

[54] **PORTABLE SELF-CONTAINED
ELECTRICAL CARDIOMETRIC DEVICE
WITH THREE FIXED-POSITION
NONUNIFORMLY SPACED INPUT PROBES**

[76] Inventor: **Herbert J. Semler**, 2330 N.W.
Flanders, Portland, Oreg. 97210

[22] Filed: **Sept. 20, 1971**

[21] Appl. No.: **181,862**

Related U.S. Application Data

[63] Continuation of Ser. No. 36,065, May 11, 1970,
abandoned.

[52] U.S. Cl. **128/2.06 R**, 128/2.06 E, 128/417,
128/DIG. 4

[51] Int. Cl. **A61b 5/04**

[58] Field of Search 128/2.05 R, 2.05 T,
128/2.06 A, 2.06 B, 2.06 E, 2.06 F, 2.06 R,
2.1 E, 2.1 R, 417, DIG. 4

[56] **References Cited**

UNITED STATES PATENTS

3,476,104 11/1969 Davis 128/2.06 E
2,660,165 11/1953 Miller 128/2.06 B
2,555,037 5/1951 Jensen 128/417

3,326,207 6/1967 Egan 128/2.06 E
3,380,445 4/1968 Frasier 128/2.06 E
3,547,107 12/1970 Chapman et al. 128/2.06 A

FOREIGN PATENTS OR APPLICATIONS

250,557 11/1966 Austria 128/2.06 R

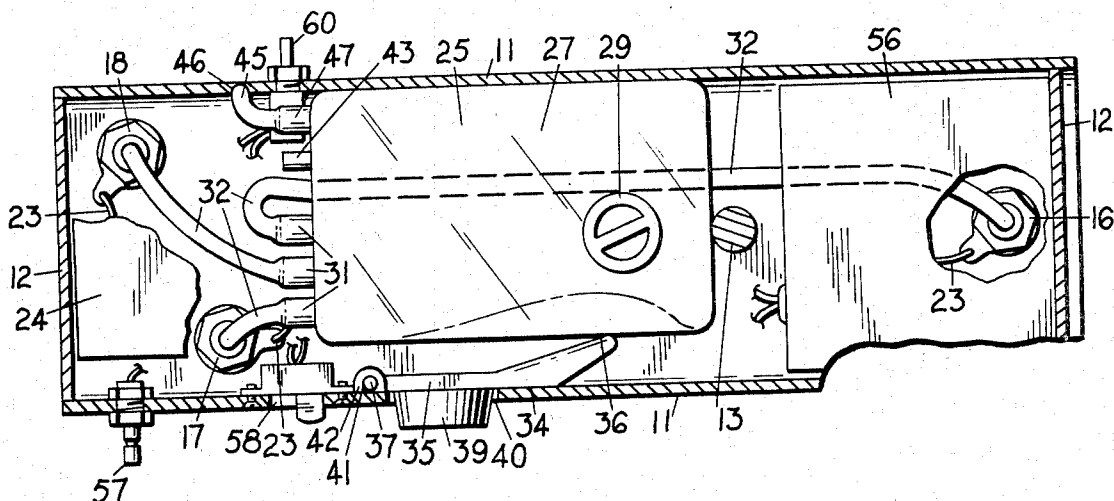
Primary Examiner—William E. Kamm

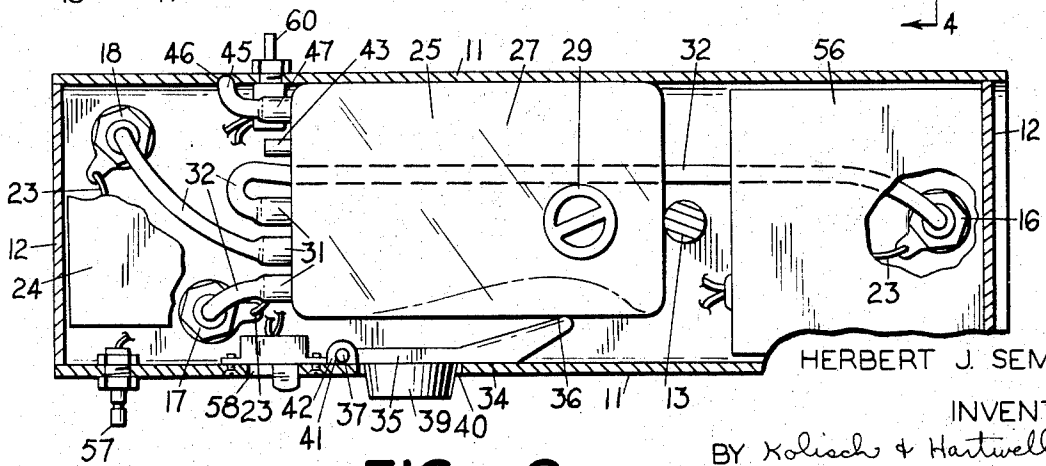
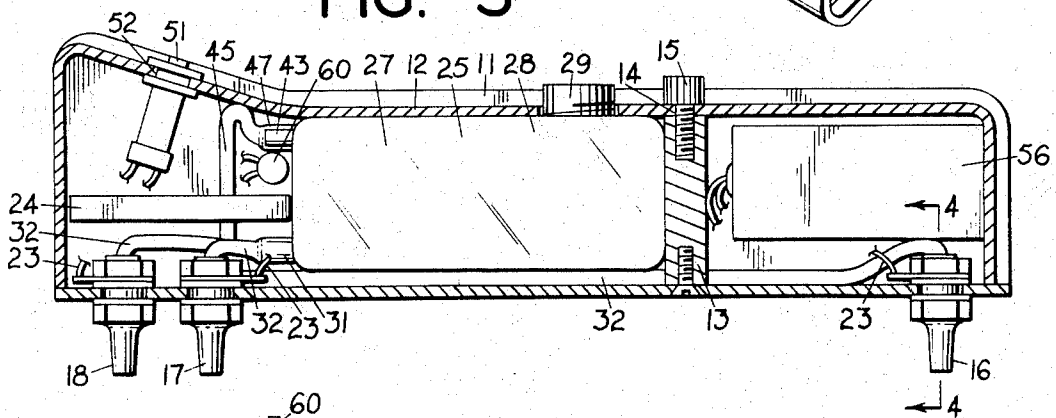
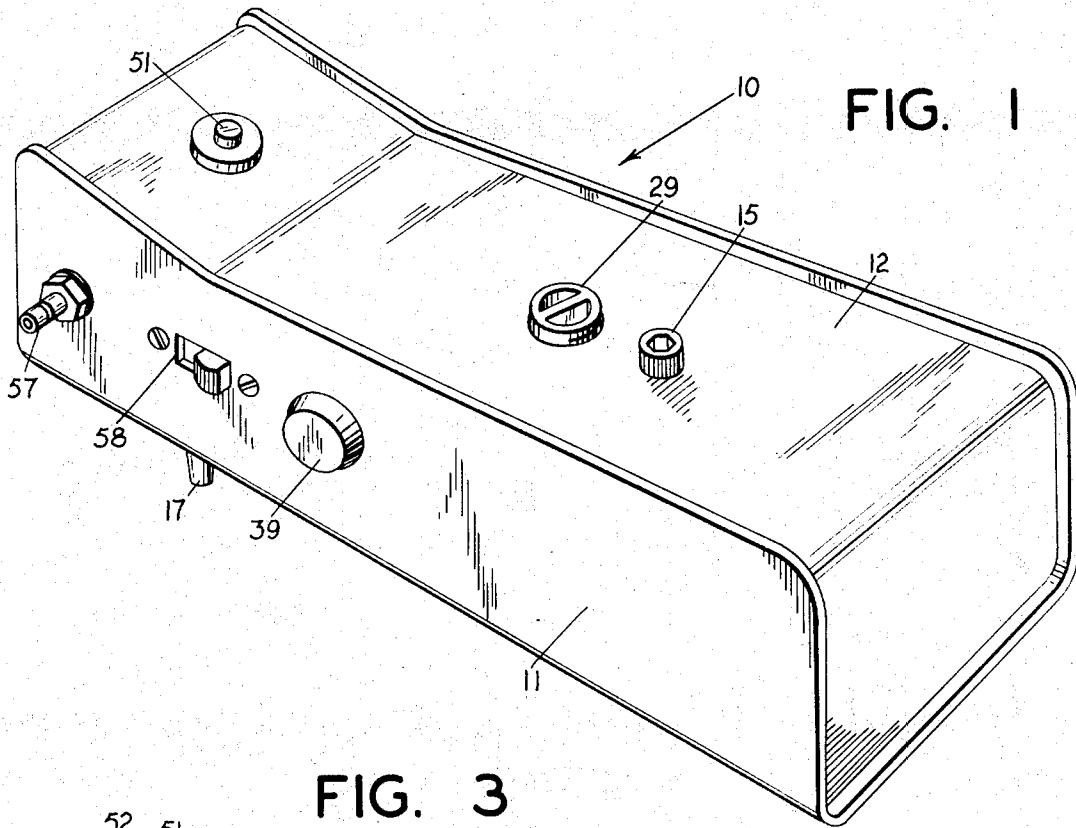
Attorney—Kolisch, Hartwell & Dickinson

[57] **ABSTRACT**

A portable self-contained electrical cardiometric device employable for the quick monitoring and indicating of a heart-produced electrical signal in a person's body. The device includes three specially positioned electrical probes which are for electrically contacting a person's body to detect such a signal, a battery-powered electronic amplifier connected to these probes for amplifying a detected signal, and a suitable display or indicating unit for following the instantaneous amplitude of an amplified signal. The probes include fluid passages that communicate with a pump and a fluid reservoir in the device from which a conductive fluid may be ejected to enhance the electrical contact between the probes and a person's skin.

5 Claims, 8 Drawing Figures





HERBERT J. SEMLER

INVENTOR

BY Kolisch & Hartwell

ATTY.

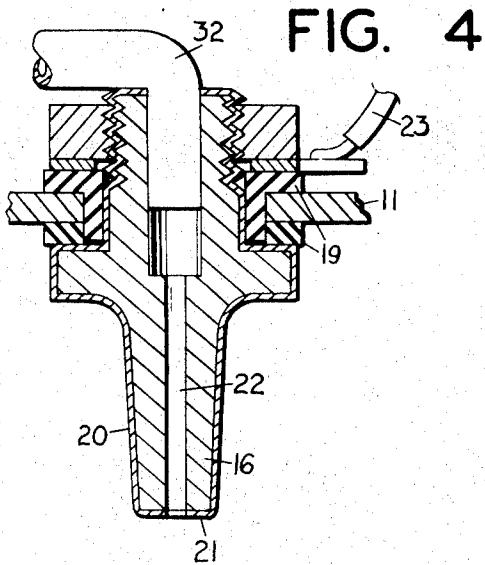


FIG. 4

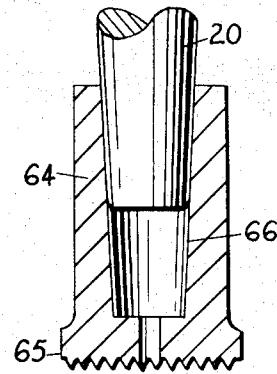


FIG. 5

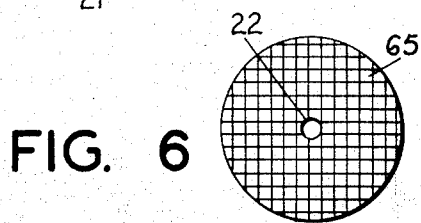


FIG. 6

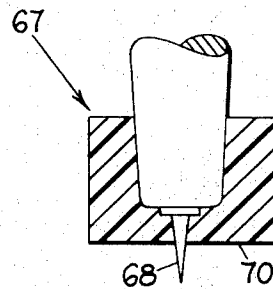


FIG. 7

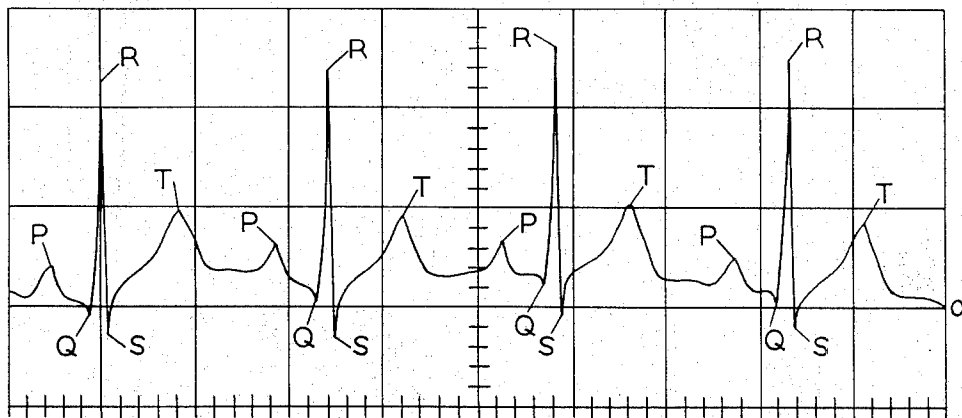


FIG. 8

HERBERT J. SEMLER

INVENTOR

BY Kolisch & Hartwell

ATTY.

PORTABLE SELF-CONTAINED ELECTRICAL CARDIOMETRIC DEVICE WITH THREE FIXED-POSITION NONUNIFORMLY SPACED INPUT PROBES

CROSS REFERENCE TO RELATED PRIOR-FILED APPLICATION

This is a continuation of my now abandoned prior-filed copending application, Ser. No. 36,065, filed May 11, 1970, entitled "Portable Cardiac Monitor."

BACKGROUND AND SUMMARY OF THE INVENTION

This invention pertains to a portable self-contained electrical cardiometric device. More particularly, it pertains to such a device which features three specially fixed-position electrical input probes that are for contacting a person's body in a manner ensuring extremely accurate detection of electrical signals produced therein by the heart.

There is an urgent need for a portable device of the type just generally indicated. Emergency situations arise constantly where it is desired, and necessary, to obtain immediate, on-the-spot, accurate information regarding a person's heart activity if prompt and proper treatment is to be given. Often, quickly obtained information of this type is what makes the difference between saving and losing a life.

Obviously, conventional, cumbersome cardiac monitoring equipment, which is relatively nonportable, and which may require considerable warmup and setup time, does not meet this need.

A general object of the present invention, therefore, is to provide a novel, portable self-contained electrical cardiometric device which takes care of the need expressed above in a practical and satisfactory manner.

Another object of the invention is to provide such a device which can easily be carried in a person's pocket or in a small travel case, readily held and operated by one hand, and which permits a substantially immediate reading, or monitoring, of a person's heart activity.

More specifically, an object of the invention is to provide such a device which reliably monitors an electrical signal produced by heart activity in a person's body, and which affords an accurate, and easily readable and interpretable, indication of such a signal.

A further object of the present invention is to provide a device of the type so far generally described which features three novel fixed-position, nonuniformly spaced input probes that are specially oriented in the device to promote accurate detection of electrical signals of the kind mentioned above.

According to a preferred embodiment of the invention, the proposed cardiometric device comprises a small elongated housing containing an electronic amplifier, and a battery power source therefor. The housing is easily held in one hand. Connected to the amplifier are three fixed-position input probes, oriented as contemplated by the invention, and a suitable indicating device, such as a lamp, or a meter. The three input probes are arranged with two of them, which are designated herein as positive and negative probes, no less than seven centimeters apart, and with the third probe, which is designated a ground probe, disposed closer to the negative probe than to the positive probe. Preferably, the ground probe is offset from a straight line extending between the positive and negative probes.

DESCRIPTION OF THE DRAWINGS

These and other objects and advantages attained by the invention will become more fully apparent as the description which follows is read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a full scale top perspective view of a device constructed according to the present invention;

FIG. 2, on essentially the same scale as FIG. 1, is a top plan view, partially in section, of the device of FIG. 1, with a portion of a housing in the device removed;

FIG. 3, on essentially the same scale as FIGS. 1 and 2, is a sectional side elevation of the device of FIG. 1;

FIG. 4 is an enlarged vertical section of a probe employed in the device of FIGS. 1, 2 and 3;

FIG. 5 is an enlarged vertical section illustrating one type of a removable foot which may be attached to a probe in the device;

FIG. 6 is a bottom view of the foot of FIG. 5;

FIG. 7 is an enlarged vertical section view illustrating another type of removable foot which may be attached to a probe; and

FIG. 8 is a time-base graph illustrating a typical "PQRST" voltage display of a normally healthy person's heart activity.

DETAILED DESCRIPTION OF THE INVENTION

Turning now to the drawings, and referring first to FIGS. 1-3, indicated generally at 10 in FIG. 1 is a cardiometric device constructed according to the present invention. Device 10 includes an elongated two-part case, including a base 11 and a cover 12. The base has a somewhat U-shaped transverse cross section, and when fitted together with cover 12 (as shown in FIG. 1), forms a completely enclosed protective housing for various other parts in the device. Such a housing is relatively easy and inexpensive to fabricate. Preferably, its parts are made of a relatively lightweight metal, such as aluminum.

Although it is appreciated that the precise outside dimensions of the housing in device 10 may be made to suit different particular applications, the housing shown herein preferably has a length of about 6 to 7 inches, a width of about 2 to 2½ inches, and a depth of about 1½ inches. It will be apparent that with dimensions such as these, the device may easily be held in one hand, and can readily be carried in a person's pocket or in various forms of small travel cases, such as a briefcase.

In the embodiment of the invention being described, the cover and base of the housing are releasably secured together by screws, such as exposed thumb screw 15, which are screwed into posts, such as post 13 (see FIGS. 2 and 3). With such an arrangement, components inside the housing (still to be described) are readily accessible for service and other purposes.

Suitably mounted on the underside of base 11 and protruding outwardly from the base, are three signal input probes constructed and arranged as contemplated herein. These three probes are designated by reference numerals 16, 17, 18. For reasons which will be more fully explained herein, probe 16 constitutes a positive probe, probe 17 constitutes a ground probe, and probe 18 constitutes a negative probe. As will also be more fully explained later on, these three probes are employed to make electrical contact with a person's skin, for the purpose of picking up the usual electrical

signal produced in the person's body by heart activity.

The relative positioning and spacing of the probes has been found to constitute an important and critical factor in the device's ability to provide accurate and easily interpretable information regarding heart activity. More specifically, it has been discovered that for the highest possible accuracy, the negative and positive probes should be spaced apart no less than seven centimeters, with the ground probe positioned more closely to the negative probe than to the positive probe. Probe positionings and spacings differing from these criteria have been found to produce inaccurate and poorly interpretable information. Particularly satisfactory performance has been found to result with the probes spaced apart and oriented essentially as indicated in FIG. 2, which (as indicated above) is approximately a full scale view of a device 10. In this specific probe arrangement, it will be noted that ground probe 17 is offset from a straight line extending between probes 16, 18. Further, it will be observed that the distance between probes 16, 17 is somewhat less than the distance between probes 16, 18.

Preferably, probes 16, 17, 18 are fabricated of, or plated with, a suitable highly electrically conductive material, such as silver or nickel. The probes have essentially the same constructions — their lower end portions being tapered as indicated. As can be seen clearly in FIG. 4, which illustrates positive probe 16, the probes include axially disposed central, double-open-ended bores 22, the purpose for which will be explained shortly. In their respective mountings on base 11, the probes are insulated from electrical contact with the base by means of insulators 19 (see FIG. 4).

Referring for a moment to FIGS. 5 and 6, illustrated therein is what might be thought of as a detachable contact foot 64 which is shown detachably mounted on probe 16. Similar feet may be provided for and mounted on probes 17, 18. A foot 64 has the axial cross-sectional configuration clearly illustrated in FIG. 5, and includes a knurled bottom surface 65, and a central, axial, tapered bore 66 which joins axially with a considerably smaller bore 69 that opens to the base of the foot. Each foot 64 is adapted to be easily twisted onto and off of a probe, with the tapered outside surface of the probe fitting snugly against the tapered inside wall of the bore 66 inside the foot. Preferably, feet 64 are constructed from the same type material used in the probes.

Feet 64 may be used advantageously in various circumstances where it is desired to maximize the contact area with a person's skin. It will be apparent that the knurled bottom surfaces of these feet facilitate relatively large-area contact with skin.

Considering FIG. 7, this illustrates at 67 another type of foot which may be fitted (in a manner similar to that described for feet 64) onto a probe. A foot 67 includes a substantially flat bottom face 70 from which projects a short central needle 68. This kind of a foot may be used on the probes under circumstances where it is desired to make electrical contact with a person through puncturing of his skin.

It will be noted that the two different types of feet which have just been described, do not appreciably change the relative positions and spacings of the points at which electrical contact is made with a person's skin. This is an important feature.

Considering now other components employed in device 10, and referring again particularly to FIGS. 1-3, suitably mounted inside the housing are a fluid supply system 25, and an electronic amplifier, or electrical circuit means, 24. The fluid supply system is adapted to be used in conjunction with the central axial bores mentioned previously in the probes, for the purpose of ejecting through these bores, and onto a person's skin, a suitable conductive fluid, such as alcohol or water, to enhance the electrical contact between the probes and the skin. Accordingly, the fluid supply system includes a reservoir 27, a digitally operable pump 34, and three flexible tubes 32 which connect outlets 31 in the reservoir with the interiors of the bores in the probes. Access for filling and draining the reservoir is had through an inlet 29 which is exposed through housing cover 12.

Reservoir 27 preferably is made of a relatively thin flexible material, such as a pliable plastic material. Pump 34, which is used to eject fluid from the reservoir, comprises an elongated arm 35 which is pivoted at 37 on housing base 11. An end portion 36 of the arm contacts a side of the reservoir (as can be seen clearly in FIG. 2), and the arm carries a push button 39 which extends freely through a bore 40 in base 11, outwardly of the housing.

With fluid stored in the reservoir, digital pressure by an operator upon button 39 forces end portion 36 of the arm against the reservoir, distorting the same and causing the ejection of fluid through the outlets, tubes, and probes. A conventional air inlet valve 43 admits air to the reservoir to replace ejected fluid.

The ejecting of fluid through the probes to improve electrical contact with a person's body is especially useful where it is desired to establish such contact without removing clothing. In other words, by ejecting fluid, the fluid wets the clothing and reaches the skin to establish adequate electrical contact between the skin and the probes.

Amplifier 24 is a conventional three-input, high-gain, high-frequency-AC-isolation-type amplifier capable of responding to relatively low frequency electrical signals, such as those produced by the heart. The amplifier includes the usual positive, negative and ground input terminals (hidden from view in the drawings), and is adapted to detect a differential voltage between its positive and negative terminals. Probes 16, 18, 17 are suitably conductively connected to the amplifier's positive, negative and ground terminals, respectively—thus accounting for the reference made earlier to these probes as positive, negative and ground probes, respectively. Power for energizing the amplifier is supplied by a battery 56 which is contained within the housing. A switch 58 mounted on base 11, and interposed electrically between the amplifier and battery, is provided for turning the amplifier on and off.

Details of the amplifier form no part of the present invention, and thus are not illustrated. Preferably, however, the amplifier is constructed using modern semiconductor devices, thus enabling it to be relatively compact, whereby it can easily fit into a housing having dimensions like those described above, and permitting it to operate at relatively low power levels. In addition, there is preferably provided in the amplifier, interconnecting the three input terminals, a conventional diode protective circuit which protects the amplifier per se from any excess input voltages (such as might occur during defibrillation of a patient), and which, more im-

portantly, protects a patient against any possible internal malfunction of the amplifier that might accidentally place a harmful voltage between any two of its input terminals.

An output signal from the amplifier takes the form of an intensity-varying signal which follows intensity variations in the differential voltage appearing between its positive and negative input terminals. In device 10, such an output signal is supplied both to an indicating lamp 51, which is mounted on cover 12, and also to a conventional output jack 57 mounted on base 11.

Referring now to FIG. 8, the manner in which device 10 may be used to monitor a person's heart activity is explained. FIG. 8 is a time-base graph illustrating typical "PQRST" voltage excursions which occur in a normally healthy person's body due to heart activity. In this type of display, various points in a single cycle reflecting heart activity are designated by the letters P, Q, R, S and T. Medical practitioners skilled in the art are fully familiar with such a graph.

With device 10 turned on, and with electrical contact established between probes 16, 17, 18 and a person's skin (typically on the person's chest), the electrical voltage signal in the person's body is picked up by the probes, fed to amplifier 24, amplified therein, and then supplied to lamp 51 and jack 57. Under such circumstances, the intensity of light coming from lamp 51 follows intensity changes in the output signal from the amplifier. Through experience in using the device, one can readily detect in the flickering of the lamp all of the significant points—P, Q, R, S and T—in a cycle of heart activity. As a consequence, and with such experience, a skilled medical practitioner can easily determine the then condition of the person's heart.

With a device such as device 10 available, it will be obvious that an immediate on-the-spot emergency diagnosis of a person's heart condition can be made. If desired, lamp 51 may be replaced by a suitable meter whose needle tracks or follows the output signal of the amplifier. Further, and under circumstances permitting such operation, output jack 57 may be employed to supply a signal to any desired external indicating device, such as a strip-chart recorder.

The novel positioning and spacing of the fixed probes employed in the device facilitate the obtaining of accurate information regarding heart activity. This is especially important in making the device practical for use in emergency-type situations, where time must not be wasted in setting up to take measurements. Under different kinds of circumstances, and as dictated by user experience, the different kinds of probe-mounted feet described above may be used, and/or the fluid system may be employed, to enhance electrical contact with a person's body.

It is thus apparent that the proposed device adequately fills the need expressed earlier herein. And, while a preferred embodiment of the invention has been described, and certain modifications suggested, it is appreciated that other variations and modifications may be made without departing from the spirit of the invention.

It is claimed and desired to secure by Letters Patent:

1. In a self-contained portable electrical cardiometric device including a housing, electrical circuit means therein for processing heart-produced electrical signals

including positive, negative and ground input terminals for said signals, a power source for said circuit means, and indicator means coupled to said circuit means for indicating heart activity,

means for electrically contacting a person's body and picking up heart-produced electrical signals therein, said means consisting of three electrically conductive probes, including a positive, a negative and a ground probe each connected to a corresponding one of said input terminals, mounted in spaced-apart fixed triangularly disposed positions on said housing,

said positive and negative probes being spaced apart by a distance of at least seven centimeters, and said ground probe being disposed closer to the negative probe than to the positive probe.

2. In a self-contained portable electrical cardiometric device including a housing, electrical circuit means therein for processing heart-produced electrical signals, a power source for said circuit means, and indicator means coupled to said circuit means for indicating heart activity,

means connected to said circuit means for electrically contacting a person's body and picking up heart-produced electrical signals therein, said means comprising three electrically conductive probes mounted in spaced-apart fixed triangularly disposed positions on said housing,

two of said probes being spaced apart by a distance of at least seven centimeters, and the third probe being disposed closer to one of said two probes than to the other probe, with the distance between said third and one probes being less than 7 centimeters.

3. The device of claim 2, wherein said electrical circuit means includes positive, negative and ground input terminals, said one probe is connected to said negative terminal, said other probe is connected to said positive terminal, and said third probe is connected to said ground terminal.

4. In a self-contained portable electrical cardiometric device including a housing, electrical circuit means therein for processing heart-produced electrical signals, a power source for said circuit means, and indicator means coupled to said circuit means for indicating heart activity,

means connected to said circuit means for electrically contacting a person's body and picking up heart-produced electrical signals therein, said means consisting of three electrically conductive probes mounted in spaced-apart fixed triangularly disposed positions on said housing,

two of said probes being spaced apart by a distance of at least 7 centimeters, and the third probe being disposed closer to one of said two probes than to the other probe, with the distance between said third and other probes being less than the distance between said one and said other probes.

5. The device of claim 4, wherein said electrical circuit means includes positive, negative and ground input terminals, said one probe is connected to said negative terminal, said other probe is connected to said positive terminal, and said third probe is connected to said ground terminal.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,776,228 Dated December 4, 1973

Inventor(s) Herbert J. Semler

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 22, Claim 2, change

"heat activity" to --heart activity--.

Signed and sealed this 16th day of April 1974.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents