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CARDIOGRAPH ELECTRODE

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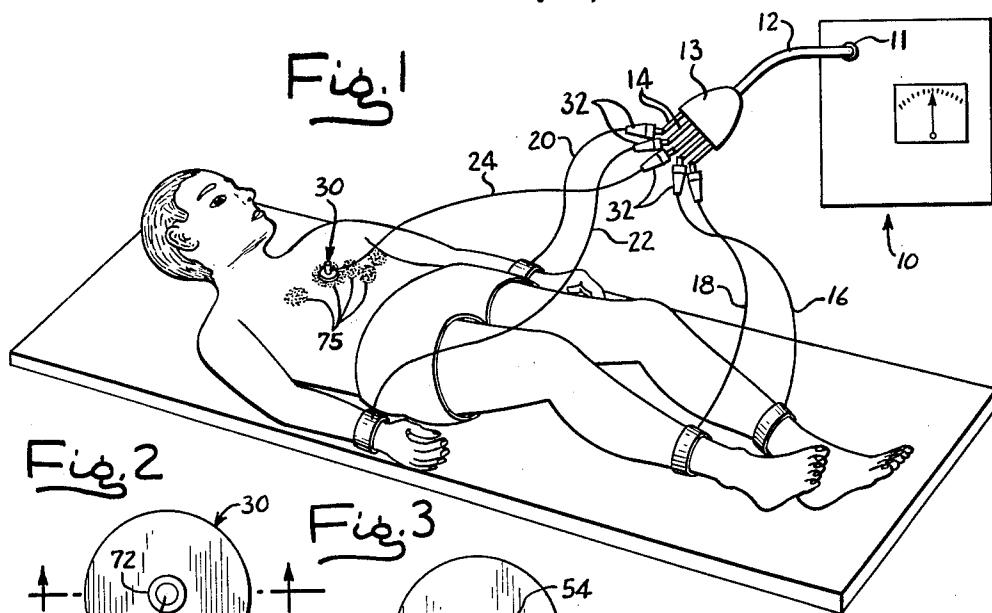


Fig. 2

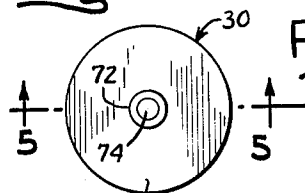


Fig. 3

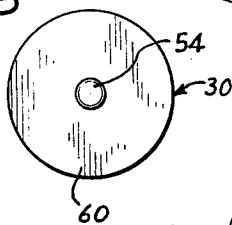


Fig. 4

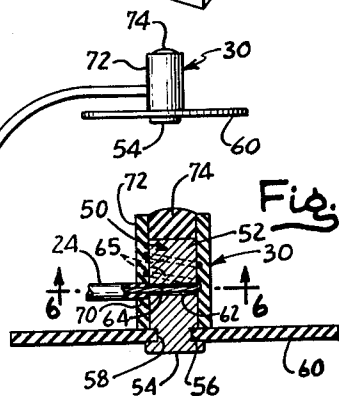
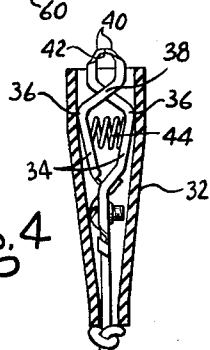


Fig. 6

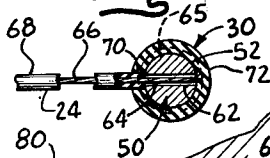


Fig. 5

Fig. 8

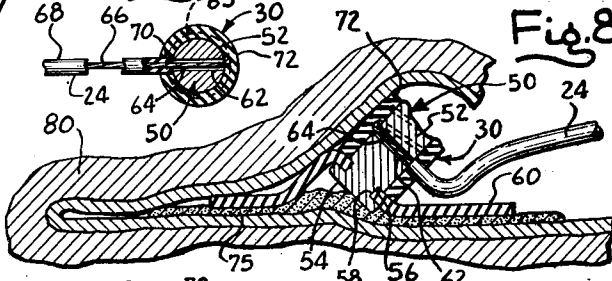
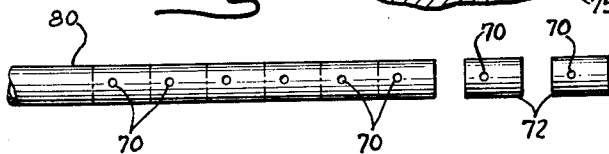


Fig. 7



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CARDIOGRAPH ELECTRODE

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1 Claim. (Cl. 128—404)

The present invention relates to electrocardiograph machines of the type commonly employed in the medical profession in the production of cardiograms representing the movements of the human heart. The invention has particular reference to a novel form of exploratory anatomical electrode designed for use in connection with such machines.

Present day electrocardiograph machines utilizing unipolar limb and chest leads employ essentially two electrical terminals including a central terminal from which multiple wire conductors or leads extend and which leads are designed for attachment to various parts of the human body. Ordinarily at least four such leads extend from the central terminal to the arms and legs. Such electrocardiograph machines also employ a second terminal, commonly referred to as the exploring terminal from which an exploratory lead extends, this lead being designed for successive application by the physician or other operator of the machine to various portions of the chest. Such lead is commonly known as the unipolar chest lead and it carries at the distal end thereof an electrode whereby it may conveniently be caused to establish electrical contact with the body at the desired region of exploration.

Various types of exploratory unipolar chest electrodes are currently in use and have met with varying degrees of success and acceptance by the medical profession. However, insofar as I am aware, each of these types of electrodes is possessed of certain limitations. For example, one of the most common types of exploratory electrodes designed for chest exploration consists of a flat rigid circular metal plate or disk which is slightly greater than one inch in diameter and which carries a manipulating insulating handle which, for convenience, extends approximately two inches outwardly at right angles from the plane of the disk, the entire disk with the exception of the central regions thereof where the handle abuts the same being exposed. The patient is prepared for chart exploration by the external application thereto at selected regions of the chest of daubs of a suitable conductive electrode paste, such paste consisting of a jelly-like substance containing sodium chloride in clear or colorless and odorless solution. The purpose of such electrode paste is to increase the conductivity of the patient's body at the point of contact of the electrode. After the patient has been thus prepared, the exploratory electrode is successively applied to or seated within the conductive paste daubs for purposes of making the cardiogram.

Electrodes of the type briefly outlined above are possessed of several limitations, principal among which is the fact that two operators are usually required, one to position the electrode and maintain the same position during current flow through the patient's body while the graph is being recorded, and the other to manipulate the cardiograph machine. Alternatively, one operator may suffice if the patient is instructed in the manipulation of the exploratory electrode, or at least in the maintenance of the same in position during energization of the electrocardiograph machine. The latter procedure is not always reliable in that certain patients, for example children or incapacitated adults, are incapable of properly performing the necessary function, while others,

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due for example to timidity or fright, may refuse the assignment or may improperly perform the same. Another limitation that is attendant upon the use of the flat metal disk type of exploratory electrode resides in the inability of such electrode, at times, to properly seat coextensively upon the intended region of the body to be explored, particularly if the exposed chest or other body area is not substantially flat. Occasionally, in the absence of the requisite amount of flesh in the vicinity of a rib or other body portion of the anatomy, improper seating of the electrode will result, especially if the electrode is self-applied. The situation is augmented in the presence of an undue amount of hair.

A second and widely employed type of exploratory electrode consists of a semi-cylindrical rigid metal suction cup, to which there is attached a rubber or other resilient bulb designed for application of subatmospheric pressure to the interior of the cup. This type of electrode is also used in connection with a conductive electrode paste. Such an apparatus is not suitable for self-application by the patient, and, when applied by the physician or other attendant, will not always hold its vacuum pressure, particularly if the application is made in the presence of a large quantity of hair or over body areas lacking in flesh. Furthermore, if there are abrasions, contusions, unhealed cuts or wounds and the like in the vicinity of the region of application of the suction cup, the electrode cannot be applied. Still further, the degree of subatmospheric pressure required to hold the cup in position, coupled with the relatively sharp circular edge of the electrode, renders the application to the body painful and, if the application is of a prolonged nature, frequently leaves a temporary rash after the electrode is removed. Another limitation associated with such suction devices resides in the fact that if the attendant collapses the suction-applying bulb to the fullest extent of which it is capable of being collapsed before application to the desired region, the created degree of sub-atmospheric pressure is unduly high, while at the same time, it is impossible for the attendant, upon attempting to remove the electrode, to counteract the sub-atmospheric pressure by further collapse of the bulb. In such an instance the electrode must be forcefully pulled from the body to destroy the vacuum, this operation frequently being extremely painful.

In connection with both the above-outlined types of exploratory electrodes, the fact that the rigid manipulating handle, in the one case, and the bulb which constitutes the handle, in the other case, protrude an appreciable distance from the metal part of the electrode, prevents application of the electrode to certain parts of the body, for example, beneath the female breast. Similarly, if the electrode is to be applied to portions other than the chest, for example to certain regions of the back when a patient is lying facing upwards, the electrode cannot be conveniently applied.

The present invention is designed to overcome the above noted limitations that are attendant upon the construction and use of conventional types of exploratory electrodes for use in connection with the unipolar terminals of electrocardiograph machines, and toward this end, it contemplates the provision of an extremely simple and inexpensive electrode which needs no self-manipulation or other attention on the part of the patient and which, having been applied by the physician or other attendant, leaves the attendant free for operation of the machine, such being among the principal objects of the invention.

It is another important object of the invention to pro-

vide an exploratory electrode of this character which employs an electrode proper having a relatively small contact area as compared to the disk and suction cup type of electrode, and in which the effective contact area of the electrode is very materially increased by the confinement of a quantity of the conductive electrode paste in the immediate vicinity of the electrode, such quantity of paste forming, in effect, a constructive extension of the electrode area.

Yet another object of the invention is to provide such an electrode having a relatively small metallic electrode area and a relatively large electrode extension area as outlined above, and wherein the electrode extension area is of a flexible non-metallic area capable of yielding to the contour of body irregularities so that the same may be applied to portions of the body hitherto unavailable for the application of conventional exploratory electrodes.

It is another object of the invention to provide an exploratory electrode for electrocardiograph machines in which the exposed, viewable amount of metal associated therewith is relatively small, thus being conducive toward the dispelling of any psychotic fears which certain patients entertain in the presence of metal objects in the hands of a physician.

Still another object is to provide an electrode which has an extremely small overall dimension which in no way decreases its ohmic resistance in the vicinity of body contact and which therefore may be applied to many areas of the body of a patient hitherto inaccessible, as for example to such back areas as are in coextensive contact with the operating table or other supporting surface.

The provision of an exploratory electrode for use in connection with the unipolar chest leads of an electrocardiograph machine which is extremely simple in its construction and which may therefore be manufactured at a low cost; one which is relatively small and which therefore requires but little storage space in an instrument case or physician's bag; one which is possessed of a minimum number of parts and has no moving parts whatsoever and which therefore is unlikely to get out of order; one which is capable of ease of assembly and disassembly for purposes of inspection or replacement of parts; one which may be easily cleaned; one which does not require the use of solder, clamps or other binding posts for application of the electrode proper to the lead wire; one which does not require the services of a skilled or trained operator in its use; and one which, otherwise, is well adapted to perform the services required of it are further desirable features which have been borne in mind in the production and development of the present invention.

Other objects and advantages of the invention not at this time enumerated will become more readily apparent as the following description ensues.

In the accompanying single sheet of drawings forming a part of this specification one illustrative embodiment of the invention has been shown.

In these drawings:

FIG. 1 is a plan view of an exploratory electrode assembly constructed in accordance with the principles of the present invention showing the same operatively applied to the chest of a patient and operatively connected to the conventional unipolar chest lead of an electrocardiograph machine;

FIG. 2 is an enlarged plan view of the electrode assembly;

FIG. 3 is a bottom plan view of the electrode assembly;

FIG. 4 is a side elevational view of the electrode assembly and its attached lead;

FIG. 5 is a sectional view taken substantially along the line 5—5 of FIG. 2;

FIG. 6 is a sectional view taken substantially along the line 6—6 of FIG. 5;

FIG. 7 is a schematic view illustrating certain steps employed in connection with the manufacture of the electrode assembly; and

FIG. 8 is a sectional view similar to FIG. 5 showing a special specific use of the electrode assembly.

Referring now to the drawings in detail and in particular to FIG. 1, a conventional electrocardiograph machine is designated in its entirety at 10 and is provided with the usual central terminal 11, from which there extends a multi-wire insulated cable 12 having a terminal connection 13 associated therewith. The connection is provided with a series of fine electrical taps 14 designed for connection to the body of a patient. Leads 16 and 18 extend from certain of the taps 14 to the left and right legs respectively of the patient, while leads 20 and 22 extend from other taps to the left and right arms respectively of the patient in the conventional manner of attaching such leads during the use of the machine 10 in effecting the desired electrocardiogram. The lead 24 is an exploratory lead and is designed for attachment to the center tap 14. This lead 24 carries at its distal end an exploratory electrode assembly, designated in its entirety at 30 and embodying the principles of the present invention. The proximate end of the lead 24 may be operatively and electrically connected to a conventional attachment clip assembly 32 (see also FIG. 4) commonly known as an "alligator clip" and which is obtainable on the market from practically all radio supply and equipment establishments. The clip assembly 32 consists of elongated clamping arms 34 hingedly connected together at their proximate ends, bent as at 36 so that they cross each other as at 38 and provide at their distal ends a pair of opposed inturned jaws 40, usually carrying antifiriction teeth 42 whereby an object such as the terminal 14 may be engaged between the jaws 40 for effective electrical contact therewith. A spring 44 interposed between the arms 34 serves to maintain the jaws 40 normally closed upon each other. A rubber or other flexible insulating tubular covering or sheath encompasses substantially the entire operative metal parts of the clip assembly and enables the clip to be manipulated in a well known manner without necessitating electrical contact with the metal portions of the clip assembly by the fingers of the user. Such a clip is well known in the art and no claim is made herein to any novelty associated with the same, the novelty of the present invention residing rather in the construction and assembly of the exploratory electrode assembly 30, the nature of which will be made clear.

Referring now to FIGS. 2 to 6 inclusive, the exploratory electrode 30 of the present invention involves in its general organization an electrode proper 50 which is in the form of a stainless steel rivet-shaped member having a cylindrical shank portion 52 and a head portion 54 of slightly increased diameter but of slight thickness in an axial direction. At the base of the shank portion 52 there is formed an annular external groove 56 designed for reception therein of the edge or rim regions of a central opening 58 provided in a generally flat, flexible, washer-like application disk 60 which is preferably formed of resilient elastomeric material such as rubber, either natural or synthetic, or a rubber substitute such as Pliofilm, the disk also preferably being possessed of a high degree of flexibility so that it will readily conform to the shape characteristics of any body surface to which it may be applied.

As best seen in FIGS. 5 and 6, the shank portion 52 of the electrode proper 50 is formed in the medial regions thereof with a transverse bore 62 therethrough, the internal diameter of the bore being slightly greater than the external or over-all diameter of the flexible insulated lead 24. The distal end of the lead, i.e. the end which is bared as at 64 so that it is physically and electrically exposed and this end is passed through the bore 62

and wrapped around the shank portion 52 of the electrode proper 50 to provide a few helical turns 65 which are in direct electrical contact with the shank portion 52.

It is to be noted at this point that the insulated lead is comprised of a core 66 (FIG. 6) of soft flexible braided copper or other conductive wire strands covered by a rubber or other flexible insulating jacket or sheath 68. The use of braided wire lends extreme flexibility to the lead 24 as a whole, such flexibility being essential. The use of such braided wire also lends extremely good electrical and frictional contact between the bared end 64 of the conductor core and the electrode shank 52.

The end of the insulation or sheath 68 projects into a small hole or opening 70 provided in a tubular covering 72 which is telescopically received over the shank portion 52 of the electrode proper 50 and one end of which abuts against the upper side of the flexible disk 60 so that, above the disk at least, the electrode is entirely concealed with no portion thereof being exposed so that contact with the regions of the electrode above the disk 60 by the fingers of the operator is precluded.

The axial extent of the tubular covering 72 is slightly greater than the axial extent of the shank portion 52 of the electrode 50 so that the upper end of the covering projects a slight distance outwardly beyond the upper end of the electrode. A plug 74 of a suitable insulating material is pressed into the upper open end of the tubular covering 72 to seal the electrode within the covering. The tubular covering 72 has a tight fit with the electrode and thus it serves to firmly bind the helical turns 65 into electrical contact with the electrode so that the use of solder or other bonding agent is not required.

In the use of the electrode assembly, the tubular covering 72 which is rigidified by the presence of the shank portion 52 of the electrode proper 50 therein, constitutes a manipulating handle for the electrode assembly 30 as a whole. Daubs of a suitable conductive electrode paste, commercially available on the market, are smeared on the patient's chest or other portions of the body as shown at 75 in FIG. 1 to be explored at the desired regions, and, thereafter the electrode assembly 30 may selectively be applied to the smeared regions by direct application of the underneath side of the flexible disk 60 to and over these regions, utilizing the covering 72 as a manipulating handle.

When the electrode is applied to the patient's body, the head portion 54 makes direct contact with a limited region of the outer surface of the patient's skin and is thus electrically connected to the body of the patient at this region. However, direct face-to-face contact between the electrode and skin of the patient is not relied upon as the sole electrical union since the conductive electrode paste, which adheres to the disk 60, presents a wide area of intimate electrical contact in the vicinity of the electrode, and establishes a large cross sectional area therethrough for current flow.

The conductive paste possesses an appreciable degree of tenacity or cohesiveness and serves in a large measure to maintain the electrode assembly in position at the desired region of the patient's body so that it is not necessary for either the operator or the patient to assist in the production of the electrocardiogram by manually maintaining the electrode assembly in position during energization of the electrocardiograph machine 10. To a lesser degree, the phenomenon of suction may assist in maintaining the electrode assembly in position on the patient's body although this phenomenon is not relied upon in the presence of the electrically conductive paste.

In FIG. 8, one of the electrode assemblies 30 is shown as being put to a specific use wherein it is applied beneath an overlying mass of skin and tissue 80, for example, a female breast. Here the electrode is tilted at an angle so that the flexible washer-like disk flexes in an irregular manner and does not lie flat against the skin. However, the intervening quantity of conductive paste 75 establishes

the necessary path for current flow from the skin to the electrode proper 50.

In the manufacture of the electrode assemblies 30 in quantity, the tubular coverings may conveniently and economically be severed from perforated lengths of rubber or other flexible tube stock such as has been shown in FIG. 7 at 80, the row of perforations 70 being preformed in the stock and, upon severing of the individual lengths 72 therefrom the planes of severance being maintained appropriately between adjacent perforations. Each tubular covering thus severed from the tube stock may be applied to its respective electrode assembly in several ways, one way being to pass the bared end 64 of the lead 24 and a portion of the insulation through the hole 70, after which the bared end may be passed through the transverse bore 62 and wrapped around the shank portion 52 of the electrode 50 as previously described. Thereafter, the tubular covering 72 may be slid along the lead 24 and telescoped over the shank portion 52, while at the same time tension is applied to the lead 24 to withdraw the portion of the insulation previously passed through the hole until the parts assume the positions in which they are shown in FIG. 5.

From the above description it will be appreciated that the electrode assembly of the present invention, because of its relatively small overall axial extent, and because of its flexibility, i.e. the ability of the rigid electrode to "lie down," so to speak, as shown in FIG. 8 when encountering an obstruction such as overlying breast tissue 80 in the case of chest exploration, or the operating table supporting surface in the case of back exploration, lends to the electrode assembly a utility not possessed by conventional rigid assemblies designed for the same purpose.

The invention is not to be limited to the exact arrangement of parts shown in the accompanying drawings or described in this specification as various changes in the details of construction may be resorted to without departing from the spirit of the invention. Only insofar as the invention has particularly been pointed out in the accompanying claim is the same to be limited.

Having thus described the invention what I claim as new and desire to secure by Letters Patent is:

An exploratory electrode assembly designed for application to selected surface regions of a patient's body during the production of electrocardiograms, said electrode assembly comprising an electrode proper in the form of an elongated non-corrosive metal body having an annular groove formed therein adjacent the distal end thereof, said groove dividing the electrode proper into a relatively long cylindrical shank portion of uniform diameter and a relatively short cylindrical head portion of slightly larger diameter, said cylindrical head portion presenting a flat circular end face, a thin flat application disk of flexible elastomeric material and having a central opening formed therein, the rim region of said central opening extending into said annular groove with a tight fit and substantially filling the same so that the head portion underlies said application disk in close proximity thereto, a tubular insulating sheath telescopically received over said shank portion of the electrode proper on the side of the disk opposite said head portion and closely fitting the shank portion coextensively therewith, said sheath being formed of resilient material and of normally open ended construction, one open end of the sheath projecting beyond the distal end of the shank, a filler plug of insulating material closing said one open end of the sheath, there being a transversely extending bore in said shank portion above the disk, and a flexible insulated conductor for said electrode assembly, said insulated conductor including a length of soft braided wire and a flexible covering of insulating material, there being a circular hole formed in said tubular sheath in register with the bore in said shank portion of the electrode proper, the braided wire at one end region of said flexible con-

ductor being bared and projecting through said hole and bore transverse and being helically wound around said shank portion so as to extend between the outer cylindrical surface of the latter and the inside surface of the sheath, said covering of insulating material extending 5 into said hole and frictionally and sealingly engaging the circular rim of the latter.

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