United States Patent

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[54] EKG PICKUP ASSEMBLY

9 Claims, 2 Drawing Figs.

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[50] **Field of Search** ..... 128/2.05, 2.06, 2.1, 404, 405 (Pickup electrode digest)

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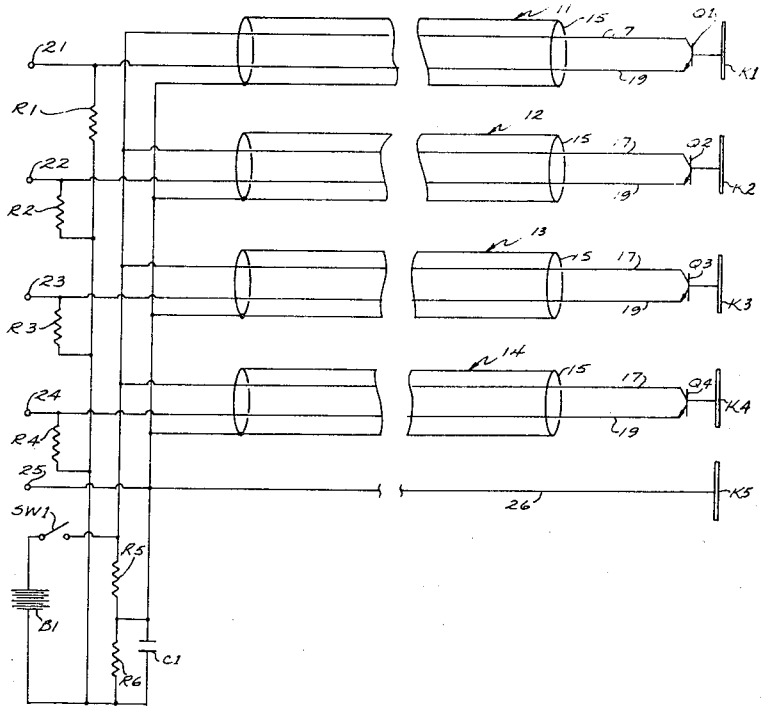
ABSTRACT: The EKG pickup assembly disclosed herein employs an emitter-follower transistor amplifier at the electrode end of each of a plurality of shielded cables. The emitter-follower transistor amplifiers provide a low impedance signal source so that substantially distortion-free signals which are continuous functions of the potentials occurring at corresponding points on a patient's body are transmitted through the cables.



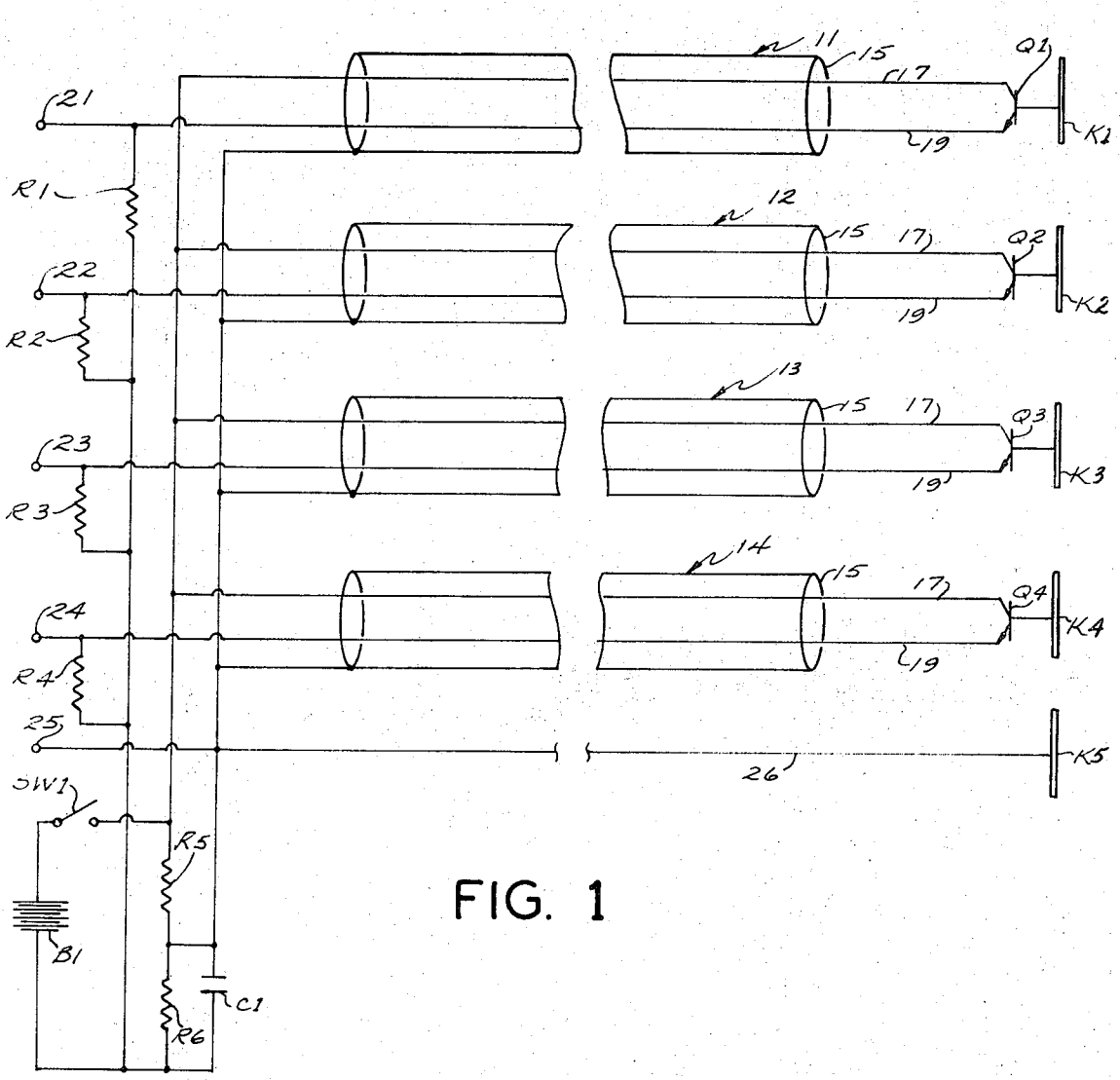


FIG. 1

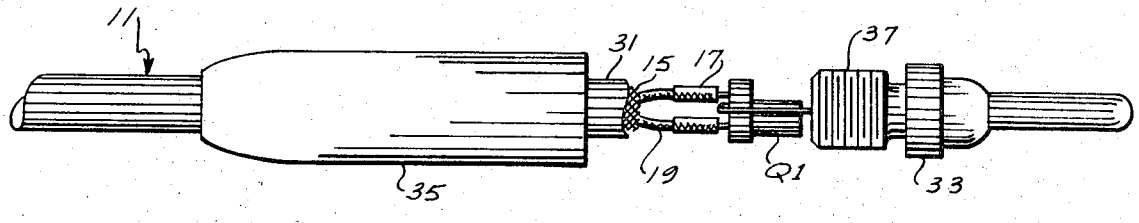


FIG. 2

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EKG PICKUP ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates to an electrocardiogram pickup assembly and more particularly to such an assembly which reduces signal distortion and baseline shift.

In obtaining electrocardiogram signals herebefore, it has been necessary to abrade the patient's skin at the sensing points and/or to apply an electrolytic paste to provide a good electrical contact and to control electromotive potentials caused by the reaction of the electrode material with the patient's skin secretions and fluids. Even with such precautions, difficulty is frequently experienced using such conventional procedures with so-called baseline shift, that is, with a shift in the nominal DC potential upon which the desired EKG signal is impressed. Further, noises or so-called "artifacts" are often generated by movement of the connecting cables and these extraneous signals interfere with or obscure the desired EKG signal.

Among the several objects of the present invention may be noted the provision of an electrocardiogram pickup assembly which substantially eliminates baseline wander; the provision of such an assembly which substantially eliminates distortion of the desired electrocardiogram signal; the provision of such an assembly which substantially eliminates the pickup of electrical noise; the provision of such a pickup assembly which does not require the abrading of a patient's skin at the sensing points and which does not require the use of electrolytic paste; the provision of such an assembly which is relatively compact; and the provision of such an assembly which is relatively simple, reliable and inexpensive. Other objects and features will be in part apparent and in part pointed out hereinafter.

SUMMARY OF THE INVENTION

Briefly, an electrocardiogram pickup assembly of this invention includes a plurality of shielded cables one end of each of which is adapted for connection to an electrocardiogram machine. The assembly also includes a transistor at the other end of each of the shielded cables, an input terminal of each transistor being provided with means adapted for connection to a corresponding sensing point on a patient's body. A follower output terminal of each transistor is connected to a shielded conductor within the respective shielded cable and the shielded cable includes conductive means for supplying current to a terminal of the respective transistor which is common to the input and output circuits thereof. Accordingly, the shielded conductor connected to each transistor follower terminal provides to the electrocardiogram machine at low impedance a substantially distortion-free signal which is a continuous function of the potentials occurring at the corresponding sensing point on the patient's body.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic circuit diagram of an electrocardiogram pickup assembly of the present invention; and

FIG. 2 is a view of an electrode connector employed in the assembly of FIG. 1, partially disassembled.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, the electrocardiogram pickup assembly illustrated there includes a plurality of shielded cables 11—14 each of which includes an outer shield 15 and first and second shielded conductors within the shield, 17 and 19 respectively.

At one end of each of the shielded cables 11—14 is a respective terminal 21—24 adapted for connection to an electrocardiogram machine. The shielded conductor 19 in each cable 11—14 is connected to a respective one of the terminals 21—24. A fifth terminal 25, which constitutes a reference point or potential, is also provided. As the pickup assembly of this invention may be employed with different types of information handling systems, *e.g.*, a telephone EKG signal transmitter, as well as with a conventional electrocardiograph machine, the term "electrocardiogram machine" should be understood to include any equipment for utilizing or transmitting EKG signals.

At the other end of each of the shielded cables 11—14 is a respective NPN bipolar transistor Q1—Q4. The emitter of each of the transistors Q1—Q4 is connected to the respective shielded conductor 19 and its collector is connected to the shielded conductor 17. The base terminal of each transistor is connected to a respective EKG electrode K1—K4, these electrodes being adapted to be placed in contact or connection with respective sensing points on a patient's body. A fifth electrode K5 is connected to the terminal 25 by a lead 26. Following conventional practice the electrodes K1—K5 are applied respectively to a patient's right arm, left arm, left leg, chest and right leg, the right leg being taken as the reference potential point.

Power for energizing the transistors is obtained from a battery B1 through a switch SW1. While battery power has been shown by way of illustration in an electrode assembly which is adapted for use with a conventional electrocardiograph machine without modification thereof, it should be understood that power for energizing these transistors may be provided by the machine itself when the machine is adapted or designed for use with an electrode assembly according to the present invention. Current is applied to the collector terminals of the transistors Q1—Q4 from the positive side of the battery B1 through the switch SW1 and the conductors 17 while the negative side of the battery is connected, through respective emitter load resistors R1—R4, to the conductors 19 which are connected to the emitters of the respective transistors Q1—Q4. While the resistors R1—R4 are a part of the pickup assembly as illustrated, it will be understood that they too can be incorporated into an EKG machine designed for use with a pickup assembly of this invention.

A preselected reference potential which is intermediate the collector and emitter circuit supply potentials is applied to the patient's body through electrode K5 by means of a voltage divider comprising a pair of resistors R5 and R6. Resistor R6 is shunted by a filter capacitor C1 for suppressing transient variations in this reference potential. Each of the shields 15 is also connected to this reference potential source. An alternative construction is to use the shield to conduct the collector current, suitable insulation over the shield being provided.

In operation with a conventional electrocardiograph machine, the terminals 21—25 are connected respectively to the machine's right arm, left arm, left leg, chest and right leg input terminals and the electrodes K1—K5 are applied to corresponding points on the patient's body. When the switch SW1 is closed, the transistors Q1 and Q4 are energized and are biased into conduction by current which flows through the patient's body from the electrode K5, through the respective electrodes K1—K4, to the base terminals of the respective transistors.

As is understood by those skilled in the art, the input terminal to a bipolar transistor is its base terminal and, when the transistor is energized as illustrated, the emitter functions as a follower output terminal, that is, the emitter output voltage follows the base input voltage very closely. The collector of the transistor constitutes a terminal which is common to the input and output circuits of the transistor in this configuration. As is also understood, follower circuits, such as the emitter-follower or common-collector circuit illustrated, provide a relatively high input impedance and a relatively low output impedance.

The transistors Q1—Q4, being operated as emitter-follower amplifiers, provide a very high input impedance which does not load the effective source impedance presented by the patient's body and thus the signals provided to the electrocardiograph machine through the respective shielded cables 11—14 are substantially distortion-free signals which are continuous

functions of the potentials occurring at the corresponding points on the patient's body. Further, since the emitter terminal of each of the transistors Q1—Q4 presents a relatively low source impedance to the respective shielded conductor 19, the pickup of noise or signals by the cable is greatly reduced. Thus, so-called "artifacts", often produced in conventional pickup arrangements by a movement of the cable, are substantially eliminated. Also, the effects of capacitive loading by the cable are reduced.

In addition, it has been found that the use of an emitter-follower amplifier at the electrode end of each of the cables substantially eliminates baseline wander although it is not entirely clear whether the reason for this is the high input impedance of the emitter-follower configuration or the flow of biasing current from the patient's body to each of the electrodes K1—K4 which "swamps out" electromotive effects caused by the reaction of the electrodes with the patient's body fluids. These advantages, furthermore, are obtained without abrading the patient's skin or applying electrolytic paste.

A particular electrode connector construction useful in the assembly of FIG. 1 is illustrated in FIG. 2. In this physical construction the shield 15 of cable 11 is covered by a layer of insulation 31. The transistor Q1 is constituted by a relatively inexpensive epoxy encapsulated unit and the shielded conductors 17 and 19 are directly connected to the collector and emitter terminals of the transistor. The base terminal of the transistor is soldered directly to a conventional pin plug 33. A plastic cover is adapted to be slid over and thereby protect the conductors 17 and 19 and the transistor Q1, the cover 35 and the plug 33 having matching threads as indicated on the plug at 37. As is understood by those skilled in the art, many presently commercially available EKG electrodes have pin jack receptacles for pin plugs such as that indicated at 33 and thus such conventional electrodes can be employed in the pickup assembly according to the present invention.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. An electrocardiogram pickup assembly, said assembly comprising:
- a plurality of shielded cables;
- means at one end of each of said shielded cables adapted for connection to an electrocardiogram machine;
- a transistor at the other end of each of said shielded cables, an input terminal of each transistor being provided with means adapted for connection to a corresponding sensing point on a patient's body, a follower output terminal of each transistor being connected to a shielded conductor within the respective shielded cable, each said shielded cable including conductive means for supplying current to a terminal of the respective transistor which terminal is common to the input and output circuits thereof, whereby the shielded conductor connected to each transistor follower terminal provides to the electrocardiogram machine at low impedance a substantially distortion-free signal which is a continuous function of the potentials occurring at the corresponding sensing point on the patient's body.

2. An electrocardiogram pickup assembly, said assembly comprising:
- a plurality of shielded cables;
- means at one end of each of said shielded cables adapted for connection to an electrocardiogram machine;
- a transistor at the other end of each of said shielded cables, the emitter terminal of each transistor being connected to a shielded conductor within the respective shielded cable, the base terminal of each transistor being provided with means adapted for connection to a corresponding sensing point on a patient's body, each said shielded cable including conductive means for supplying current to the collector terminal of the respective transistor whereby the shielded conductor connected to each transistor emitter provides to the electrocardiogram machine at low impedance a substantially distortion-free signal which is a continuous function of the potentials occurring at the corresponding point on the patient's body.

3. An electrocardiogram pickup assembly as set forth in claim 2 including means for applying to the patient's body a preselected potential with respect to the potential at which current is provided to the collectors of said transistors whereby said transistors are biased into conduction by current flowing through the patient's body.

4. An electrocardiogram pickup assembly as set forth in claim 3 including at said one end of each of said shielded cables a load resistor for the emitter of the respective transistor which is at the other end of that cable, said resistor being connected between said shielded conductor and means providing a predetermined potential relative to the potential at which current is provided to the collectors of said transistors, said preselected potential applied to the patient's body being intermediate said predetermined emitter circuit potential and the collector potential.

5. An electrocardiogram pickup assembly as set forth in claim 4 wherein each of said cables comprises a metallic shield and said preselected intermediate potential is applied to the cable shields.

6. An electrocardiogram pickup assembly as set forth in claim 4 including a resistive voltage divider for providing said preselected intermediate potential from the collector current potential and said predetermined emitter circuit potential.

7. An electrocardiogram pickup assembly as set forth in claim 6 including a capacitor for filtering said intermediate potential.

8. An electrocardiogram pickup assembly as set forth in claim 2 wherein said conductive means comprises a second shielded conductor within said cable.

9. An electrocardiogram pickup assembly, said assembly comprising:
- a plurality of shielded cables;
- means at one end of each of said shielded cables adapted for connection to an electrocardiogram machine;
- a transistor at the other end of each of said shielded cables, the emitter terminal of each transistor being connected to a shielded conductor within the respective shielded cable, the base terminal of each transistor being provided with electrode means adapted to be placed in contact with a corresponding sensing point on a patient's body, each said shielded cable including conductive means for supplying current to the collector terminal of the respective transistor;
- a respective emitter load resistor at the said one end of each of said cables connected to the shielded conductor;
- means for applying a first potential to said conductive means;
- means for applying a second potential to each of said resistors; and
- means for applying a potential intermediate said first and second potentials to the patient's body whereby the shielded conductor connected to each transistor emitter provides to the electrocardiogram machine at low impedance a substantially distortion-free signal which is a continuous function of the potentials occurring at the corresponding point on the patient's body.