ELECTRODE FOR ELECTROMEDICAL EQUIPMENT

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This invention relates to a skin contact electrode and more particularly to a disposable electrode for use with electromedical equipment which may be attached directly to the skin to provide a low resistance contact therewith and which does not require the use of externally applied means for holding the electrode in place.

The present invention has reference to electromedical apparatus such as electroencephalographs, electrocardiographs, and the like, which requires attachment of an electrode and an interconnecting leadwire between the skin surface of a body under test and the test equipment. Heretofore, it has generally been necessary to employ cumbersome bands, clamps, fixtures or other mechanical means for holding the electrode in close contact with the skin. Attempts to employ an adhesive to hold the electrode in contact with the skin have not been entirely satisfactory owing to the difficulty in applying the exact quantity of adhesive to the skin and/or the electrode, required to make an adequate bond, without interfering with the electrical contact. Furthermore, the application of adhesives directly on the skin is unpleasant to the patient and is generally untidy. At best, such attempts are usually time-consuming, particularly when a large number of electrodes must be applied.

In order to provide a low resistance contact between an electrode and the skin, pads moistened with an electrolyte or a conductive paste are often interposed between the electrode and the skin. Heretofore, it has been the practice to apply the electrode paste directly to the skin and thereafter, apply the electrode over the area to which the paste is applied. A lead-wire connection to the electrode is then made by means of a clip or other attachment. This procedure is both time consuming and costly. Moistening of the skin or applying the paste, in addition to being both time consuming and messy, is also costly. These and other shortcomings of prior electrode application techniques are overcome by the present invention which contemplates improved means for holding electrodes in close contact with the skin when in use and improved means for the retention of an electrolyte in contact with an electrode both prior to, and during use.

These difficulties are overcome by providing the electrode with a self-contained quantity of electrolyte paste confined within a surrounding band or strip of pressure-sensitive adhesive, on the under surface of the electrode, for directly bonding the electrode to the skin of the patient.

It is therefore a principal object of the invention to provide an electrode for direct application to a body surface and having a self-contained electrolyte surrounded by a pressure-sensitive adhesive seal to facilitate direct attachment to the body surface.

Another object of the present invention is to provide a self-contained, disposable electrode which is low in cost, and simple to use.

Another difficulty experienced in connection with electrodes of the type contemplated in the present invention, relates to the establishment of good electrical contact over an irregular surface.

Therefore, it is an object of the present invention to provide a tissue contact electrode which adapts itself to the irregular surfaces of the tissues against which it is applied, while at the same time maintaining electrical contact substantially coextensive with the area of the electrode.

A further object is to provide an electrode of simple and inexpensive construction which may be applied at will to various portions of the body so as to provide wide and uniform contact therewith.

Still another object of the invention is the improvement of electrodes for electromedical equipment generally.

These and other objects of the invention will more readily be understood upon review of the following specification, taken in conjunction with the drawings in which:

FIGURE 1 is a perspective view of a preferred embodiment of the invention shown prior to application.

FIGURE 2 is a cross sectional view taken along line 2—2 of FIGURE 1.

FIGURE 3 shows the method of removal of the protective web from the apparatus of FIGURE 2.

FIGURE 4 is a cross sectional view showing the device FIGURE 3 applied to be surface of the patient's skin.

FIGURE 5 illustrates an alternative shape of the electrode layer.

FIGURE 6 shows the bottom surface of the electrode after the protective web has been removed.

FIGURE 7 is an elevational view illustrating an alternative embodiment of the protective web means.

FIGURE 8 illustrates the method of removal of the protective web means from the apparatus of FIGURE 7.

FIGURE 9 is a sectional view of a modified form of the invention employing an electrode layer comprising a metallicized plastic film.

FIGURE 10 is a fragmentary plan view of the apparatus of FIGURE 9 illustrating an alternative method of attaching the lead wires to the electrode layer.

FIGURE 11 is a perspective view illustrating an alternative embodiment of the invention employing a detachable lead connector.

FIGURE 12 is a perspective view showing a perforated strip for packaging the electrode.

The embodiment of the invention shown in FIGURE 1 comprises a disk-shaped layered fabricated from metal foil or the like, to which is attached a flexible lead wire 2. Lead wire 2 is attached to the conductive layer 1 by soldering, riveting, or other suitable fastening means 3. Lead wire 2 may, if desired, have an insulating covering 5, as will be apparent to those versed in the art.

The under side or bottom surface of the electrode has an annular ring of pressure-sensitive adhesive 4 for bonding the electrode to the skin or tissue surface upon which it is to be attached. Adhesive 4 preferably is disposed in a closed path on the bottom surface of layer 1, adjacent to the edge thereof. The adhesive 4 should, preferably, be biologically inert so as not to irritate the skin to which it is applied. An adhesive suitable for this use is the cyanoacrylate type. Located within the ring of adhesive 4 is a quantity of highly viscous electrolyte 6. This electrolyte 6 may comprise a saline paste or jelly commonly referred to as "electrode paste." This paste exhibits good electrical conductivity and provides a low resistance path between the electrode layer 1 and the skin surface to which the electrode is attached.

Prior to application, the underside of the electrode carries an impermeable plastic film or membrane 7 to maintain cleanliness of the contact surface of the electrode and to prevent the paste 6 from drying out. The membrane 7 extends beyond the outer edge of layer 1 and is held in place by adhesive 4. The adhesive 4 will make a better bond with the surface of layer 1 than it will with the surface of membrane 7, thus permitting membrane 7 to be stripped off without removing the adhesive 4 from layer 1. This plastic membrane 7 is peeled off immediately prior to usage, and the electrode is then pressed.
onto the skin 8 of the patient in a manner similar to the application of the well-known ready-made adhesive bandage. The ring of adhesive 4 bonds to the skin 8 and confines the electrolyte 6, which flows over the skin surface to effect a low ohmic contact. After having served its purpose, the electrode may be removed merely by peeling it off, in which instance the lead-wire 2 may be used as a means by which the electrode may be pulled upward and away from the skin. The low cost and simplicity of the device permits it to be disposed of after usage.

While there has been shown in connection with FIGURES 1–3 and 6 a foil contact layer which is disk-shaped or of circular area, it will be understood that this layer may, if desired, be formed in any desired pattern and/or may have other shapes. For example, there is shown in FIGURE 5, an embodiment wherein the electrode has an elongated or oval shape. The device may also be rectangular, free-form or other outline, as may be required for a specific application.

To facilitate removal of the protective membrane from the electrode prior to use, the protective membrane may be divided into two sections 9 and 10, each of which has an extended tab portion 9' and 10' adjoining each other at a line extending diametrically across the under surface of the electrode. Tab portions 9' and 10' may be grasped between the fingers of each hand and pulled apart, as shown in FIGURE 8, thus exposing the under surface of the electrode. This modification of the protective membrane minimizes handling of layer 1 and thus prevents damage thereto or undue distortion thereof.

As a further modification of the structure of the invention, it is contemplated that the metal layer 1 may be replaced by a highly flexible conductive layer.

Looking now at FIGURE 9, the conductive backing layer of the electrode comprises a flexible plastic sheet 12 which may be Teflon, Mylar, acetate or other suitable plastic materials, to one surface of which there is applied a very thin metallic film 13. Film 13 is electrically conductive and may be produced by metallizing or evaporating a metal film on the plastic substrate. 12. Since the film 13 comprises a lamina on the underside of the electrode structure, a tab portion 14 is folded back upon the upper side as shown in FIGURES 9 and 10, thus providing a convenient location for the attachment of the lead wire 15. This conductive film 13 may be connected to the film 15 on tab 14 by soldering, riveting or other suitable fastening means 16. The remaining elements may be identical with those of the embodiment of FIGURE 1: namely, adhesive 4, electrolyte 6, and membrane 7.

Still another modification of the basic electrode structure is shown in FIGURE 11. In certain instances, it may be desirable to have means for selectively connecting and disconnecting the lead wire from the electrode. Accordingly, there is provided an electrode layer 17 to which is attached a metal sleeve-like receptacle 18 into which may be inserted pin 19, dimensioned to fit snugly within receptacle 18. Lead wire 20 is permanently attached to pin 19. An insulating sleeve 23 may be used to cover the junction between pin 19 and lead wire 20. Receptacle 18 may be soldered to layer 17 or attached thereto by other suitable means as will be obvious to those skilled in the art. Layer 17 is temporarily attached to protective membrane 21 by adhesive 22 as in the case of the above-described embodiment.

There is shown in FIGURE 12 an individual packaging feature for convenient handling of the electrodes prior to use. The electrode 1 is supported on membrane 7 which in turn is carried on perforated strip 24. This comprises a so-called "tear-off" package in which paper strip 25 may be torn along perforations 25 in order to separate a single electrode and its protective "peel-away" membrane 7 from a continuous strip carrying a plurality of electrodes. As will be apparent to those skilled in the art, strip 24 may be formed into rolls to facilitate handling and dispensing. Also, a semi-rigid plastic bubble may be placed over the electrode layer as shown by strip 24 in order to further protect the electrode prior to use.

There has been shown and described, heretoforeabove, a self-contained, self-attaching electrode for use with electromedical equipment which is conveniently packaged and simple to use. Furthermore, the novel electrode of the present invention is sufficiently low in cost to permit being disposed of after one-time use, thus preventing the possibility of spreading communicable skin disease. While there have been shown and described and pointed out the fundamental novel features of the invention as applied to preferred embodiments, it will be understood that various omissions and substitutions and changes in the form and details of the devices illustrated and in their operation may be made by those skilled in the art. For example, the conductive layer of the electrode need not be a circular disk as shown in FIGURES 6 and 11, but may be of any other suitable shape, as determined by application requirements of adhesively bonded elongated strips, rectangles or ovals such as shown in FIGURE 5. Other modifications will suggest themselves to those skilled in the art; therefore, it is intended that the invention be limited only as indicated by the scope of the following claims.

What is claimed is:

1. An electrode adapted for application to a body surface, comprising: a layer of flexible conductive material one surface of which is of a layer of conductive foil, and adhesive material applied to a portion of said surface of said layer and defining a closed path adjacent the peripheral edge of said surface, a viscous electrolyte located on said surface within said closed path; an impermeable membrane semi-permanently bonded to said adhesive material, said membrane covering said electrolyte and extending beyond the peripheral edge of said layer of said conductive material, and flexible lead wire means connected to the surface of said conductive material opposite said one surface.

2. An electrode adapted for application to a body surface, comprising: a layer of conductive foil, and adhesive material applied to a portion of one surface of said layer and defining a closed path adjacent the peripheral edge of said surface, a viscous electrolyte located on said one surface within said closed path, lead wire means connected to said conductive foil, and a flexible impermeable sheet adjacent said one surface and extending beyond said layer, said sheets each having an edge portion foldable outward from said one surface, said folded edge portions meeting along a common line extending across said one surface.

3. A tissue contact electrode comprising: a foil disk, a flexible lead wire attached to said disk, a strip of adhesive applied to a portion of one surface of said disk adjacent the edge thereof and extending in a closed path along the perimeter of said one surface, a viscous electrolyte on said one surface and confined within said strip of adhesive, and said one surface being beyond said disk adjacent said one surface and detachably bonded to said adhesive strip.

4. A tissue contact electrode as defined in claim 3, wherein said membrane means comprises first and second flexible sheets extending beyond said disk, said sheets each having an edge portion foldable outward from said one surface, said folded edge portions meeting along a common line extending across said one surface.

5. A tissue contact electrode comprising, a flexible plastic disk having a metal film laminate thereon, a flexible lead wire attached to said laminate, a viscous electrolyte located in the center of the exterior surface of said laminate, a ring of pressure-sensitive adhesive on said laminate surrounding said electrolyte, and an impermeable membrane means adjacent said electrolyte and detachably bonded to said adhesive ring.
6. An electrode adapted for application to a body surface comprising:
a disk of conductive foil;
a viscous electrolyte located in the center of one surface of said disk;
a ring of pressure-sensitive adhesive on said one surface surrounding said electrolyte;
an impermeable membrane semi-permanently bonded to said adhesive ring, said membrane covering said electrolyte and extending beyond the periphery of said disk; and
lead wire means connected to said disk.
7. An electrode as defined in claim 6, wherein said membrane comprises
first and second flexible sheets, said sheets each having an edge portion folded outward from said one surface, said folded edge portion meeting along a common line extending across said one surface.
8. An article of manufacture comprising:
an elongated paper strip longitudinally divided into a plurality of separable areas by a plurality of transverse perforations;
an impermeable membrane carried on at least one surface of each of said separable areas;
a plurality of flexible foil disks equal in number to the number of said membranes;
a viscous electrolyte confined within the center portion of one surface of each of said disks;
a ring of pressure-sensitive adhesive on said one surface of each of said disks surrounding said center portion
and semi-permanently bonding each of said disks to a corresponding one of said membranes; and
a plurality of lead wire means, one each of which is connected to a corresponding one of said disks.
9. A tissue contact electrode comprising:
a laminar element having an upper layer of flexible plastic and a coextensive lower layer of thin metal film, said element having a generally circular shape and an extended tab portion folded back upon said upper layer;
flexible lead wire means attached to the upwardly exposed metal film surface of said folded tab portion;
a viscous electrolyte located in the center of the exterior surface of said lower layer;
a closed ring of pressure-sensitive adhesive surrounding said electrolyte and carried on the exterior surface of said lower layer; and
impermeable membrane means covering said electrolyte and detachably bonded to said lower layer by said adhesive ring.

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