July 5, 1955 F. F. OFFNER 2,712,309

ELECTROENCEPHALOGRAPHIC APPARATUS

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Fig. 1

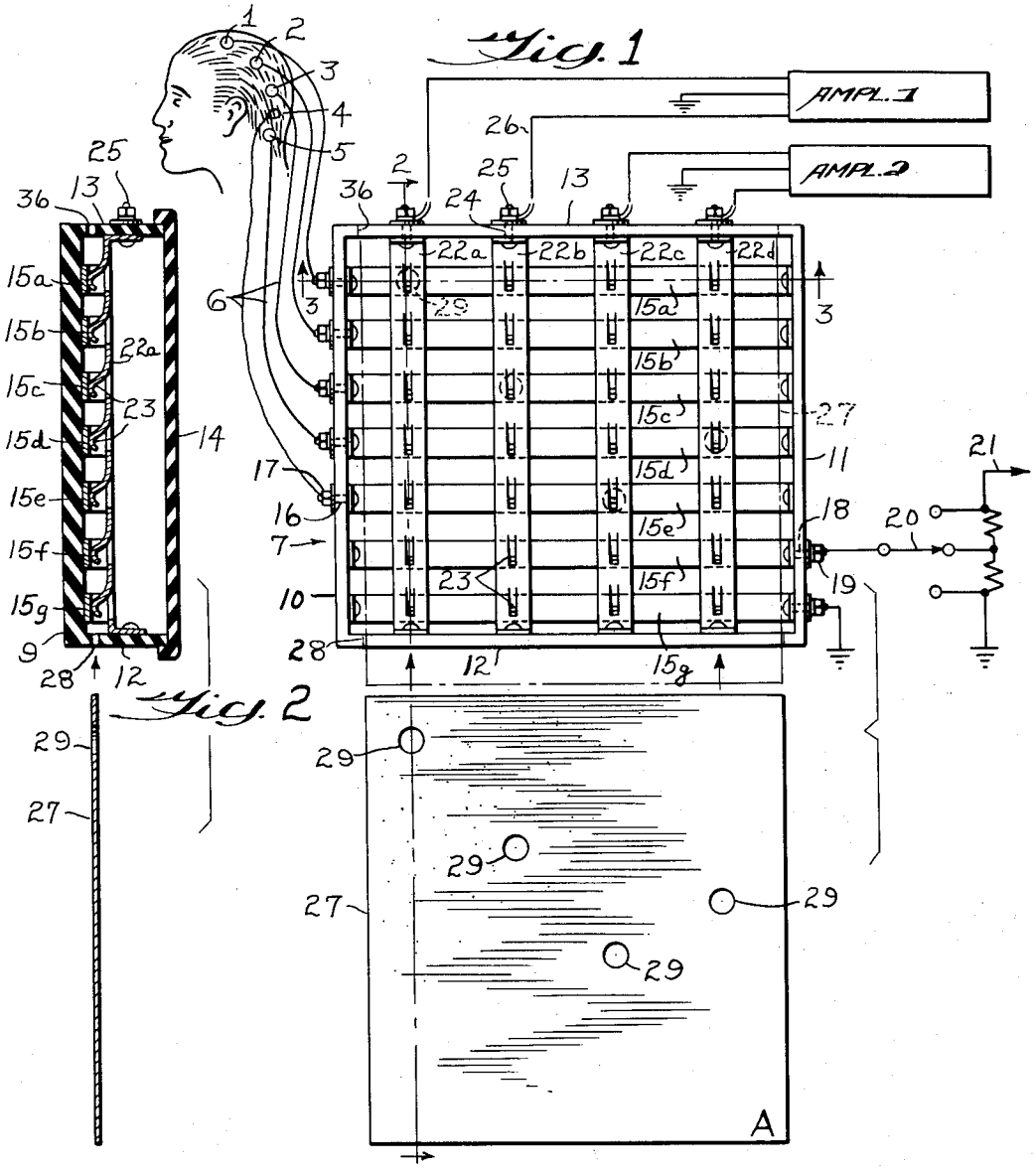
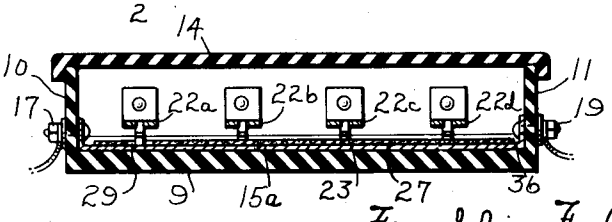


Fig. 2

Fig. 3



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Fig. 7

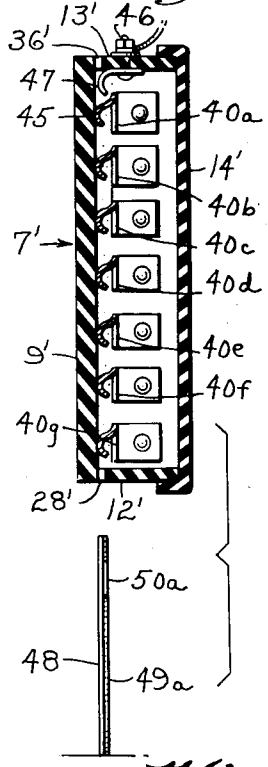


Fig. 6

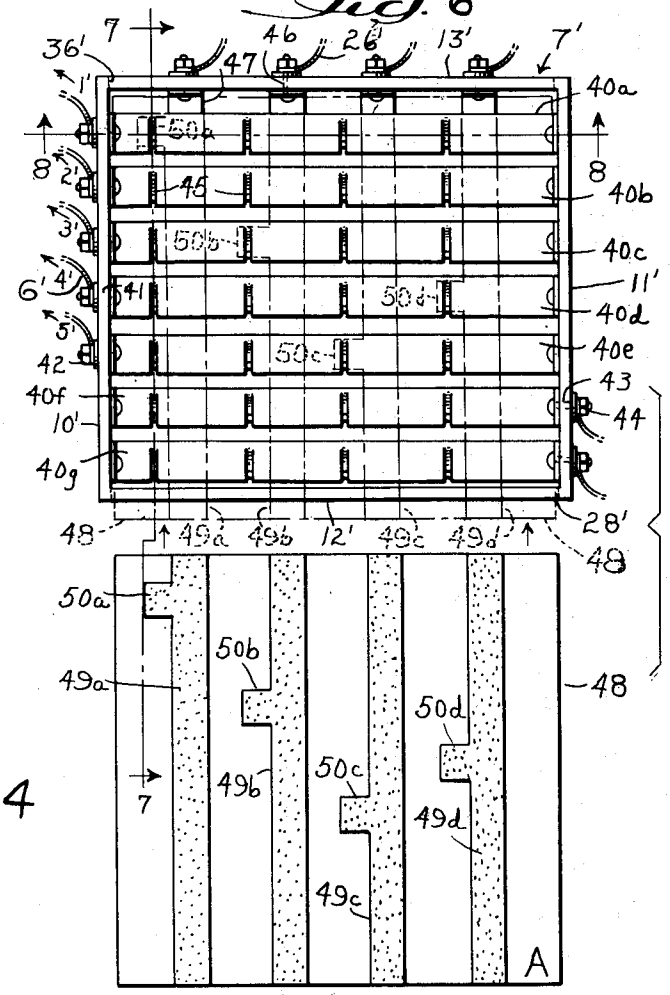


Fig. 4

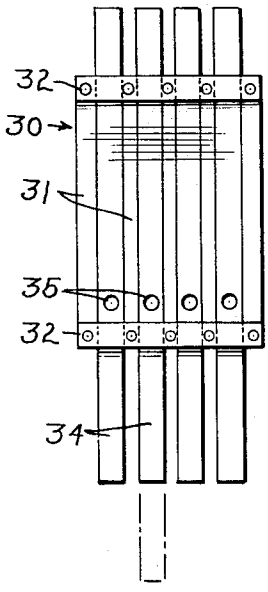


Fig. 8

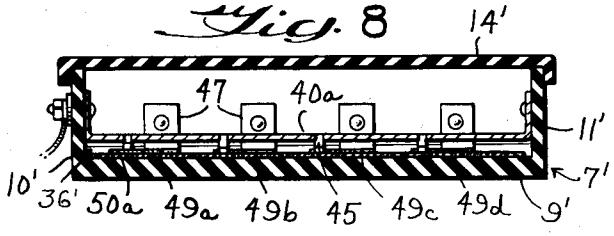
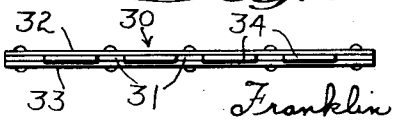


Fig. 5



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Fig. 11

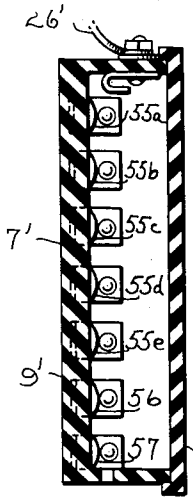


Fig. 9

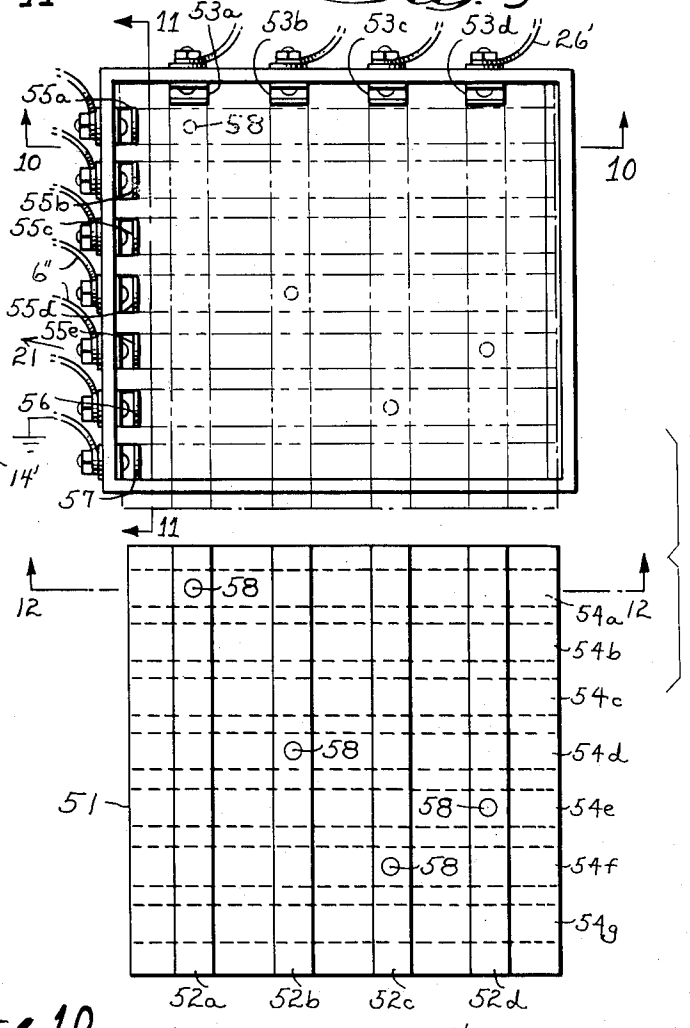


Fig. 10

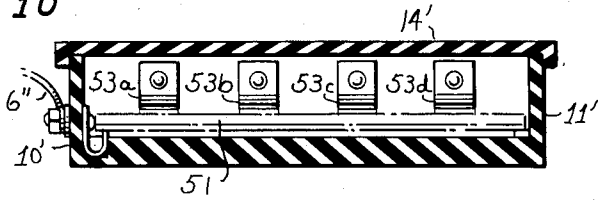
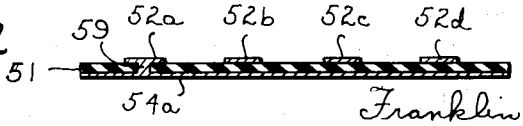


Fig. 12



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ELECTROENCEPHALOGRAPHIC APPARATUS

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Application December 23, 1953, Serial No. 399,919

12 Claims. (Cl. 128—2.1)

The present invention relates to the technique of electroencephalography and in particular to an improved arrangement for connecting different combinations of electrodes from the head of the subject to the electroencephalographic apparatus more quickly and accurately than has been possible in the past.

In past electroencephalographic instruments, it has been customary to provide a series of switches, whereby any one of a plurality of electrodes placed on the scalp of the subject could be connected to either input terminal of a series of amplifiers. In this way, any desired connection between the electrodes and the amplifiers could be set up, but it required the changing of two switches for each amplifier. In order to overcome this troublesome manipulation of switches, it is possible to have a single switch pre-wired, with a number of previously determined connection arrays wired in. In this way, it is only necessary to change a single switch for changing the input connections, but if a different arrangement from that previously wired in is desired, it is necessary to rewire the switch. Furthermore, the wiring of a switch of this type is quite complex.

The invention herein described overcomes the objections of previous connection methods. It provides an immediate selection of any desired input connection, and it accomplishes this without the need for pre-wiring any switch or similar arrangement. Both the construction and the use of the invention herein described is considerably simpler than previously used methods.

More specifically the objective of the invention is reached through the use of a plurality of differently coded connection cards each of which is coded to select a certain combination of electrodes for connection to the input circuits of the amplifiers. The coding of the cards and associated switching contact assembly may take different forms and three different embodiments are shown in the accompanying drawings wherein:

Fig. 1 is a plan view of one embodiment of switching contact assembly together with a representative coded card used therewith wherein the desired circuit connections are made through holes in the card;

Fig. 2 is a transverse section on line 2—2 of Fig. 1;

Fig. 3 is a transverse section on line 3—3 of Fig. 1;

Fig. 4 is a plan view of a modified card construction for use with the embodiment shown in Fig. 1 which enables one to set up any desired electrode-amplifier connection;

Fig. 5 is an end elevation of the card shown in Fig. 4;

Fig. 6 is a plan view of a different embodiment of switching contact assembly together with a representative coded card for setting up preselected electrode-amplifier connections and wherein such connections are established by means of laterally projecting tab portions of conductive strip material applied in layer form to the face of the card.

Fig. 7 is a transverse section on line 7—7 of Fig. 6;

Fig. 8 is a transverse section on line 8—8 of Fig. 6;

Fig. 9 illustrates yet a third embodiment of the invention in which conductive strips are applied to opposite faces of the cards, the latter being coded by interconnections between the strips on the opposite faces;

Figs. 10 and 11 are transverse sections on line 10—10 and 11—11 of Fig. 9 respectively, and

Fig. 12 is a transverse section of the card taken on line 12—12 of Fig. 9.

With reference now to these drawings and the embodiment shown in Figs. 1–3, the head of the patient is represented as having five electrodes **1** through **5** applied to the scalp at different locations in order to allow the recording of potentials between pairs of selected points as may be desired. These electrodes extend via flexible leads **6** to a selective switching apparatus indicated generally at **7**. The latter is comprised of a rectangular housing of electrically insulating material having a bottom wall **9**, side walls **10** and **11**, front and rear walls **12** and **13**, and a cover **14**. Extending transversely between the side walls **10** and **11** in parallel spaced relation are a plurality of flat strips **15***a*–**15***g* made of electrically conductive material such as copper, and studs **16** which secure the ends of strips **15***a*–**15***e* to side wall **10** extend to the exterior of the housing to provide terminals **17** by which the electrode leads **6** are connected individually to the several strips **15***a*–**15***e*. Strips **15***f*, **15***g* are similarly connected via studs **18** extending through the opposite side wall **11** to terminals **19** by which electrical connections can be made from strip **15***g* to ground and from strip **15***f* via potentiometer switch **20** to a source of calibration voltage **21**.

Arranged generally crosswise to strips **15***a*–**15***e* in the housing and preferably at right angles thereto is a second set of conductive strips **22***a*–**22***d* extending between the front and rear walls **12**, **13** in parallel spaced relation. Each of the strips **22***a*–**22***d* includes a series of longitudinally spaced cut-out tongues **23** aligned respectively with and bearing upon each of the strips **15***a*–**15***g* that it crosses due to the resiliency of the tongue. Also each of the strips **22***a*–**22***d* is connected via a stud **24** extending through the rear wall **13** to a terminal **25** by which the strips are connected in pairs over flexible leads **26** to the input grid terminals of amplifier channels **1** and **2**. These amplifiers are of the well known differential type and hence have been shown only in block schematic form.

In actual practice, it is customary to employ a much larger number of electrodes than five; for example sixteen to twenty-four; and also it is customary to employ eight or ten amplifier channels. However the invention has been illustrated with the lesser number of electrodes and amplifiers shown in the interest of simplifying the disclosure.

The desired connections between the several electrodes **1**–**5** and the amplifiers; or, for calibration purposes, between the amplifiers and the calibration voltage, is made by inserting a relatively thin card **27** made of insulating material through a slot **28** of substantially the same width as the card provided in the front wall **12** of the housing. As shown in Fig. 2, slot **28** is located substantially in the plane of contact between the tongues **23** and strips **15***a*–**15***g* and hence the card when so inserted to the position shown in broken lines will raise the tongues and break their contact with the several strips **15***a*–**15***g* at all places except those whose positions correspond to the location of code-punched holes **29** in card **27**.

The code punching of the particular card shown in the drawing, which is marked "A" for purposes of identification, is such as to locate a hole **29** at the junction of strips **15***a* and **22***a*, another hole at the junction of strips **15***c* and **22***b*, a third hole at the junction of strips **15***e* and **22***c*, and a fourth hole at the junction of strips **15***d* and **22***d*. Thus card "A," when so inserted, will connect amplifier **1** to electrodes **1** and **3**, and amplifier **2** will be con-

nected to electrodes 4 and 5. The connections between the desired electrode combinations and the amplifiers can thus not only be made very quickly but it is also quite evident that there is no possibility of making a mistake in the connections since all that one has to do is to select the proper card. Of course a large number of such cards, each identified by a suitable legend, and each having a differently located set of holes corresponding to the desired electrode combinations, would be provided for this purpose.

For calibrating the several amplifiers, a special card, not shown, is provided. This card is provided with two holes for each amplifier channel, one of the holes serving to connect one input to strip **15***f* and hence to the calibration voltage **21** and the other hole serving to connect the other input of that same amplifier to strip **15***g* and hence to ground.

Occasionally, input connections to the amplifiers different from any of those selected by the set of code punched cards furnished with the apparatus may be required. For such purposes it is convenient to be able to make individual lead selections, as may be required. In order to accomplish this, a specially constructed card **30**, shown in Figs. 4 and 5, but drawn to a scale smaller than Figs. 1–3, may be employed. Card **30** includes a plurality of parallel spaced, stationary strips **31** of insulating material held in such position between transverse strips **32**, **33**, also of insulating material, located at each end of the set of strips **31**. In the spaces between the several strips **31** are other movable strips **34** each having a single hole **35**. The strips **34** are slidable longitudinally of the strips **31** and hence when the card **30** is slid through the slot **28** into the housing **7** of Fig. 1, the strips **34**, which correspond in number and lateral spacing to strips **22***a*–**22***d*, may be slid longitudinally so as to bring the hole **35** in the same in registration with any of the tongues **23** in the strip (**22***a*–**22***d*) with which that particular strip **34** is associated, thus enabling one to set up any desired combination of electrode-amplifier connection. To enable the strips **34** to be slid longitudinally, the back wall **13** of housing **7** is also provided with a slot **36** in alignment with and identical with the front slot **28**.

In place of the punched card arrangement illustrated in Figs. 1–3, one may employ a card of insulating material having parallel spaced, stripe type conductive coatings thereon corresponding to the strips **22***a*–**22***d*, and which coating stripes have ear portions located in different positions on different cards to establish the desired connections between the different electrodes and amplifiers. Such an arrangement is shown in Figs. 6–8.

With reference now to these views, it will be seen that the housing for the embodiment of Figs. 6–8 is similar to that shown in Figs. 1–3 and hence the parts thereof have been assigned corresponding reference numerals but with primes added thereto for purposes of distinction.

A plurality of parallel spaced, conductive strips **40***a*–**40***g* extend transversely in the housing **7'**, the strips being secured individually in place at their opposite ends to the side walls **10'**, **11'**. Studs **41** which secure the left ends of these strips extend to the exterior of the housing and establish terminals **42** to which the electrode leads **6'** are connected, the latter thus being electrically connected respectively to the conductive strips **40***a*–**40***e*.

Conductive strips **40***f*–**40***g* are secured at their right ends by studs **43** which extend to the exterior and establish terminals **44** for connection to the source of voltage by which the amplifiers may be calibrated.

Each of the conductive strips **40***a*–**40***g* includes a plurality of longitudinally spaced cut-out tongues **45** which, as shown in Fig. 7, bear against the bottom wall **9'** of the housing in the absence of an electrode connection card.

Secured across the interior rear wall **13'** of the housing **7'** by means of conductive studs **46**, are a plurality of tongue-like connectors **47** which, as will be explained, serve to connect the selected electrodes to the amplifiers.

The electrode selector cards, one of which is shown as card "A" and identified by numeral **48**, is made of insulating material and provide on one face thereof with a plurality of parallel spaced, stripelike conductive layers **49***a*–**49***d* applied thereto in any suitable manner such as by coating. There are as many of these conductive layers as there are amplifier inputs, and each adjacent pair such as **49***a*–**49***b* or **49***c*–**49***d* feed the differential inputs of an amplifier. The layers **49***a*–**49***d* are so spaced on the card that when the card is inserted in the housing through the front slot **28'** to the position shown in broken lines, the upper ends of these layers will pass under and be engaged with the connectors **47**.

The coding of each card is effected by establishing ear portions **50***a*–**50***d* on the conductive layers **49***a*–**49***d* which extend laterally from the main body of the layer into each line of tongues **45** on strips **40***a*–**40***g* and establish contact with one of those tongues depending upon its location on the card. These ear portions **50***a*–**50***d* correspond in function to the holes **29** in card **27** and hence determine, by their location, which electrodes will be connected to which amplifiers. The locations of the ears on the particular card A shown in the drawing interconnect conductive strip **40***a* with conductive layer **49***a*, strip **40***c* with layer **49***b*, strip **40***e* with layer **49***c*, and strip **40***d* with layer **49***d*. Thus electrodes **1'** and **3'** will be connected to the inputs of amplifier **1'** and electrodes **5'** and **4'** will be connected to the inputs of amplifier **2'**.

When there is a large number of amplifiers, and a large number of electrodes, the number of spring contacts i. e. the tongues **23** becomes very large. Their number may be reduced by having the interconnections between the amplifiers and electrodes made in a fixed manner on each card, and using the spring contacts or tongues to connect only to the layers appropriate to each amplifier input and to each electrode. Such an arrangement is illustrated in the embodiment of Figs. 9–12. Here each of the insulating cards **51** has a plurality of parallel spaced conductive strips **52***a*–**52***d* on one face and each such strip is connected to its corresponding amplifier input through spring contacts **53***a*–**53***d* respectively. On the opposite face of the card, and at right angles to the set of strips **52***a*–**52***d*, is another set of parallel spaced conductive strips **54***a*–**54***e* connected respectively to the electrode leads **6''** through spring contacts **55***a*–**55***e*. Strip **54***f* is connected to the source of calibration voltage **21** by spring contact **56** and strip **54***f* is connected to ground by spring contact **57**.

Coding of a particular card **51** is accomplished by piercing it at the proper strip cross-over points **58**, corresponding to the holes **29** in the card shown in Fig. 1 and inserting conductive material **59** so that the latter will interconnect the strips on opposite faces of the card which cross at such points. The material **59** may take any suitable form such as an eyelet, rivet, or drops of solder or of electrically conductive paint.

In conclusion it is to be understood that while the embodiments of my invention as illustrated herein are to be preferred, various changes in the construction and arrangement of the components may be made without however departing from the spirit and scope of the invention as defined in the appended claims.

Moreover, while the present invention has been described with respect to its application to the selective switching of the electrode elements of electroencephalographic apparatus it will be understood that the principles thereof are equally applicable to other forms of biographic apparatus which include a plurality of electrodes located at different points on the body of a living organism and by which the potentials at such points are to be measured.

I claim:

1. In an apparatus for amplifying potentials produced at a plurality of points in the body of a living organism,

a plurality of electrodes adapted to be secured at different locations on said body, a plurality of amplifier inputs, an electrical circuit from each of said electrodes, an electrical circuit to each of said amplifier inputs and a card of insulating material cooperative with said circuits, said card including means provided thereon in accordance with a predetermined coding for establishing predetermined interconnections between said electrode circuits and said amplifier input circuits.

2. In an apparatus for amplifying potentials produced at a plurality of points in the body of a living organism, a plurality of electrodes adapted to be secured at different locations on said body, a plurality of amplifier inputs, a circuit selector housing, an electrical circuit from each of said electrodes into said housing, an electrical circuit from each of said amplifier inputs into said housing, and a card of insulating material insertable into said housing and which is cooperative with said circuits, said card including means thereon provided in accordance with a predetermined coding for establishing predetermined interconnections between said electrode circuits and said amplifier input circuits.

3. In an apparatus for selectively amplifying potentials produced at a plurality of points in the body of a living organism, a plurality of electrodes adapted to be secured at different locations on said body, a plurality of amplifier inputs, and means for selectively connecting said electrodes with said amplifier inputs comprising a first set of spaced lines of contact means electrically connected respectively to said electrodes, a second set of spaced lines of contact means crossing the lines of contact means of said first set and being electrically connected respectively to said amplifier inputs, and a card of insulating material insertable between said sets of contact means, said card including means located thereon at the crossing points of certain of said lines of contact means according to a predetermined code for establishing a connection at such points between certain contact means of said first and second sets and preventing a similar connection at all other crossing points.

4. Apparatus for selectively amplifying potentials as defined in claim 3 wherein the lines of contact means of said first and second sets are normally connected with each other at the crossing points thereof and said card serves to disconnect the same at all crossing points except those selected by the card coding.

5. Apparatus for selectively amplifying potentials as defined in claim 3 wherein the card coding consists of apertures in said card coincident with the selected crossing points and through which the electrical connection is made between the selected contact means of said first and second sets.

6. Apparatus as defined in claim 3 and wherein said first set of spaced lines of contact means includes other lines of contact means connected to a source of calibration voltage.

7. In an apparatus for amplifying potentials produced at a plurality of points in the body of a living organism, a plurality of electrodes adapted to be secured at different locations on said body, a plurality of amplifier inputs, and means for selectively connecting said electrodes with said amplifier inputs comprising a first set of spaced conductive strips electrically connected respectively to said electrodes, a second set of spaced conductive strips crossing the strips of said first set, the strips of said second set being electrically connected respectively to said amplifier inputs, each of the strips of one of said sets including a plurality of longitudinally spaced contact means disposed respectively at the crossing points with the strips of the other set for engagement respectively therewith, and a card of insulating material insertable between said contact means and the strips of said other set, said card having a plurality of holes located therein at certain of said crossing points according to a predetermined code and through which holes the correspondingly located contact means extend and engage the strips of said other set, the remainder of said contact means being held out of engagement with the strips of said other set by said card.

8. In an apparatus for selectively amplifying potentials produced at a plurality of points in the body of a living organism, a plurality of electrodes adapted to be secured at different locations on said body, a plurality of amplifier inputs, and means for selectively connecting said electrodes with said amplifier inputs comprising a first set of lines of contact means electrically connected respectively to said electrodes, a second set of spaced lines of contact means crossing the lines of contact means of said first set and being electrically connected respectively to said amplifier inputs, and a card of insulating material insertable between said sets of contact means, said card including portions thereof coincident with the lines of contact means of one set and movable individually along said lines across the lines of contact means of the other set and which include means for establishing a connection between selected lines of contact means of both sets.

9. Apparatus for selectively amplifying potentials as defined in claim 8 wherein the movable portions of said card each include an aperture through which the connection is made between the selected lines of contact means of both sets.

10. In an apparatus for selectively amplifying potentials produced at a plurality of points in the body of a living organism, a plurality of electrodes adapted to be secured at different locations on said body, a plurality of amplifier inputs, and means for selectively connecting said electrodes with said amplifier inputs comprising a set of lines of contact means connected respectively to said electrodes, and a card of insulating material cooperative with said contact means, said card having spaced stripes of conductive material thereon, said stripes having laterally extending ear portions located thereon according to a predetermined code of connections for electrically connecting said ear portions respectively with certain of said lines of contact means and said stripes being electrically connected respectively with said amplifier inputs.

11. Apparatus for selectively amplifying potentials as defined in claim 10 wherein each said line of contact means is constituted by a strip of conductive material having a plurality of longitudinally spaced tongues adapted to register with the ear portions of the conductive stripes on said card and which further includes other contact means connected respectively to said amplifier inputs and which engage said stripes.

12. Apparatus as defined in claim 10 and wherein said set of spaced lines of contact means includes other lines of contact means connected to a source of calibration voltage.

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