

July 5, 1960

W. L. HOWELL
ELECTRODE ASSEMBLY

2,943,628

Filed Feb. 27, 1957

2 Sheets-Sheet 1

FIG. 1.

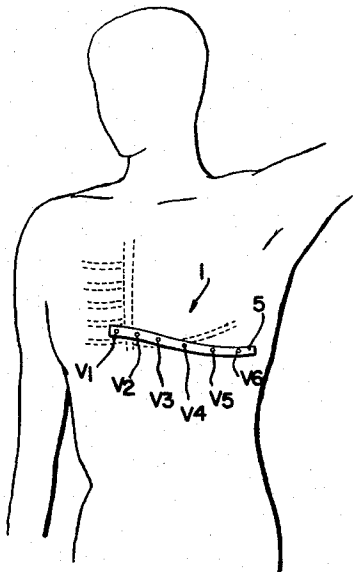


FIG. 2.

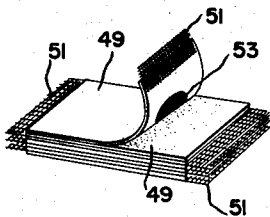
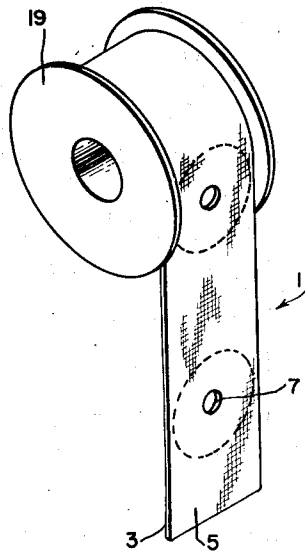


FIG. 10.

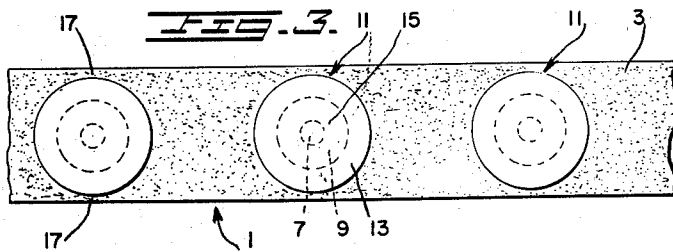


FIG. 3.

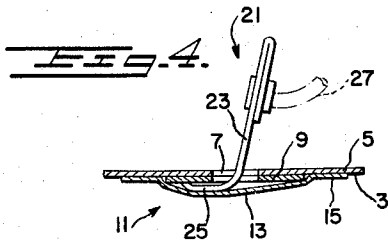


FIG. 4.

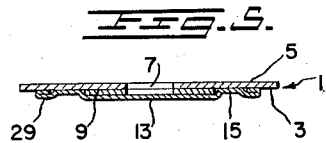


FIG. 5.

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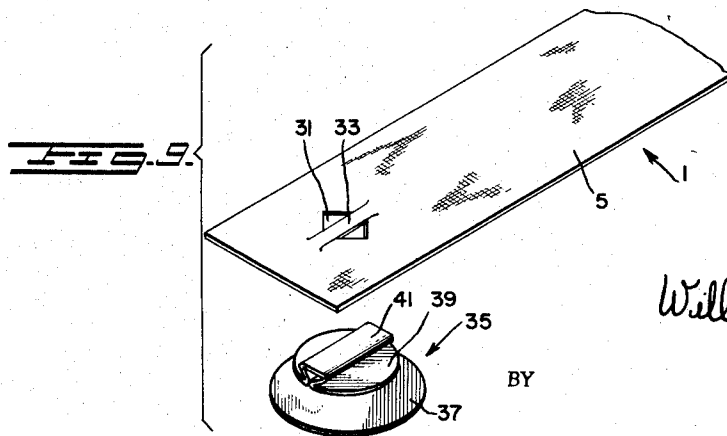
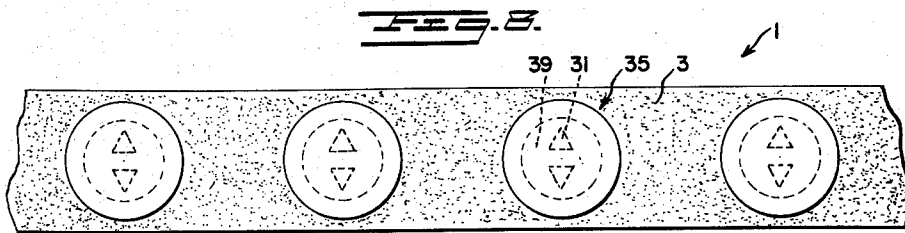
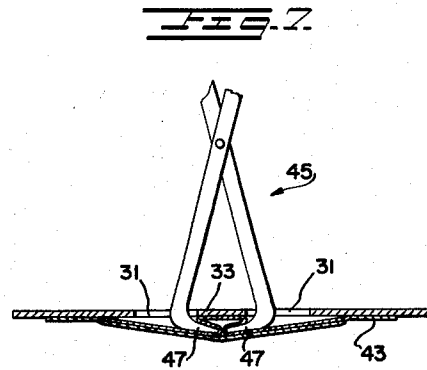
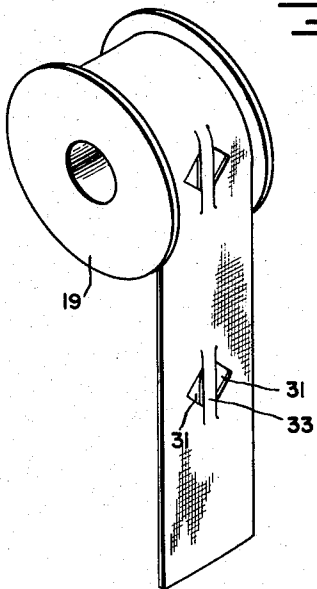
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1

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ELECTRODE ASSEMBLY

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8 Claims. (Cl. 128-418)

This invention relates broadly to electrode assemblies and in its more specific aspects it relates to such assemblies which are especially designed for application to the human bodies as a component of an electrocardiograph apparatus used for making electrocardiograms; and the nature and objects of the invention will be readily recognized and understood by those skilled in the arts to which it relates in the light of the following explanation and detailed description of the accompanying drawings illustrating what I at present believe to be preferred embodiments or mechanical expression of my invention from among various other forms, arrangements, combinations and constructions, of which the invention is capable within the spirit and scope thereof.

Broadly speaking, an electrocardiograph apparatus records the changes of electrical potential initiating the heart beat and such apparatus includes means for putting the heart in connection with the apparatus either by means of contacts or electrodes from the chest wall and a hand or foot, or, by three electrodes which may be connected to both hands and one foot. The apparatus produces a graphic curve of the electrical variations associated with each heart beat together with appropriate time marks.

It has been found desirable for a variety of reasons to make tests from a plurality of chest points, usually six. It is usual practice to use one electrode for the chest contact which is moved from one test point to the other while the circuit is opened and a reading taken from each test point. The electrode must be positioned against the chest properly in order to provide a good contact and there are several methods now in use for fastening the electrode to the human body. They may, for instance, be held by hand, by a strap or by suction cups. There are objections to all such methods, for instance, suction cups may bruise the body which causes ecchymosis. It will also be appreciated that the transferring and attaching of the one electrode at the six chest locations is time consuming and not always a pleasant procedure for the patient.

It has been found that highly advantageous diagnostic results may be had by serial testing by electrocardiograph and it is now common practice to run a series of tests on a patient, for example, from day to day. In this manner a plurality of serial tracings is obtained and their comparison is essential in order to obtain a definitive diagnosis.

It is desirable in practicing the serial testing technique to have the electrode or electrodes placed at the same chest locations for each test of the series of tests and I have found that a slight change of location of the electrode may make a significant change in the Q.R.S.-T. complex. Under prior procedures where one electrode was moved from one chest location to another and was not attached to the particular test point or chest location for the duration of the series of tests it was unlikely that each time the electrode was positioned on the chest that it would be positioned at the same location as previously positioned, and due to this the value of the results obtained from serial testing under prior procedures may be questionable.

I have evolved an electrode assembly which overcomes

2

the above mentioned and other disadvantages which are inherent in present day procedures and electrocardiograph apparatus.

I have devised an electrode assembly which involves a mounting means for a plurality of electrodes, usually six, wherein the electrodes are properly and permanently spaced so that upon application of the assembly to the chest each electrode will be disposed at the desirable test point.

The supporting base for the electrodes comprises a flexible strip of the proper proportions having an adhesive side upon which the electrodes are caused to firmly adhere and which will adhere to the body of the patient when the assembly is applied thereto. The highly advantageous characteristics of my assembly will be recognized when it is appreciated that by affixing each electrode in the desired spaced relation on the supporting base they will maintain such positions, and by providing an adhesive surface on the base it may be easily and quickly applied to the body of the patient. When the assembly has been adhesively applied to the body it may remain thereon for a series of tests, and a highly advantageous result of this is that each electrode will remain in the same body location for each test of a series of tests to thereby eliminate the possibility of the test results being untrue.

The assembly which I have provided being flexible will conform to body curvature and body movements and will cause no distress to the patient wearing it for the period of time necessary to complete the series of tests.

It will be evident that a good electrical contact must be made between the electrode and the body if the apparatus is to operate efficiently and produce the proper results. With this requirement in mind I have not only produced the supporting base of a flexible material but I have also formed each electrode of a flexible material having a relatively large plane surface for contact with the body of the patient. Thus, the electrode itself will conform to the configuration of the part of the body to which it is attached and its entire conductive surface will be in close engagement with the body. The proper contact of each electrode of the assembly with the body is also ensured by the supporting base which being held in taut condition when applied to the body will constantly urge and maintain each electrode in flat full electrical contact with the patient's body.

In the use of certain types of electrodes such as those formed of brass, silver or the like the conductive surface of each electrode may be coated with a water soluble paste including an electrolyte and this paste must be maintained in condition and must not be permitted to dry. The electrode arrangements of which I am aware are not designed to keep the paste from drying and hence would be inoperative if left on the patient's body for the duration of testing in a serial testing procedure. The assembly which I have devised is of such construction and the electrodes are mounted thereon in such a manner that the coated conductive surface is substantially protected from the air so that the paste coating will not dry and become useless.

It is also within my contemplation to form the electrodes of any suitable metallized cloth or any fabric which is treated to provide for electrical conductivity. I have found that when such metallized cloth is used it is unnecessary to use the aforementioned paste in order to obtain a good electrical contact, instead it is merely necessary to dampen the cloth with tap water.

The electrodes of my invention may be furnished the user in rolls as mentioned above and the user may cut each electrode from the roll for its use as an independent unit or the electrodes may be furnished the user in separated condition, that is each electrode on its supporting base may be supplied as an independent unit. The inde-

3

pendent electrode units may be used in generally the same manner as when a plurality on the same base are used. Thus, a unit may be caused to adhere to each test point on the chest of a patient and will, of course, remain thereon during the series of tests and such independent units may be applied to other parts of the body.

The electrode assembly of this invention may be supplied to the user in rolls to thereby reduce shipment and storage problems. The spacing of the electrodes on the supporting base and the length of the base may be varied to fit different sized chests and to cause each electrode to be properly located at a chest point.

It has been one of my purposes to provide an electrode assembly which may be produced inexpensively so that an assembly may be disposed of after it has been used on a patient.

For an assembly of this nature to be practical and efficient means must be provided for the easy attachment and detachment of the electric circuit leads to the electrodes and to ensure a good electrical contact between the electrode and the lead. My electrode assembly has these necessary attributes for I have provided attachment means which are positive in their action and make the connection of the lead to an electrode a simple and easy operation.

I have also devised a package organization for the independent electrode units which provides for ease of handling and dispensing of one unit at a time from the package.

It will be evident that my invention is versatile in its uses and adaptations and, while I shall describe its use as a component of an electrocardiograph it is to be distinctly understood that it is within my contemplation that it may be used in other than the medical field. It will also be understood that in its medical use my assembly may be used equally well on other parts of the body than those mentioned.

With the foregoing general objects, features and results in view, as well as certain others which will be apparent from the following explanation, the invention consists in certain novel features in design, construction, mounting and arrangement and combination of elements, as will be more fully and particularly referred to and specified hereinafter.

Referring to the accompanying drawings:

Fig. 1 is a view of my electrode assembly in operative position on the chest of a patient.

Fig. 2 is a view in perspective of my electrode assembly rolled on a spool, with a section thereof unrolled.

Fig. 3 is a plan view of the operative surface of a portion of an electrode assembly.

Fig. 4 is a view in section through an electrode and the supporting base and illustrating a connection attached to the assembly.

Fig. 5 is a view in section through an electrode and the supporting base, the electrode being a modified form.

Fig. 6 is a view in perspective of a modified form of electrode assembly rolled on a spool, with a section thereof unrolled.

Fig. 7 is a view in section through an electrode and supporting base of the assembly illustrated in Fig. 6 and illustrating a connector attached to the assembly.

Fig. 8 is a plan view of the operative surface of the electrode assembly illustrated in Fig. 6.

Fig. 9 is a view in perspective with the supporting base and the electrode of Fig. 6 in separated positions.

Fig. 10 is a view in perspective of a package of independent electrode units.

Referring to the accompanying drawings and particularly Figs. 1 through 4 thereof wherein I have used the numeral 1 to designate in its entirety the supporting base of my electrode assembly. The supporting base may be formed of any suitable flexible fabric material or of any other suitable material and may be of any desired length and preferably though not necessarily the base is

4

approximately 1" in width. The supporting base may, if desired, be not only flexible but also elastic. Consideration of the drawings clearly indicates that the supporting base of the assembly is in the nature of a tape and on the operative face of the tape or supporting base I provide a layer or coating of any suitable adhesive 3, the other or outer surface 5 of the base being uncoated. The adhesive coating 3 is preferably a pressure sensitive adhesive and one which will adhere to the skin of the human body and to metal foils and metallic fabrics for reasons which will hereinafter be made clear.

The supporting base 1 is provided throughout its length with a plurality of longitudinally spaced openings 7 there-through, the openings being equally spaced apart and formed through the base intermediate the longitudinal edges thereof. While I have illustrated the openings 7 as being circular they may be of a variety of configurations and still fall within the spirit and scope of my invention.

I provide an annulus 9 at each opening 7 in the supporting base. Each annulus is applied to the adhesively coated side of the supporting base in such position that it encircles the opening. The annuli may be formed of paper or any other appropriate material and provide at each opening an encircling area which is uncoated, that is each annulus covers the coated surface of an annular area of the base immediately adjacent to and surrounding the opening. I provide a plurality of electrodes indicated generally by the numeral 11, of a thin metal foil, metallized fabric or other suitable pliant conductive material which is a good conductor of electricity, each electrode is preferably though not necessarily of circular configuration providing a disc-like electrode. For example, shim stock of brass may be used, or thin silver foil or any conductive material which is pliant. An electrode is located on and caused to adhere to the coated side of the supporting base at each opening therein in position thereon over and covering the opening and covering the annulus 9 and extending therebeyond. Consideration particularly of Fig. 4 of the drawings clearly illustrates the manner of attachment of the electrodes to the supporting base so that the central free portion 13 of each electrode is free of and not in contact with the adhesive coating due to the annulus and the peripheral surface 15 of each electrode is the portion which is attached to the adhesive on the supporting base. The electrodes are applied to the base so that there is a degree of looseness in the central free portion for a purpose which will hereinafter become clear. The electrodes, whether of circular or some other suitable configuration are preferably dimensionally such that they do not extend across the width of the supporting base but instead an adhesively coated area 17 extends between the longitudinal edges of the supporting base and the most adjacent portion of the periphery or side of the electrode. The purpose and advantages of such electrode positioning will become clear as this description proceeds.

The electrode assembly may be supplied to the user in long strips, that is long strips of the supporting base with the openings therein and the electrodes applied in permanent position as described. These strips of the assembly in any desirable lengths may be rolled on any suitable spool 19 as shown in Fig. 2 of the drawings. When it is desired to use an assembly the user merely must unroll enough of the strip from the spool to form an assembly having the desired number of electrodes and then cut across the strip. For instance if the assembly is to be used in a cardiograph apparatus for application to the chest a strip containing six electrodes may be cut off the supply length, if an assembly only involving one electrode for application to the foot or hand or some other part of the body is to be used a strip containing one electrode may be cut from the supply length. Of course, for other applications and uses of the assembly strips may

5

be severed from the supply length which contain any desired number of electrodes.

If it is desired to take a series of tests for a cardiogram, the strip containing six electrodes is cut from the supply length and is applied to the chest of the patient by pressing the coated side of the supporting base against the chest in the manner of the conventional adhesive tape. It will be recognized that when the supporting base is so applied the electrode discs will be pressed against the chest in good electrical contact therewith, and the base and the electrodes being formed of flexible or pliable material they will conform to the curvature of the chest and ensure an excellent and lasting contact of each electrode with the chest. The supporting base is caused to adhere firmly to the chest and all portions thereof including those edge portions 17 will be caused to adhere to the chest. It will now be apparent that the paste with which the operative face of each electrode is coated will be maintained in substantially airtight condition so that the paste will not dry during the time the assembly is left in operative position on the chest of the patient during the series of tests.

In using the assembly it is desirable that each electrode be placed at a particular location on the chest of the user. There are normally six chest points where the physician wishes to place an electrode. In Fig. 1 of the drawings they are, reading from left to right as the drawing is looked at: V-1 the fourth right inter-costal inter space; V-2 the same horizontal location as V-1 except to the left of the sternum; V-3 half way between V-2 and V-4; V-4 the fifth inter-costal inter space in the mid-clavicular line (approximately half way between the ends of the collar bone); V-5 the same horizontal level as V-4 where anterior axillary line bisects the horizontal plane of V-4; V-6 the same horizontal line as V-4 and V-5 where it bisects the mid-axillary line.

It will be understood that the electrodes are longitudinally spaced apart substantially the same distance as the aforementioned chest test points. It will also be understood that the assembly may be made in different sizes, to suit persons with different sized chests and in making the different sizes the spacing of the electrodes would be slightly varied.

With the six electrode assembly applied to the chest so that the electrodes are positioned as described the assembly may be left on for several days during the period of serial testing and it will be recognized that there can be no chance of any electrode not being at the same chest location for each test of the series of tests.

In Fig. 4 of the drawings I have illustrated one form of connecting an electrode to the lead of the electric circuit of the apparatus. I provide a connector designated generally by the numeral 21, the connector may include a stem 23 and a hook portion 25. When it is desired to connect any electrode into the circuit lead 27 which is attached in any suitable manner to the stem of the connector element the hook of the connector is inserted through the opening 7 in the supporting base and extended between the electrode and the annulus 9. It will be understood that the free or non-adhered portion of the electrode permits this good electrical connection to be made, it will be also understood that a relatively long portion of the hook is in good contact with the electrode. Any other suitable type of connector may be used and still fall within the spirit and scope of my invention.

In use the connector is connected with one electrode for the necessary length of time and then to each succeeding electrode of the assembly and it will be apparent that I have provided a mounting arrangement for the electrodes on the supporting base which makes the attachment of any type of suitable connector an easy matter.

In Fig. 5 of the drawings I have illustrated a modified form of electrode and I have used the same reference characters for parts which are the same as those hereto-

6

fore described. In this form of my invention the electrode 11 is formed with a peripheral edge which is rolled inwardly as at 29 to provide a bead about the peripheral edge of the electrode. I have done this to eliminate any small possibility of the edge of the electrode irritating or otherwise damaging the skin of the patient in the event that the edge of the electrode happened to be unusually sharp.

In Figs. 6 through 9 of the drawings I have illustrated a further form which my invention may take and in describing this form of my invention I shall use the same reference numerals for parts which are the same as those described above. In this form of the invention the same type of supporting base 1 may be used as described in connection with the form of the invention shown in Figs. 1 through 5, however I provide pairs of openings in each electrode point and in longitudinally spaced relation on the supporting base. Each pair of openings may comprise triangular openings 31 with a bridge 33 extending between them and longitudinally of the supporting base, the bridge being, of course, a section of the supporting base.

I have designated the electrodes generally by the numeral 35 and each electrode consists of a portion 37 which I shall term a "contacting portion" and a further portion 39 which I shall term a "connecting portion." The connecting portion 39 is preferably of reduced dimensions relative to portion 37. The connecting portion 39 is formed with a diametrically extending upstanding rib 41 for a purpose to be described. As in the case of the electrodes described in connection with Figs. 1 through 5 the electrode 35 is formed of a very thin metal foil of flexible and electrical conductive material. The electrode portions 37 and 39 are cemented together by means of any suitable cement which is conductive to electricity and an electrode unit consisting of the two portions 37 and 39 is applied to the coated side 3 of the supporting base 1 at each pair of openings in such position over the openings that they are closed by the electrode and the rib 41 extends below and in alignment with the bridge 33 of the supporting base, all as clearly illustrated in Fig. 7 of the drawings. Since the contacting portion 37 of each electrode is dimensionally greater than the other portion of the electrode it is the peripheral free portion 43 of the connecting portion which will contact and adhere to the adhesive surface 3 of the supporting base. I may provide a pincer or clamping connector designated generally by the numeral 45 for connecting the electrodes into the electric circuit of the apparatus. The working noses 47 of the connector are adapted to be inserted in a pair of openings 31 in engagement with the electrode to make a good electric contact therewith. It will be seen that the working noses of the connector extend between the rib 41 and the body of the electrode so that they are in conductive relation with not only the body of the electrode but also with the rib of the connector portion of the electrode.

The electrode assembly which I have illustrated in Figs. 6 through 9 of the drawings is used in the same manner as that which is illustrated in Figs. 1 through 5 and has the same inherent advantageous characteristics.

As I have pointed out above each electrode mounted as described may be furnished as an independent unit and may be used as an independent unit and function in generally the same manner as when a plurality of electrodes are mounted on the same supporting base. It is to be understood that my invention is intended not only to cover the assembly of a plurality of electrodes mounted on a common supporting base but also a single electrode mounted on a supporting base providing an independent electrode unit. In Fig. 10 I have illustrated a convenient arrangement for packaging a plurality of independent electrode units and I have used the numeral 49 to designate each independent electrode unit. On one end of each such unit I provide a tab 51 which is caused to adhere to the adhesive on the coated side of

7

the supporting base of the unit and to extend from and beyond the transverse end of the unit. The electrode 53 which is illustrated in Fig. 10 is formed of metallized fabric, although I may form the package of independent units which include electrodes formed of metal foils or any other suitable pliant conductive material.

A plurality of independent electrode units are assembled into the package of Fig. 10 by placing them in an aligned pile or stack with the adhesively coated side of a unit in engagement with the uncoated surface of the next adjacent unit. At one end of the unit the adhesively coated sides of the end adjacent units are placed face to face so that the end units will have their uncoated faces outermost. In assembling a plurality of the units into a package each unit is alternately arranged so that adjacent units have the tabs extending from opposite ends. When it is desired to separate a unit from the package for use the tab on an outside unit is grasped and the unit is peeled from the stack. The package may be wrapped in any desired and convenient manner.

I claim:

1. An electrode assembly including, in combination, an elongated flexible supporting base having an adhesive coating on one face thereof, said supporting base and coating having a plurality of longitudinally spaced openings therethrough, a plurality of separate electrodes being affixed to said supporting base by said adhesive coating, each of said electrodes being affixed to said supporting base in position covering an opening and comprising a metal foil unitary section having a surface adapted to engage the skin of a patient and an opposite surface adapted to be engaged by means for connecting an electric lead to the electrode, and means loosely and removably extended through each opening for connecting an electrical lead to each of said electrodes.

2. An electrode assembly, including, in combination, a flexible supporting base having an adhesive coating on one face thereof and the supporting base and coating having an opening therethrough, and a unitary metal foil electrode, a portion of said electrode being affixed to said coating and the remainder of said electrode being free of the coating and the electrode extending over the opening, and electrical conductive means extending through the opening and between and in contact with the free portion of the electrode and the supporting base and connected to an electric lead for connecting the electrode in an electric circuit.

3. An electrode assembly including, in combination, a flexible supporting base having an adhesive coating on one face thereof and the supporting base and coating having an opening therethrough, and a metal foil elec-

8

trode, a portion of said electrode being affixed to said coating, means being affixed to said coating and surrounding the opening to keep the remainder of said electrode from adhering to said coating to thereby provide a free electrode portion, said free electrode portion extending over the opening, and electrical conductive means extending through the opening and between the free portion of the electrode and said first named means and connected to an electric lead for connecting the electrode in an electric circuit.

4. An electrode assembly in accordance with claim 3 wherein said first named means comprises an annulus of flexible material.

5. An electrode assembly in accordance with claim 3 wherein said electrode comprises a metal foil disc and said first named means comprises an annulus of flexible material and said electrode portion is affixed to said coating radially outwardly with respect to the outer periphery of said annulus.

6. An electrode assembly including, in combination, an elongated flexible supporting base having an adhesive coating on one face thereof, said supporting base and coating having a plurality of spaced pairs of openings therethrough, and the openings of each pair of openings being separated by a bridging member integral with the supporting base, a plurality of separate electrodes being affixed to said supporting base by said adhesive coating, each of said electrodes being affixed to said supporting base in position covering a pair of openings and a bridging member, and means for connecting an electrical lead to each of said electrodes.

7. An electrode assembly in accordance with claim 6 wherein each electrode is provided with an upstanding rib in adhering engagement with a bridging member.

8. An electrode assembly in accordance with claim 6 wherein each electrode is provided with an upstanding rib in adhering engagement with a bridging member and said means comprises a connector having a pair of noses, one nose being insertible in one opening and the other being insertible in the other opening of a pair of openings.

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