertures through the base member;
   c. threading an uninsulated wire through one of the apertures from the exposed face to the body face, thence therealong to another aperture, and therethrough back to the exposed face, and thence therealong, to thus provide a leg portion contiguous with the body face, structurally secured to the base member;
   d. coating said leg portion and said body face with a sheetlike coating of liquid electroconductive adhesive of a type adapted to dry but again become adhesive when wetted with a solvent, thus embedding the leg portion in the adhesive; and
   e. drying the adhesive, forming a dried bond between same and the wire and also a bond to the base member.

10. The method of claim 9 including the further steps of threading the wire through the base member, alternately from one face to the other, to provide a plurality of leg portions contiguous with the body side.

11. The method of claim 9 including the further step of twisting the terminal end of the wire about an intermediate portion thereof.