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PHYSIOLOGIC ELECTRODE TABLET

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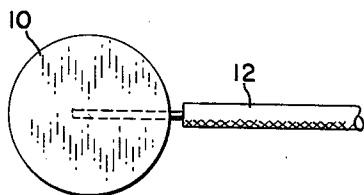
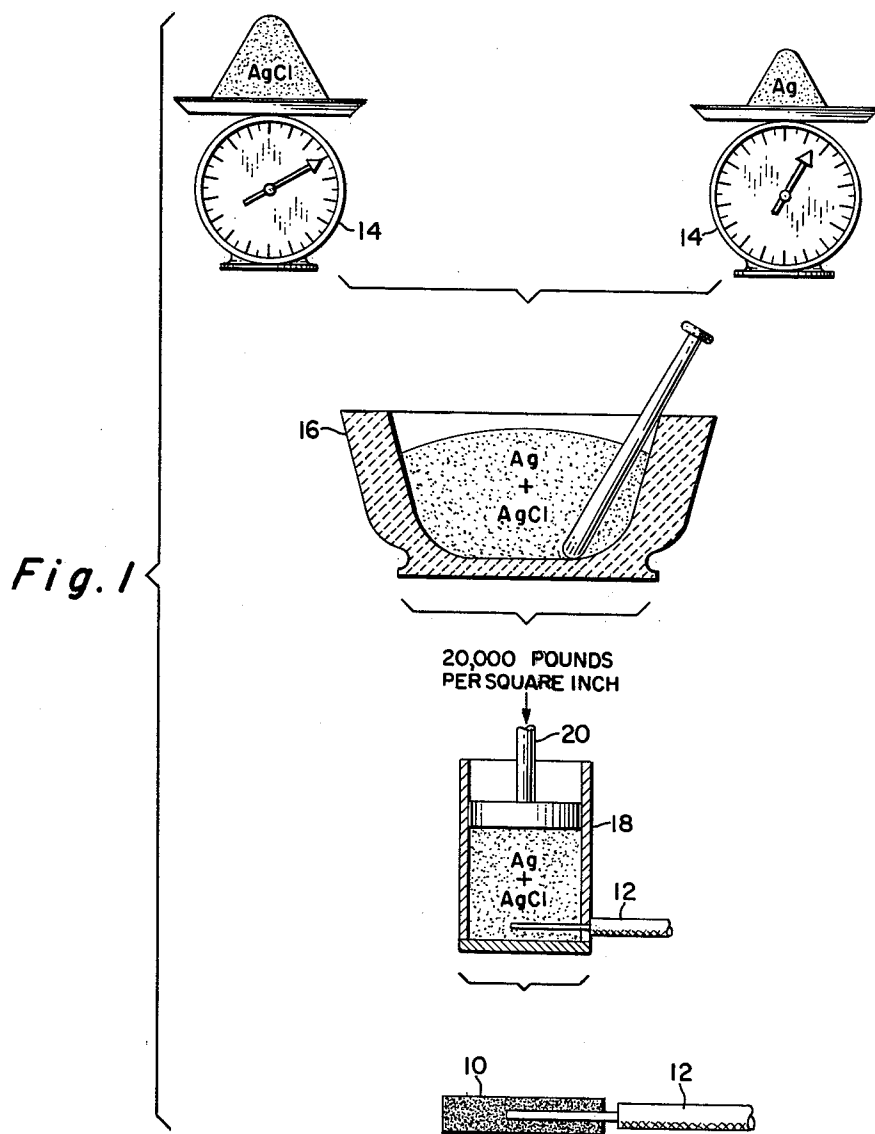


Fig. 2

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PHYSIOLOGIC ELECTRODE TABLET

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2 Claims. (Cl. 128-2.1)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The invention relates to medical instrumentation, and more particularly to the composition of an electrode tablet and the method of fabrication.

In U.S. patent application Serial No. 181,214, having a common co-inventor with the present application, there is described a unique physiologic electrode package comprising a plurality of cork discs for supporting a metallic pellet in fixed spaced relation to the skin of the wearer. A compatible electrolytic gel provides the conductive electrical bridge between the pellet and the skin. The present invention is directed to the composition and method of making the metallic pellet used in the above described electrode package, although not limited thereto.

The electrode package functions to intercept the minute bio-electric voltages at the body surfaces, and makes them available for amplification and processing into useable clinical records. Specifically, the metallic tablet, being an integral part of the electrode package allows the interception of the desired coherent A.C. voltages without the unwanted random D.C. voltages which are usually co-existent. Such D.C. potentials are generated between the inner face junctions, or couples, of the pellet/gel and gel/skin surfaces and affect the quality of the recording. These D.C. voltages are a function of the electromotive series of the metals employed, the ionic description of the gels employed plus other relatively minor factors including temperature, humidity and ionizing radiation.

Another important electrical characteristic is the skin/electrode resistance. Low values are desirable to minimize the resistance modulation of the driven amplifier in the recording system.

One of the more important physical characteristics of the metallic pellet is longevity to handling and use.

A careful laboratory evaluation of the prior art electrodes disclosed excessive contact potentials and resistances which degrade the clinical records. The use of deposited film electrode tablets were found to be deficient from the standpoint of high resistance value, as well as longevity since the coatings have a tendency to rub off with use and handling.

The disadvantages of the prior art electrodes have been avoided by fabricating an electrode from a selected ratio of Ag and AgCl by weight, which mixture is finely divided and uniformly mixed. With the lead conductor suitably positioned, the desired amount of the mixture is inserted in a stainless steel die, and by means of a hydraulic press a pressure in the order of 20,000 lbs./sq. inch is applied to the mixture for approximately a minute. The high pressure achieves an intimate bonding between the two ingredients without the need for a binder.

An electrode made by this process achieves the desired characteristics namely low resistance, low contact potential and good longevity.

An important object of this invention is to provide a physiologic electrode tablet that will enable improved recordings of bio-electric voltages.

Another object is to provide such a tablet that will intercept coherent A.C. voltages without the unwanted random D.C. voltages.

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Still other objects are to provide an electrode which is more rugged in construction; has a longer life; and is relatively inexpensive in cost.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a schematic representation of the steps in the method of manufacturing the novel electrode tablet; and FIG. 2 is a plan view of the electrode tablet.

Referring to the drawing where like reference numerals refer to similar parts there is shown in the lower end of FIG. 1 a physiologic electrode tablet 10 having imbedded therein a conductor 12 and manufactured in the following manner. Tablet 10 comprises a mixture of silver (Ag) and silver chloride (AgCl).

It has been found that the following specification for the mixture with regard to the impurities in the two ingredients has given good results:

Ag=impurities not more than:	Percent
Cu -----	.001
Iron and foreign heavy metals-----	.002
Chloride -----	.005
AgCl=impurities not more than:	
Cu -----	.001
Iron -----	.001
Heavy metal-----	.005
Nitrate -----	.001

Conductor 12 can be a fine grade wire Ag #20 AWG or tinned Cu #20 AWG. In carrying out the method the following steps are taken:

(1) Weigh out the selected ratio of Ag and AgCl by scales 14.

For purposes of this example, a ratio of 30% finely ground Ag and 70% finely ground AgCl is used.

The effects of other ratios of Ag and AgCl will be hereinafter discussed with reference Table No. 1.

(2) Pulverize AgCl to as fine a powder as possible in a porcelain mortar 16.

(3) Add Ag to AgCl and mix thoroughly approximately for 5 minutes or until mixture appears to have uniformity. It should be noted that to avoid discoloration of the pellet, it is advisable to conduct all weighing in darkness or artificial light, and to keep the mixture covered whenever possible.

(4) Place bared end of conductor 12 in die 18.

(5) Insert the necessary amount of mixture in die 18, which is made of stainless steel. For a pellet of 9 mm. in diameter and 2 mm. in thickness approximately 1.2 grams of the mixture is used.

(6) Place die 18 in a hydraulic press 20 and apply a pressure in the order of 20,000 lbs./sq. inch.

(7) Hold pressure in die for a duration of 30 to 60 seconds.

(8) Remove electrode pellet from die and trim away any excess material.

(9) Remove all traces of the mixture from the die since it is very corrosive to metal.

The precise phenomena which occurs between the fine divided Ag and AgCl ingredients when subjected to the high pressure in the order of 20,000 lbs./sq. inch or greater is not fully understood. It is believed that the two ingredients ionically act as a liquid under the high pressure to achieve an intimacy not otherwise obtainable. It is well known that Ag is a very good conductor, and that AgCl is a very poor conductor. However, the combination when subjected to such high pressure causes the combination to give desired results, namely, low D.C. lead potentials and high conductance.

As noted therefor, some fifteen different ratios of Ag to

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AgCl were examined to determine their pertinent electrical characteristics of resistance and potential. The test was conducted in a manner which eliminated skin resistance and the skin/gel couple. The results appear in the following Table No. 1:

Table No. 1.—Electrical Characteristics of Electrodes Varying in Ratio of Ag to AgCl

Ag/AgCl by Weight	Resistance in ohms, K	E.M.F. in Millivolts
100/0.....	60	120
99/1.....	45	2
95/5.....	40	2
90/10.....	30	1
80/20.....	30	1
70/30.....	20	1
60/40.....	20	1
50/50.....	20	1
40/60.....	20	1
30/70.....	20	1
20/80.....	40	1
10/90.....	40	0
5/95.....	70	0
1/99.....	180	0
0/100.....	600	0

As will be observed from Chart No. 1, the 100% Ag generated an unacceptable contact potential, whereas the high ratios of AgCl to Ag resulted in prohibitively high resistances. Between these limits, excluding about six combinations which are marginal, five ratios appear identical. The mechanical strength of these five tablets with the identical electrical characteristics, as well as longevity characteristics, were so similar, that the only consideration that remained was a matter of cost. The 30/70 tablet

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contains less than one-half the amount of silver of the 70/30 tablet and thus the 30/70 tablet is the obvious choice.

The instant invention provides a novel composition and method of manufacturing an electrode tablet that is particularly suitable for electroencephalograph and electrocardiograph devices both from an electrical and physical consideration, as well as cost and comfort to the user.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

We claim:

1. A physiological electrode tablet for electrical contact with a person's skin through an electrolytic gel for recording the ionic energy in the body with a minimum of contact potential, which electrode contains an intimately bonded homogeneous mixture of only finely divided Ag and AgCl selected from a range of the ratios between 30% Ag to 70 AgCl and 70% Ag to 30 AgCl.

2. The tablet of claim 1 wherein a silver wire conductor is integrally embedded therein.

References Cited in the file of this patent

UNITED STATES PATENTS

2,654,795	Brill et al.	Oct. 6, 1953
2,654,945	Richardson et al.	Oct. 13, 1953
2,729,559	Matsukawa	Jan. 3, 1956
2,895,479	Lloyd	July 21, 1959