

July 5, 1960

W. L. HOWELL

2,943,627

ELECTRODE

Filed April 5, 1957

2 Sheets-Sheet 1

FIG. 1.

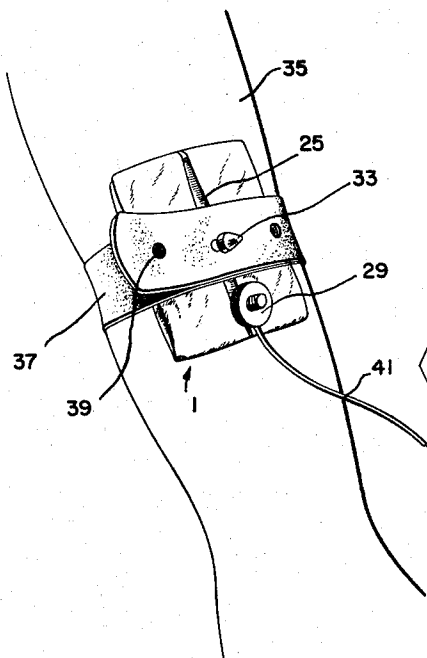


FIG. 2.

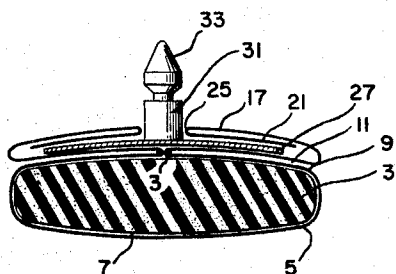
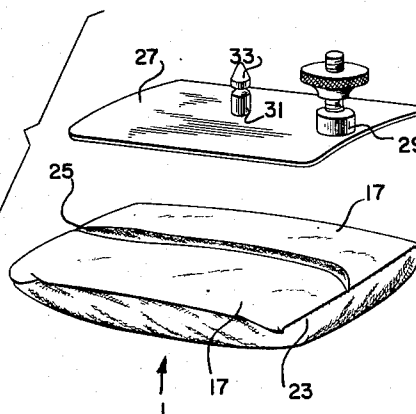


FIG. 3.

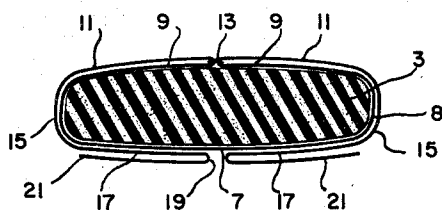


FIG. 4.

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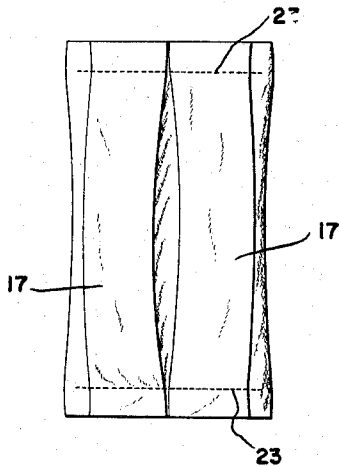


FIG. 5.

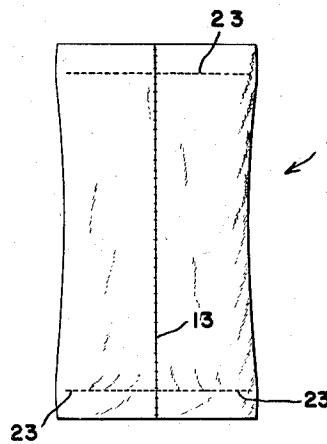


FIG. 6.

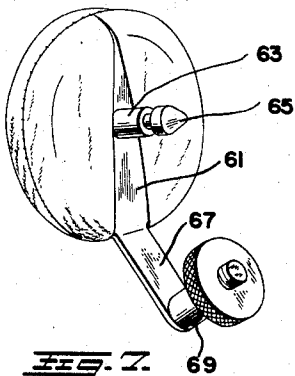


FIG. 7.

FIG. 8.

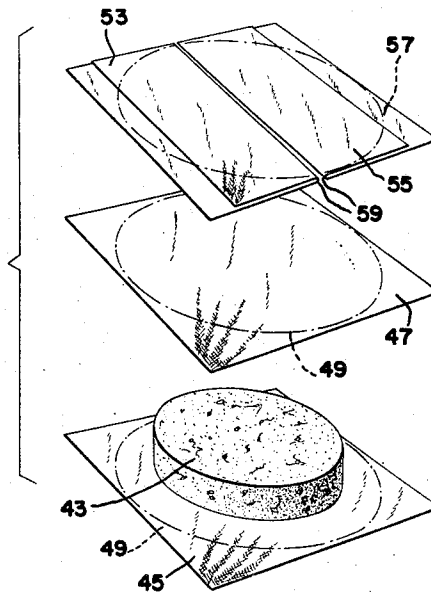
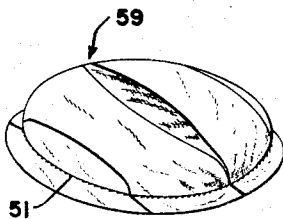


FIG. 9.



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ELECTRODE

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2 Claims. (Cl. 128—416)

This invention relates broadly to the art of electrodes and in its more specific aspects it relates to electrodes which are especially adapted for application to various parts of the human body in the making of electrocardiograms and in other electro-medical applications; 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 the preferred embodiments or mechanical expressions of my invention from among various other forms, arrangements, combinations and constructions, of which the invention is capable within the spirit and scope thereof.

In prior electrodes which are adapted for application to the skin of the human body it has been necessary to apply a paste which is a good conductor of electricity to the electric conductor in order to assure a good electric contact between the electrode and the dry skin. It will be obvious that the use of such a paste is objectionable for a variety of reasons and that any electrode for this use which does not require the use of such conducting pastes would constitute a definite advance in this art.

The conventional practice of applying paste either to the skin of the patient or to the electrode in some manner is not only a time consuming operation requiring the use of a damp wash cloth, towel or the like but is also a "messy" operation to both the patient and the technician, and is one which is undesirable from every aspect.

The use of various types of conducting pastes and the like electric conductors cause corrosion of the metal conducting portion of the electrode which requires the use of steel wool on the metal electrode in order to maintain it in proper and uniform conductive condition. Another factor which emphasizes the need for an electrode which does not require the use of the conducting pastes of prior practice is the cost of the pastes.

Not only is the use of paste a time consuming operation, "messy" and objectionable to all concerned and expensive but its use not infrequently causes unpleasant reactions in the patient. It is not uncommon for rashes to appear on the patient's skin which results directly from the application of paste thereto in the application of the electrode to the body of the patient. It will now be apparent that the use of paste is objectionable for the above reasons and for other reasons which are known to skilled workers in this field. Thus, for many years there has been a need for an electrode for application to the human skin which does not require the use of the objectionable pastes and as far as I am aware no one prior to this time has developed such an electrode which may be successfully and continuously used for the many medical applications which are in use in present medical practice.

It is a fact that the conventional metal electrode does not produce a uniform and good contact with the skin of the human body unless it is applied tightly thereto,

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and then it is often uncomfortable to the patient and when it is so applied slight tugs on the cable produce artefacts in their record or the electrocardiogram which obviously is highly undesirable from the standpoint of

5 accuracy of the recording.

I have overcome the many objectionable features which are inherent in the electrodes which are now being used by the medical professions and technicians in electro-medical applications. I have devised an electrode which eliminates the need for using paste of any character whatsoever to provide a good and satisfactory electrical contact with the human body. The electrode of this invention while involving a metal conducting plate also involves a pliant body of uniformly absorbent material 15 encased in a flexible envelope which has certain electrical and physical characteristics which assure a good and uniform contact with the skin of the patient. In doing away with the use of paste I merely wet the body of absorbent pliant material with water preferably adding a small amount of a wetting agent, and the electrode so treated may be used repeatedly without any further wetting or other treatment. There is no substantial corrosion as in former electrodes used with paste, the electrode may be applied lightly to the skin and a uniform 20 and good contact obtained, thereby eliminating any unpleasantness to the patient and the possibility of artefacts appearing in the record due to tugs on the electric cable or other movements to which the electrode may be subjected when in use.

In the development of my greatly improved electrode I have evolved an arrangement for mounting it in operative position on many different parts of the human body without requiring the use of suction cups which are now used in many instances for this purpose. Suction cups 35 for this purpose are not desirable for they often cause objectionable sensations to the patient being subjected to the test, they often cause ecchymosis and blisters, they often pull away from operative applied position which delays the taking of the tracing and suction cups are difficult to use and apply on hairy chests of patients, and many times require large applications of the afore- 40 said objectionable pastes.

The electrode of this invention comprises generally a body of pliant absorbent material encased within a metallized cover or envelope which is pervious to moisture, is flexible, washable and an excellent conductor of electricity. The envelope of metallized fabric is in electrical contact with a conducting plate so that an electrical path is formed over the cloth to the skin of the human body to which the electrode is applied in a testing operation. 50

I have found that excellent results are obtained by using a metallized cloth which is characterized by a structure or a weave which causes the electric current to flow fully over the surface thereof as opposed to through it as is the case with a copper or the like wire functioning as a resistance. It is thought that this current path over the electrode is one of the contributing factors leading to the success of this electrode. While I am aware that link metal mesh envelopes and the like have heretofore been proposed for the operative surface of electrodes adapted for application to the skin of the human body it is believed that the current path in such coverings is not the same as it is in the envelope of my electrode and that this may account for the apparent failure of such proposals and the failure of workers in this field to accept and use such prior art devices. 65

In designing an electrode which may be used many times without a wetting treatment after each use I have not overlooked the necessity of providing an arrangement and organization whereby the metal conductor plate of the electrode unit may be removed from the absorbent body and its casing so that the latter may be 70

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washed and be at all times clean and sanitary. It is not enough to merely provide this removable or separable characteristic for it is highly desirable that the plate be simply and easily removable from and attachable to the rest of the unit. I have devised such an electrode and I have accomplished this end without requiring any screws, clamp or fasteners of any sort whatsoever which must be manipulated in order to remove the plate from and attach it to the electrode pad.

In designing this electrode I have not overlooked the necessity for providing an electrode which is inexpensive and relatively simple to produce and is durable under normal use conditions. The electrode of this invention is qualified under all of these counts and the various components thereof are combined and fixed together in a novel and simple manner and one which permits quick and easy removal of the conductor plate from the body of the electrode so that the latter may be washed if desired.

With the foregoing general objects, features and results in view, as well as certain others which will be apparent from the following explanations, the invention consists in certain novel features in design, construction, mounting 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 in perspective of the electrode applied and in operative position removably attached to a body member, such as an arm.

Fig. 2 is an exploded view in perspective illustrating the conducting plate removed from the body of the electrode.

Fig. 3 is a view in vertical section through an electrode.

Fig. 4 is a view in vertical section through an electrode without the conducting plate and particularly illustrating the metallized cloth envelope following the sewing thereof about the absorbent material and prior to being inverted into the operative final position illustrated in Fig. 3 of the drawings.

Fig. 5 is a top plan view of the electrode without the conducting plate operatively connected thereto.

Fig. 6 is a bottom plan view of the electrode with the casing in the condition illustrated in Fig. 4.

Fig. 7 is a view in perspective of another form of electrode embodying all of the principles of the electrode of Fig. 1 but specifically designed for application to the chest of a human.

Fig. 8 is an exploded view in perspective illustrating the various components of the electrode of Fig. 7.

Fig. 9 is a view in perspective of the electrode of Fig. 7 with the conducting plate removed therefrom.

In the accompanying drawings I have used the numeral 1 to designate generally the pad component of my electrode unit, the pad as disclosed in Figs. 1 through 4 of the drawings being of generally rectangular shape and comprising what I shall term a "body element" which is formed of a pliant and absorbent material which may be sponge rubber. Consideration of the drawings indicates that the body element is preferably of substantial thickness so that it may absorb and contain a substantial amount of water and for other reasons which will become apparent as this description is proceeded with. The absorbent and pliant body element 3 is encased within an envelope or casing 5 which is formed of a flexible metallized cloth or fabric which is pervious to moisture but is relatively closely woven. One example from among many of a metallized fabric which I have established may be successfully used as a contact or current carrying surface in an electrode of the type in which I am particularly interested, is one in which the individual non-conductive fibers are coated with metal, preferably silver, then the coated fibers are highly polished before being twisted into thread from which the fabric is woven. Thus, the fibers which are twisted into the thread from which the metallized fabric is made con-

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sist of a core which is coated with a conducting medium to provide a final thread formed of a plurality of such coated cores. It has been established that metallized cloth of this nature is characterized by having less than 10 ohms resistance per square, regardless of the size of the square. It is well known that the resistance of copper wire is measured by the cross-sectional area of the wire, the resistance being inversely proportional to the cross-sectional area. In such copper conducting wire the electric current flows through the mass thereof while the current when impressed on the metallized fabric which I have successfully used and which I have described above flows over the surface of the silverized fabric making a sound electrical contact with the body of the patient and with low resistance. I have successfully used fabrics having the aforementioned characteristics which are known in the trade as 2½ oz. rep and .06 oz. rep.

It is also within my contemplation to use a metallized fabric composed of dielectric threads which are coated with a conductive material such as silver.

In Figs. 3 and 4 of the drawings I have illustrated one method whereby the envelope or casing of metallized fabric may be applied in position encasing the body element and providing attaching means for the metal conductor plate as will hereinafter be made clear. In Fig. 4 I have illustrated the first steps of this method which consist of taking a section of metallized fabric dimensionally greater than the dimensions of the body element 3 and placing it over one surface of the body element as at 7. The length of fabric is then brought up and around each longitudinal edge of the body element as at 8 and brought inwardly from each such edge over the opposite surface of the body element as at 9 and to the mid transverse point thereof wherein each end is folded back on itself and extended back toward each longitudinal edge as at 11, the meeting folded edges of the fabric being sewed together as at 13 to provide a central longitudinally extending seam line. The lengths 11 of fabric are then brought down over the longitudinal edges of the body element as at 15 and inwardly toward each other over the fabric section 7 as at 17 to substantially the center thereof and are then turned back on themselves as at 19 to form outwardly extending flaps 21. The fabric casing is fixed about the body member in this position by sewing the meeting ends thereof at the transverse edges of the body element as at 23. It will be understood that this is possible due to the fact that the original section of metallized fabric is of greater width than the length of the body element.

Since it is desirable that the flaps 21 of the casing be covered the casing is inverted in the following manner. The flaps 21 and lengths or sections 17 are in effect peeled from the position disclosed in Fig. 4 upwardly and about the longitudinal sides of the body element into the final position illustrated in Fig. 3 of the drawing so that the free flaps 21 are positioned underneath the sections 17 and are thus out of the way and not in position where they might be torn or otherwise damaged in the use of the electrode.

It will be evident that I have provided an electrode pad which includes an absorbent and pliable body element enclosed within a metallized fabric conducting casing or envelope wherein the casing is so formed about the body element that a smooth body contacting area is formed by the section of fabric 7 on one surface of the pad and on the opposite surface thereof a pair of securing flaps are formed by the sections of fabric 17 and 21, these securing flaps being oppositely disposed and spaced apart along their opposing longitudinally extending edges to form an elongated opening 25 therebetween. It will also be recognized that the flaps provide pockets into which the conducting plate is inserted.

The electrode unit of this invention also includes as a component thereof a conductor plate 27 of metal or other conductive material. The plate 27 is preferably

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slightly dimensionally reduced relative to the body element 3. Any suitable terminal post 29 is fixed to the conductor plate 27 to project upwardly therefrom. I provide an upwardly projecting post 31 which is fixed to the same surface of the plate that the terminal post is fixed to, the post preferably extending from substantially a mid point transversely and longitudinally with respect to the plate. The post 31 may have an enlarged conical-shaped head 33 on the outer end thereof.

The conductor plate component of the electrode is removably combined with the pad by inserting the plate through the opening or space 25 between the fabric securing flaps into operative position as clearly illustrated in Fig. 3 of the drawings. When the plate is in this operative position it extends between the double folds of sections 17 and 21 and the sections 19 and is in contact with the various sections of the metallized conducting fabric from which the casing is formed. The post or pin 31 extends through the unobstructed area 25 between the securing flaps and the electrode is mounted on a body member such as an arm 35 by means of a strap 37 of suitable dielectric material such as rubber, plastic or the like. The strap 37 is provided with a series of spaced openings 39 therein for removably receiving the post 31 therethrough. It will be understood that the post may be inserted in a suitable hole depending upon the size of the body member to which the electrode is being operatively applied. An electrical conductor is attached to the terminal post 29 to connect the electrode into the circuit.

The electrode pad of this invention is adapted to be wet with water with a minute quantity of a wetting agent added, for instance, one drop of a wetting agent to a gallon of water, has been found to be satisfactory and when so wetted the electrode may be used repeatedly with no further treatment necessary. The time saved in eliminating the need for pastes will be apparent and the uniform contact with the wet body element conforming to the contour of the surface to which it is applied will be assured. Since the casing of metallized fabric will become dirty it may be necessary to cleanse it, this is easily accomplished merely by slipping the conductor plate from its operative position within or under the securing flaps and then washing the fabric with soap and water while it still envelops the body element.

In Figs. 7, 8 and 9 of the drawings I have illustrated a circular electrode which embodies the same operating principles as does that which I have just described, however I have formed this electrode as a circular unit and one which is particularly adapted for application to chest areas of the patient.

The electrode of this form of my invention involves a body element 43 of sponge rubber or other suitable pliant and absorbent material which is preferably of circular form providing a disc. I provide two squares 45 and 47 for covering the top and bottom surfaces of the body member. The squares 45 and 47 are preferably formed of a metallized fabric material having the general char-

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acteristics set forth above in connection with the material used in connection with the electrode disclosed in Fig. 1 of the drawings. The material of the squares 45 and 47 may be cut into circular form along the dotted lines 49 whereupon they are applied permanently to the body element by an annular line of stitching 51. I provide securing flaps for this form of electrode by forming two sections 53 and 55 preferably of double thickness metallized cloth and cutting each of them along the dotted lines 57, whereupon they are placed on the body element over the cover 47 in position thereon with their opposing folded edges 59 spaced apart and are then stitched to the other fabric sections along the line of stitching 51. It will now be recognized that a diametrical opening 59 is provided across the top of the pad for receiving a circular metal conductor plate 61 having an upstanding post 63 fixed thereto, the post having a conical enlarged head 65 thereon. The conductor plate may be formed with an extending arm 67 from the end of which a terminal post 69 projects.

The conductor plate 61 is operatively positioned on the pad by inserting it through the unobstructed area 59 and between the flaps 53 and 55 in electrical contact therewith. The electrode unit may be applied to the chest in any appropriate manner as by a strap in the manner described in connection with the electrode illustrated in Fig. 1 of the drawings. This circular electrode has all of the inherent desirable characteristics and advantageous features that the electrode described in connection with Fig. 1 of the drawings has.

I claim:

1. A pad for use as a component of an electrode adapted to make electrical contact with the human body, comprising a pliant and absorbent body element, a casing enveloping said body element and in contact therewith, said casing being formed of a water pervious flexible metallized fabric, a pair of spaced apart flaps of metallized fabric extending over said casing and fixed thereto at their ends and adapted to removably receive thereunder a conductor plate.

2. An electrode adapted to make electrical contact with the human body, comprising in combination, a conductor plate and a pliant and absorbent body element, a casing enveloping said body element and in contact therewith, said casing being formed of a water pervious flexible metallized fabric and providing a smooth side for contact with the human body, and means on the other side of the casing and spaced therefrom providing pockets for removably receiving said conductor plate therein.

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