United States Patent [19]

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[11] **3,812,845**

[45] **May 28, 1974**

[54] **PATIENT CORD ASSEMBLY**

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[22] Filed: **May 19, 1972**

[21] Appl. No.: **255,006**

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

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

[58] **Field of Search** ..... 128/2.06 B, 2.06 E, 2.06 G, 128/2.06 R, 404, 418, DIG. 4

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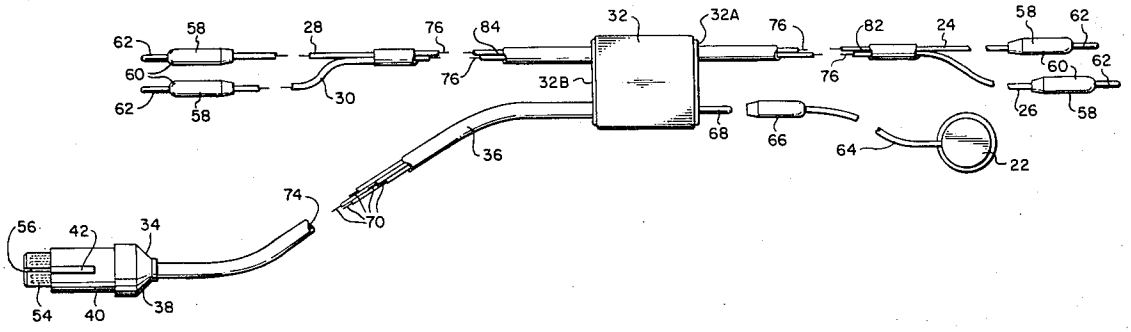
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[57] **ABSTRACT**

A patient cord assembly for connecting an electrocardiograph to arm, leg and chest electrodes includes a junction block from which electrode leads extend in such a way that the leads are easily and naturally arranged relative to the patient in the optimum configuration to reduce electromagnetically coupled interference.

18 Claims, 4 Drawing Figures



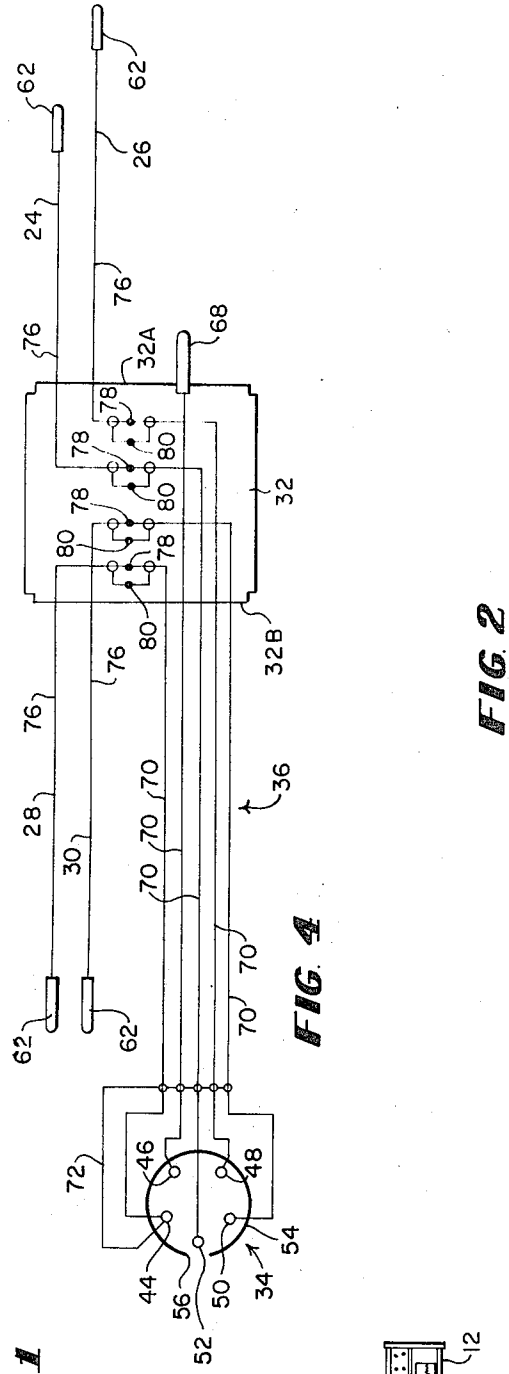


FIG. 4

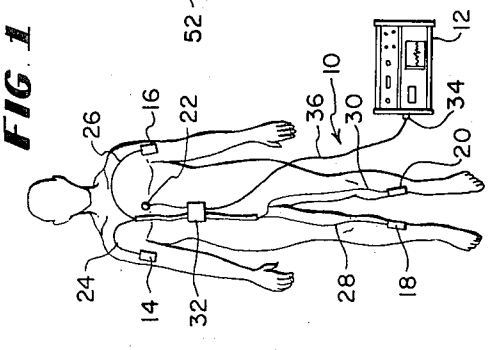


FIG. 1

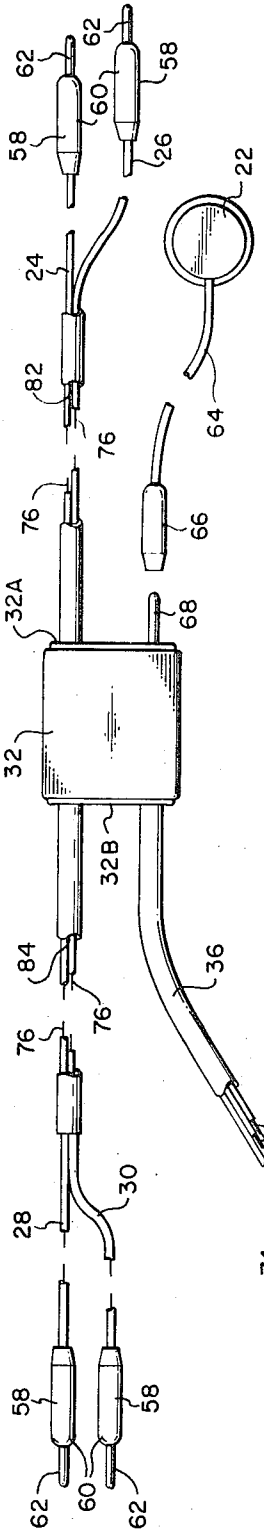


FIG. 2

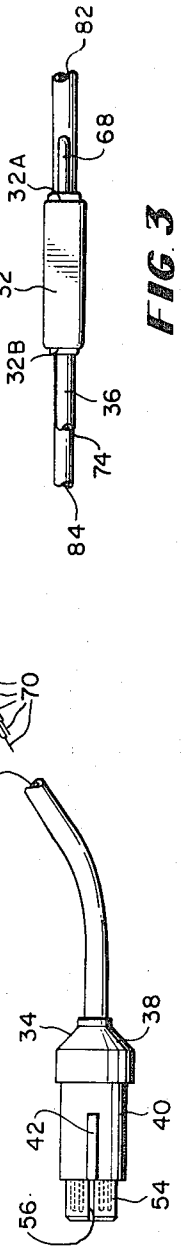


FIG. 3

PATIENT CORD ASSEMBLY

The present invention relates to an improved patient cord assembly for interconnecting an electrocardiograph and a group of electrodes located on the arms, legs and chest of a patient's body.

An electrocardiograph typically includes five inputs for receiving cardiac induced small magnitude electrical signals from electrodes disposed on the skin of a patient's arms, legs and chest. In order to interconnect the machine with the five electrodes, a patient cord assembly is used. Known cord assemblies include a patient jack plugged to the electrocardiograph machine, and a cable including five conductors extending from the jack to a junction block. The cable enters the block at one end, and five separate patient leads emerge from the other end. The leads include plug connectors for connection to the patient electrodes.

Since cardiac signals are of a low level of magnitude in the neighborhood of 1,000 microvolts or so, interference is a serious problem. The steadily improving sensitivity of modern electrocardiograph amplifiers and recorders has made the problem even more acute. One type of interference is that caused by electromagntic fields induced in the region of the patient by current flow in power conductors located in the vicinity. With the increasing use in hospitals, clinics and offices of high power consumption equipment, it is not unusual for interference caused by such fields to attain a level in the neighborhood of 100 microvolts or so. Modern equipment can exhibit a flat frequency response up to 120 hertz, so that interference at 60 hertz and at low multiple harmonic frequencies is extremely troublesome.

Electromagnetic interference is picked up by closed loops formed by the patient electrode leads of the cord assembly and by the limbs and torso of the patient's body. An operator of the electrocardiograph who is skilled and familiar with he problem attempts to reduce such interference by reducing the area of all such loops. This is done by arranging or "dressing" each electrode lead so that it runs along the contour of the body close to the torso and the limb with which it is associated. Unfortunately, many operators of such equipment do not have the requisite skill and knowledge to reduce electromagnetic interference. Moreover, the design of known patient cord assemblies is such that the electrode leads are not readily or naturally disposed in the proper locations.

Important objects of the present invention are to provide an improved patient cord assembly designed to reduce electromagnetic interference and to provide an assembly wherein the patient leads naturally extend in the proper directions and have the proper lengths so that the leads are easily arranged by even unskilled operators.

The above and other objects and advantages of the invention are realized through the provision of an improved patient cord assembly. The assembly includes a patient jack adapted to be connected to an electrocardiograph, together with a unitary, molded junction block of insulating material connected to the patient jack by a patient cable including five conductors within a common jacket. The patient cable extends from a lower end of the junction block, and a connector located at the upper end of the block provides a connection to the chest electrode. A pair of arm electrode

leads also extend from the upper end of the block and include plugs engageable with the arm electrodes. A common jacket encloses the arm electrode leads for a portion of their length so that they naturally assume the proper orientation with regard to the patient's body. A pair of leg electrode leads extend from the lower end of the junction block, and a common jacket encloses these leads for a portion of their length as well so that they naturally assume the proper position. Since the various leads extend from the junction block in the desired directions, the length of each lead can be reduced to a minimum. In use, when the block is located adjacent the patient's torso, each lead naturally and properly falls into the desired arrangement to interconnect the junction block with the corresponding patient electrode, and closed loops comprised of leads and portions of the patient's body are of minimum area.

The invention may best be understood with reference to the embodiment illustrated in the accompanying drawings, wherein:

FIG. 1 is a diagrammatic view illustrtating a patient cord assembly embodying the principles of the present invention used with a patient and with an electrocardiograph;

FIG. 2 is an enlarged, partly broken away, top view of the patient cord assembly of FIG. 1;

FIG. 3 is a side elevational view of a part of the structure shown in FIG. 2; and

FIG. 4 is a schematic diagram of the patient cord assembly.

Having reference now to the drawing, there is illustrated a patient cord assembly constructed in accordance with the present invention and designated as a whole by the reference numeral **10.** As appears in FIG. **1,** the patient cord assembly **10** serves to interconnect an electrocardiograph machine **12** with a conventional array of arm, leg and chest electrodes **14, 16, 18, 20** and **22** located on the surface of the skin of a reclining patient.

In accordance with the present invention, the patient cord assembly **10** is designed greatly to reduce the problem of electromagnetically coupled interference. In general the assembly **10** includes a pair of arm electrode leads **24** and **26** and a pair of leg electrode leads **28** and **30** all extending from a junction block **32.** Junction block **32** also includes structure described below for connection to the chest electrode **22.** A patient jack **34** adapted to be connected to the electrocardiograph machine **12** is interconnected with the junction block **32** by means of a patient cable **36.** Importantly, each patient lead extends from the junction block **32** in such a direction that the leads are easily and naturally arranged in an optimum position for reducing the area of loops formed by the lead and portions of the patient's body.

In FIGS. **2, 3** and **4** the structure of the patient cord assembly **10** appears in more detail. The assembly **10** is removably interconnected with the electrocardiograph machine **12** by means of the patient jack **34.** The illustrated jack **34** includes a molded insulating housing **38** having a tubular insertion portion **40** provided with an indexing rib **42.** Five terminal pins **44, 46, 48 50** and **52** (FIG. **3**) extend from the housing **38** and are surrounded by a protective collar **54** having an indexing slot **56.** Pins **44, 46, 48, 50** and **52** are arranged in a conventional pattern and are adapted to be received in five cooperating socket input terminals of the electro-

cardiograph when the jack 34 is plugged into a cooperating socket on the machine 12.

Each of the arm and leg electrode leads 24, 26, 28 and 30 is adapted to be removably interconnected with its corresponding patient electrode. Consequently, electrodes can be positioned and secured upon the patient's limbs prior to connection of the cord assembly 10 so that there is no interference with or hinderance by the electrode leads. In the illustrated arrangement, the end of each electrode lead is provided with an electrode plug 58 including an insulating housing 60 and a protruding pin terminal 62. Each electrode is provided with a cooperating socket terminal for receiving a pin terminal 62.

As indicated above, the junction block 32 includes structure for establishing a connection to the chest electrode. In the arrangement illustrated in the drawing, the chest electrode 22 is provided with an electrode lead 64 having a socket connector 66, and the junction block 32 includes a protruding pin terminal 68 to which the socket connector 66 may be connected. This arrangement permits the cord assembly 10 to be used with various types of chest electrodes, heat catheters, and the like. However, it should be understood that if desired the terminal 68 could be replaced with an electrode lead having an electrode plug 58.

With reference to the schematic diagram of FIG. 4, it can be seen that each of the terminals of the patient jack 34 is connected to one of the pin terminals 62 or 68 by the patient cable 36 and, except for the pin terminal 68, by one of the electrode leads 24, 26, 28 and 30. Specifically, the terminal 44 is connected by leads 28 to the right leg electrode plug 58; the terminal 46 is connected to the chest terminal 68; the terminal 48 is connected by the lead 26 to the left arm electrode plug 58; the terminal 50 is connected by the lead 30 to the left leg electrode plug 58; and the terminal 52 is connected by the lead 24 to the right arm electrode plug 58.

Cable 36 may be of conventional construction, and includes five similar electrical conductors 70. Each is separately insulated and is individually shielded by a conductive shielding layer. As indicated in FIG. 4, each shielding layer is connected by a connection illustrated as conductor 72 to the right leg terminal 44. This connection serves to ground the shielding of each of the conductors 70, since in conventional arrangements the right leg terminal 44 is grounded in the electrocardiograph machine 12. A common flexible insulating jacket 74 (FIGS. 2 and 3) encloses the five conductors 70 to form the single compact flexible cable 36.

Each of the electrode leads 24, 26, 28 and 30 is of similar construction and includes an electrical conductor 76 surrounded by insulation and by a continuous layer of conductive shielding material. All of the leads 24, 26, 28 and 30 extend into the junction block 32, as does the patient cable 36.

Junction block 32 preferably comprises a compact molded body of a suitable plastic, or other insulating material. Within the body of block 32, soldered or other connections indicated by the numeral 78 are made between four of the conductors 70 and the corresponding conductors 76. Moreover, the shielding of the conductors 70 and 76 is continued and interconnected by connections designated as 80. The remaining conductor 70 associated with the terminal 46 of the patient jack 34 is connected directly to the pin 68 within the body of the block 32. It should be noted that if desired, the separate conductors 70 and 76 may be replaced with single continuous conductors so that the necessity of making connections such as the connections 78 and 80 is avoided.

The junction block 32 is relatively flat in side profile (FIG. 3) and lies easily and confortably upon the abdominal area of the torso of a reclining patient as shown in FIG. 1. In this orientation, the block 32 can be seen to have opposed upper and lower ends 32A and 32B. Since the machine 12 is normally disposed to the side of a patient as shown in FIG. 1, the patient cable 36 extends from the lower end 32B of the block 30.

In accordance with the present invention, the patient cord assembly 10 is designed to aid in the reduction of electromagnetic interference. In order to reduce such interference, the cross-sectional area of loops formed by the patient's body and by the various electrode leads must be reduced to a minimum. Thus, the leads should extend close to and along the body.

Importantly, the arm and leg electrode leads do not all extend from th same end of the block 32 as has been the case with patient cord assemblies of the prior art. Rather, the arm leads 24 and 26 extend from the upper end 32A of the block so that they are naturally and easily directed toward the upper part of the patient's body. Conversely, the leg leads 28 and 30 extend from the lower end 32B of the block 32 so that they are naturally and easily directed downwardly toward the region of the patient's legs. The terminal 68 is disposed at the upper end 32A of the block 32 so as to be easily accessible to the chest area of the patient.

In order further to facilitate the proper arrangement of the electrode leads, the arm leads 24 and 26 are provided with a common jacket 82 serving to hold the leads 24 and 26 together for a portion of their lengths. As a result the leads are constrained to follow the body of the patient to the shoulder region, where the leads branch apart to run along the shoulders and arms. Similarly the leg leads 28 and 30 are enclosed within a common jacket 84 to hold the leads together for a portion of their lengths. The leg leads 28 and 30 are thus constrained to follow the body of the patient to the pelvic region where they branch to run along the legs of the patient. Jackets 82 and 84 are preferably formed of a suitable flexible plastic material, and if desired, may be transparent.

The jackets 82 and 84 prevent the electrode leads from being placed improperly. Thus, the arm leads cannot be directed straight across from the patient's torso to the arms of the patient without being run up to the shoulders, and the leg leads cannot be looped away from the patient's body. Both of these errors in positioning of the leads are quite common with known patient cord assemblies and lead to problems of electromagnetic interference. Jackets 82 and 84 also prevent undesirable spacing between the arm leads 24 and 26 and between the leg leads 28 and 30. Such spacing also creates large area loops which in known patient cord assemblies tend to pick up electromagnetic interference.

Since each lead in the assembly 10 is naturally and easily directed in the proper direction, and is caused to assume the desired position relative to the patient's body, the length of each lead is minimized. Thus, both leg leads 28 and 30 are of equal length sufficient to reach the leg electrodes 18 and 20. Arm leads 24 and

26 are also trimmed to the proper length, with left arm lead 26 being slightly longer in order to accommodate an off center positioning of block 32. The lead 64 of the chest electrode 22 is of minimum length since it extends from the upwardly directed pin terminal 68. This reduction in lead length is also important in reducing loops which pick up electromagnetic interference.

Although the invention has been described with reference to details of the illustrated embodiment, such details are not intended to limit the invention which is defined in the following claims.

What is claimed and desired to be secured by letters Patent of the United States is:

1. A patient cord assembly for use with an electrocardiograph and with right arm, left arm, right leg, left leg and chest electrodes, said patient cord assembly comprising in combination:

a junction block adapted to be positioned adjacent the torso of a patient;

a first electrode lead and a second electrode lead extending in one direction from aid junction block and adapted to be connected respectively to the right arm and left arm electrodes;

a third electrode lead and a fourth electrode lead extending in generally the opposite direction from the junction block and adapted to be connected respectively to the right leg and left leg electrodes;

means on said junction block for establishing a connection with the chest electrode;

and a patient cable extending from said junction block and including five conductors connected respectively to said first, second, third and fourth electrode leads and to said connection means, said patient cable extending substantially in said opposite direction from a point on the second surface of said junction block.

2. The cord assembly of claim 1, said first and second electrodes leads extending from adjacent points on a first surface of said junction block, and said third and fourth electrode means extending from adjacent points on an opposed second surface of said junction block.

3. The cord assembly of claim 2, holding means for holding said first and second electrode leads together for a portion of their lengths and for holding said third and fourth electrode leads together for a portion of their lengths.

4. The cord assembly of claim 3, said holding means comprising jackets each enclosing a pair of said electrode leads.

5. The cord assembly of claim 4, said junction block comprising a solid body of molded insulating material.

6. The cord assembly of claim 5, a patient jack fixed to the end of said patient cable, and electrode plugs fixed to the ends of said first, second, third and fourth electrode leads.

7. The cord assembly of claim 1, said connection establishing means comprising a terminal mounted on said first surface of said junction block.

8. A patient cord assembly for interconnecting an electrocardiograph and right arm, left arm, right leg, left leg and chest patient electrodes, said cord assembly comprising:

a patient jack adapted to be plug connected to the electrocardiograph;

a junction block having a unitary body of molded insulating material and having oppositely directed upper and lower ends;

a patient cable including five conductors and a common jacket extending between said patient jack and the lower end of said block, said patient cable having a length sufficient to extend from the electrocardiograph to a location at the torso of the patient;

a connector at the upper end of said block connected to one of said patient cable conductors and adapted to be connected to the chest electrode;

a pair of arm electrode plugs adapted to be plug connected to the right and left arm electrodes, and a pair of leg electrode plugs adapted to be plug connected to the right and left electrodes;

a pair of arm electrode leads each connected to a patient cable conductor and extending from the upper end of said block to said arm electrode plugs;

a second common jacket enclosing said arm electrode leads for a portion of their lengths;

a pair of leg electrodes leads each connected to one patient cable conductor and extending from the lower end of said block to said leg electrode plugs; and

a third common jacket enclosing said leg electrode leads for a portion of their lengths.

9. A device for transmitting electrical signals from a plurality of electrodes monitoring a patent's condition to an electrocardiograph comprising

a first elongated lead and first means for connecting a first longitudinal end of said first lead to a first electrode of said plurality of electrodes,

a second elongated lead and second means for connecting a first longitudinal end of said second lead to a second electrode of said plurality of electrodes,

a third elongated lead and third means for connecting a first longitudinal end of said third lead to a third electrode of said plurality of electrodes,

a fourth elongated lead and fourth means for connecting a first longitudinal end of said fourth lead to a fourth electrode of said plurality of electrodes,

an elongated cable, said cable including centrally-disposed first elongated portions of each of said first, second, third and fourth leads and fifth means for connecting a second longitudinal end of each of said first, second, third and fourth leads to said electrocardiograph, and

means for forming a junction of said first, second, third and fourth leads, said junction forming means being disposed between the first longitudinal ends of each of said first, second, third and fourth leads and said fifth connecting means, said junction forming means comprising a solid member having at least two, generally oppositely disposed regions or sides and a plurality of apertures,

said first and second leads being postioned in at least a first aperture of said plurality of apertures, said first aperture being positioned or disposed on a first region or side of said two regions or sides and said first and second leads extending exteriorly of said junction forming means away from said first region or side,

said third and fourth leads being positioned in at least a second aperture of said plurality of apertures, said second aperture being positioned or disposed on the second region or side of said two, oppositely disposed regions or sides, and said third and fourth leads extending exteriorly of said junction forming means away from said second region or side,

said elongated cable is positioned in a third aperture of said junction forming means and extends exteriorly of said junction forming means away from said second region or side.

10. A device as defined in claim **9** further comprising first means for maintaining second elongated portions of said first and second leads in a generally parallel, physically adjacent relationship, said second elongated portions being disposed between said junction forming means and said first longitudinal ends of said first and second leads.

11. A device as defined in claim **10** further comprising second means for maintaining third elongated portions of said third and fourth leads in a generally parallel, physically adjacent relationship, said third elongated portions being disposed between said junction forming means and said first longitudinal ends of said third and fourth leads.

12. A device as defined in claim **11** wherein said first and second maintaining means comprise jackets surrounding and engaging said second elongated portions and said third elongated portions, respectively.

13. A device as defined in claim **9** wherein said solid member comprises a body of molded insulating material.

14. A device as defined in claim **9** further comprising means for transmitting an electrical signal from a fifth electrode of said plurality of electrodes to said connecting means.

15. A device as defined in claim **14** wherein said transmitting means includes a conductive terminal means mounted on said junction forming means for receiving electrical signals from a fifth electrode of said plurality of electrodes.

16. A device as defined in claim **15** wherein said conductive terminal means comprises a conductive pin extending exteriorly of said junction forming means away from said first region or side.

17. A device as defined in claim **9** wherein each of said first, second, third and fourth leads comprise a unitary lead and wherein each of said first elongated portions of said first, second, third and fourth leads comprises a physically integral portion of each of said unitary first, second, third and fourth leads.

18. A device as claimed in claim **9** wherein each of said first, second, third and fourth leads comprises a lead formed by a plurality of physically distinct members electrically connected together.

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