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MULTI-ELECTRODE NEEDLE

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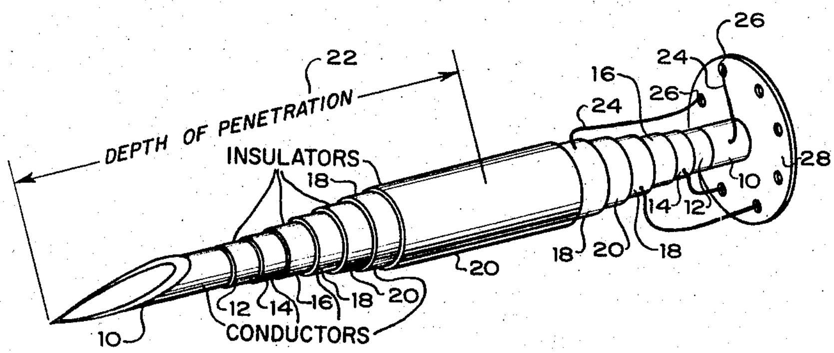

Figure 1

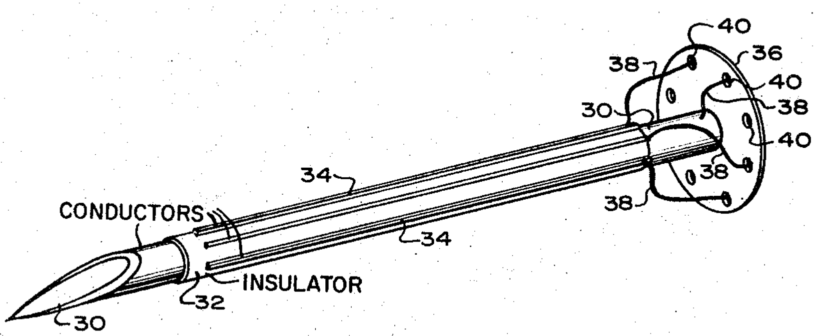

Figure 2

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MULTI-ELECTRODE NEEDLE

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This invention relates to multi-electrode needles.

One type of multi-electrode needle is conventionally used in electromyography. It has a plurality of platinum electrodes insulated from each other and molded into a stainless steel cannula at selected distances from the insertion end thereof. Separate shielded cables disposed within the cannula connect the platinum electrodes to a multi-contact connector. When the needle is inserted into a muscle the platinum electrodes detect the signal from one or more motor units in different layers of muscle tissue. However, the stainless steel cannula, being a conductor, short circuits the layers of muscle tissue it penetrates thereby reducing the effectiveness of the multi-electrode needle. Additionally, if a small diameter cannula is used to facilitate insertion, the surface area of the electrodes is seriously limited. The number of electrodes is limited because of the cabling required within the cannula.

It is the principal object of this invention to provide an improved multi-electrode needle.

In accordance with the illustrated embodiment of this invention there is provided a slender conductive rod having a pointed and a blunt end. Insulators and conductors are disposed on selected portions of the rod to form a plurality of longitudinal electrodes insulated from each other. A multi-contact connector is attached to the blunt end of the rod. Shielded cables connect the contacts of this connector with the ends of the electrodes closest thereto.

Other and incidental objects of this invention will be apparent from a reading of this specification and an inspection of the accompanying drawing in which:

FIGURE 1 is an exaggerated pictorial view of a multi-electrode needle according to one embodiment of this invention; and

FIGURE 2 is an exaggerated pictorial view of another embodiment of this invention.

Referring to FIGURE 1 there is shown an electrode **10** comprising a small diameter conductive rod having a pointed and a blunt end. Electrode **10** may be either hollow or solid and has an insulating layer **12** fixed coaxially thereon. Insulating layer **12** encompasses all of electrode **10** except the pointed end and an annular portion at the blunt end, which serve as terminals for the electrode **10**. Conducting layer **14** and insulating layer **16** are alternately deposited in the same manner so that each encompasses all but a selected annular portion at either extremity of the preceeding layer. Conducting layer **14** is therefore an insulated electrode having annular terminals of a selected surface area. Additional conducting and insulating layers **18** and **20** respectively are similarly deposited to provide as many insulated electrodes as desired.

The thickness of the insulating and conducting layers is only of the order of one-half to one micron. Thus a small diameter needle having a great number of electrodes can be formed with layers of any insulating and conducting material which can be fixed to an elongated rod by evaporation or other techniques. For example, a metal such as aluminum may be deposited to form both the conducting and insulating layers by anodizing alternate layers.

The exposed portions or terminals of the electrodes **10**, **14** and **18** have selected surface areas and are disposed

at selected distances from the pointed end of electrode **10**. Electrode terminals disposed nearest the pointed end of electrode **10** form portions of the penetration surface of the multi-electrode needle which has a normal depth of penetration **22**. Shielded cables **24** connect the electrode terminals disposed nearest the blunt end of electrode **10** to the contacts **26** of multi-contact connector **28**, which is attached to the blunt end of electrode **10**.

The multi-electrode needle of FIGURE 1 is useful in many applications either to detect a signal or to introduce a signal applied thereto. In electromyography the multi-electrode needle is inserted into a muscle to detect low frequency A.-C. and D.-C. signals from one or more motor units in different layers of muscle tissue. The layers of insulating material **12**, **16**, and **20** prevent the shorting effect between the layers of muscle tissue penetrated that is characteristic of conventional multi-electrode needles. The capacitance introduced by the alternate layers of insulating and conducting material is small enough that for the low frequency signals typically encountered it is of little or no effect.

Another embodiment of this invention is shown in FIGURE 2. Referring to FIGURE 2 there is shown a small diameter electrode **30** comprising a conductive rod having a pointed and a blunt end. An insulating layer **32** is deposited coaxially on electrode **30** encompassing all but the pointed end and an annular portion at the blunt end thereof. If desired, insulating layer **32** might also be extended to insulate the pointed end of electrode **30**. However, the same effect could be achieved by using a rod made of insulating rather than conducting material. Conducting material is deposited in longitudinal bars around the periphery of insulating layer **32** to form electrodes **34**. A multi-contact connector **36** is attached to the blunt end of electrode **30**. Shielded cables **38** connect the contacts **40** of multi-contact connector **36** to the terminal ends of electrodes **30** and **34** closest thereto.

We claim:

1. An electromedical needle for insertion into an animal body to provide a plurality of signal conduction paths to a subsurface region of the body, comprising:
   a hollow elongated conductor adapted for insertion into the body to provide a first signal conduction path to the subsurface region of the body, said conductor having a tapered end for piercing the body and having a contact portion near the tapered end for contacting the subsurface region of the body;
   an insulating layer fixedly supported on the outer surface of said conductor for insulating a selected portion of the conductor from the body when the electromedical needle is inserted into the body, said selected portion extending along the outer surface of the conductor from outside the body to the subsurface region when the electromedical needle is inserted into the body but not including said contact portion near the tapered end of the conductor; and
   a conductive layer fixedly supported on the outer surface of said insulating layer for providing a second signal conduction path to the subsurface region of the body, said conductive layer being insulated from said conductor by the insulating layer and including a contact portion for contacting the subsurface region of the body when the electromedical needle is inserted into the body.

2. An electromedical needle as in claim **1** including another insulating layer fixedly supported on the outer surface of said conductive layer for insulating a selected portion of the conductive layer from the body when the electromedical needle is inserted into the body, said selected portion of the conductive layer extending along the outer surface of the conductive layer from outside the body to the subsurface region when the electromedical

needle is inserted into the body but not including said contact portion of the conductive layer.

3. An electromedical needle as in claim **2** wherein said insulating layer and said conductive layer are each substantially less than one mil in thickness.

4. An electromedical needle as in claim **3** wherein said contact portion of said conductor and said contact portion of said conductive layer are each positioned for contacting the subsurface region of the body at a different depth below the surface of the body when the electromedical needle is inserted into the body.

5. An electromedical needle for insertion into an animal body to provide a plurality of signal conduction paths to a subsurface region of the body, comprising:

an elongated conductor adapted for insertion into the body to provide a first signal conduction path to the subsurface region of the body, said conductor having a tapered end for piercing the body and having a contact portion near the tapered end for contacting the subsurface region of the body;

an insulating layer fixedly supported on the outer surface of said conductor for insulating a selected portion of the conductor from the body when the electromedical needle is inserted into the body, said selected portion extending along the outer surface of the conductor from outside the body to the subsurface region when the electromedical needle is inserted into the body but not including said contact portion near the tapered end of the conductor; and

a plurality of conductive elements fixedly supported on the outer surface of said insulating layer so as to be insulated from said conductor, each of said conductive elements being insulated from the other conductive elements and having a contact portion for contacting the subsurface region of the body so as to provide a plurality of signal conduction paths to the subsurface region when the electromedical needle is inserted into the body.

6. An electromedical needle as in claim **5** wherein said insulating layer and said conductive elements are each substantially less than a mil in thickness.

7. An electromedical needle as in claim **6** wherein said contact portion of said conductor and said contact portions of said plurality of conductive elements are each positioned for contacting the subsurface region of the body at a different depth below the surface of the body when the electromedical needle is inserted into the body.

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