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WO 2016/092800 A1
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US 20080140171 A1
US 20050277991 A1
US 20030055478 A1

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(54) Title of the Invention: **Testing of defibrillator electrodes**
Abstract Title: **System for and method of testing defibrillator electrodes**

(57) An electrode test system of a defibrillator comprising: electrodes 3 in a face to face test arrangement forming a capacitor; an impedance measurement signal generator that sends an AC signal to the electrodes 3; an impedance measurement signal processor that processes an electrode test signal received from the electrodes 3 that is used to obtain a processed electrode test signal; a defibrillator processor connected to both the impedance measurement signal generator and the impedance measurement signal processor and which receives and analyses the processed electrode test signal to obtain an electrode test impedance signal and further analyses the electrode test impedance signal to determine a pass or fail condition of the electrodes 3. Preferably electrodes 3 are planar and comprise a first and a second face, where the first face of each electrode 3 may be provided by a dielectric liner 46 placed in the face to face test arrangement to form the capacitor, where dielectric 46 may be provided by one or more air gaps 48. The defibrillator processor may further analyses the electrode test impedance signal to determine an approximate age of the electrodes 3. Described as testing the ability of defibrillator electrodes to conduct an electrical signal.

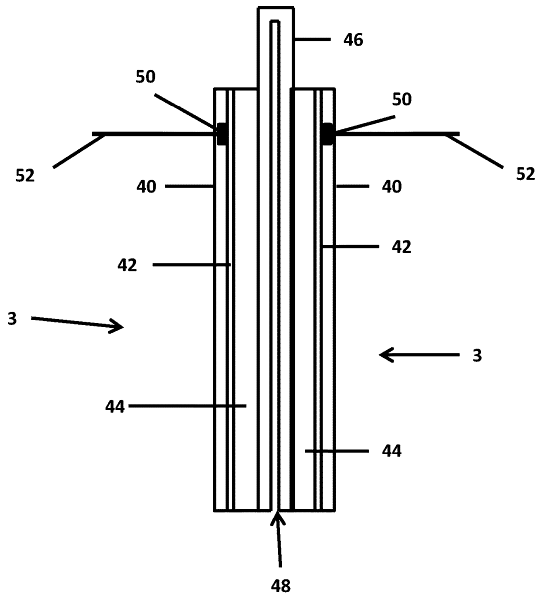

Fig. 2

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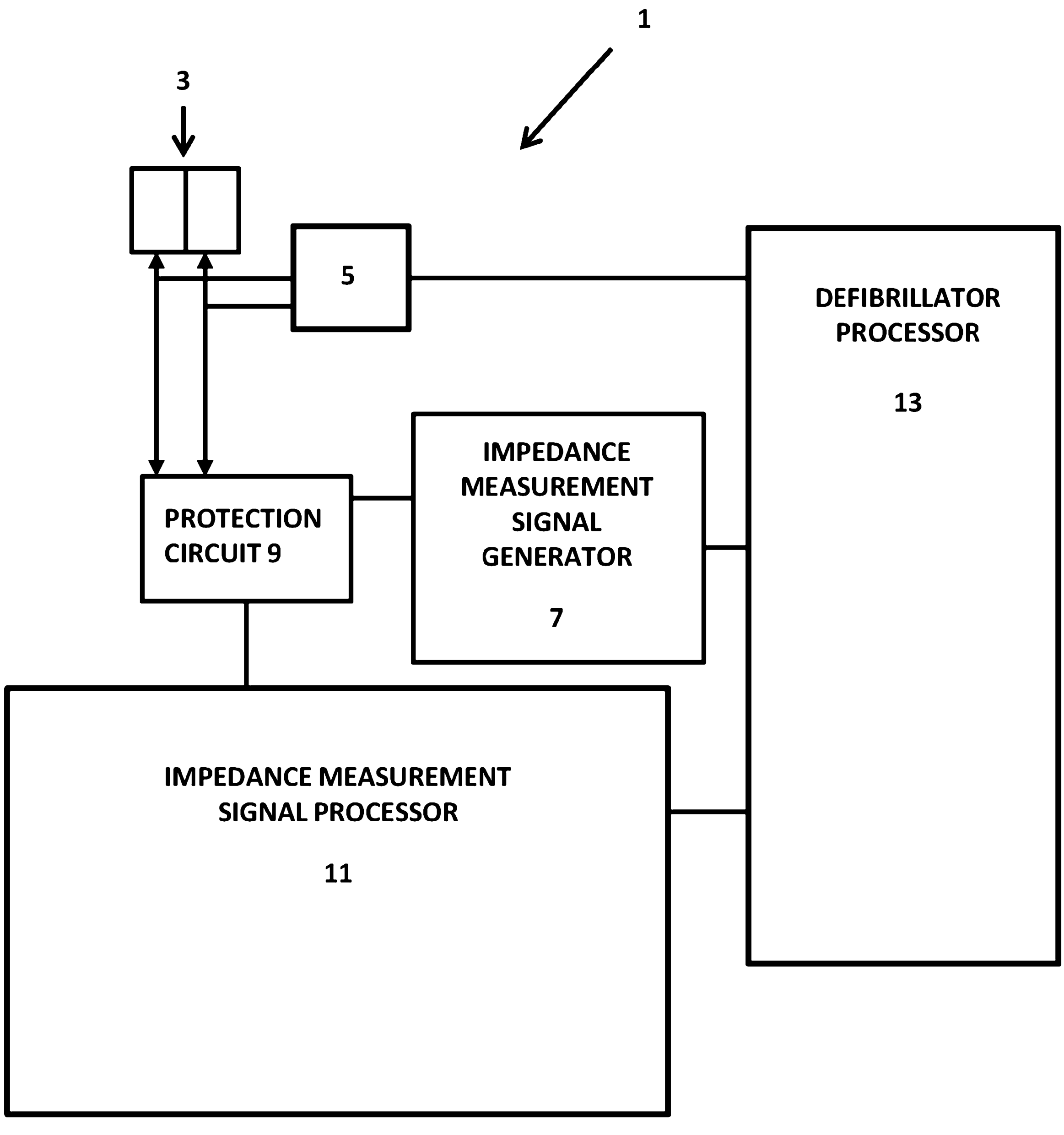
1
3
5
DEFIBRILLATOR PROCESSOR
13
IMPEDANCE MEASUREMENT SIGNAL GENERATOR
7
PROTECTION CIRCUIT 9
IMPEDANCE MEASUREMENT SIGNAL PROCESSOR
11

Fig. 1

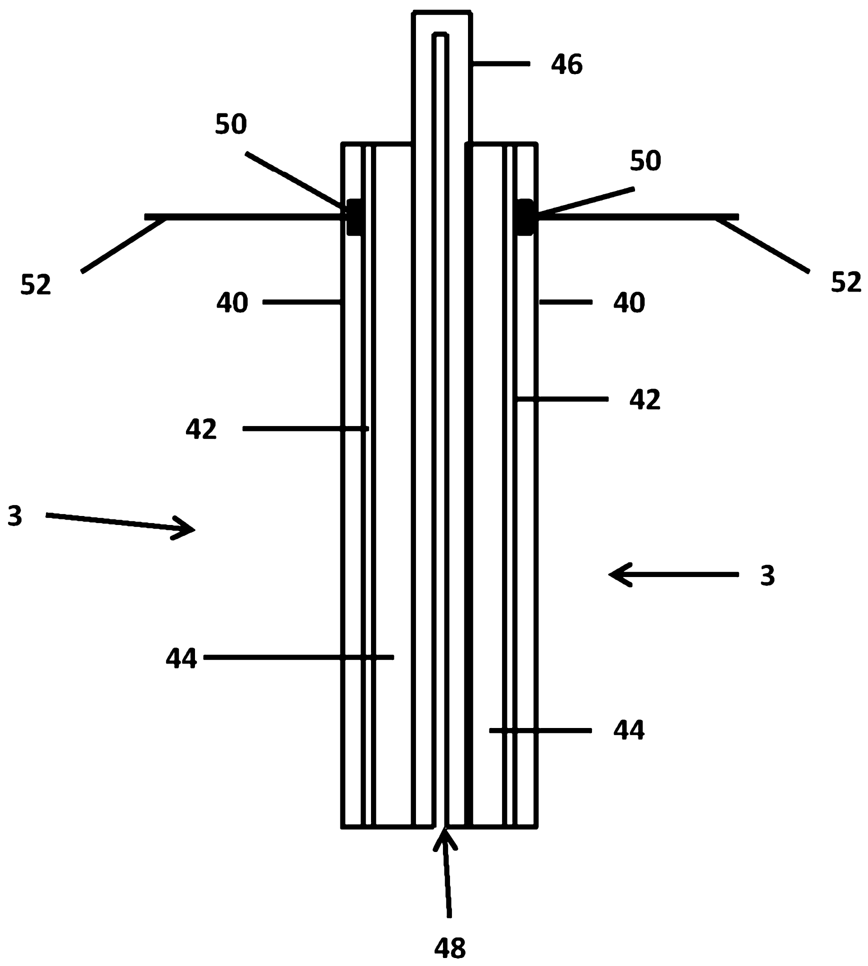

Fig. 2

Testing of Defibrillator Electrodes

This invention relates to testing of electrodes for defibrillators, and particularly to the testing of connection of the electrodes to the defibrillator and the electrical integrity of the electrodes, i.e. the ability of the electrodes to conduct an electrical signal.

Defibrillators are used to provide a 'shock', i.e. electrical signals, to a patient's heart during a cardiac arrest. Studies have shown that the efficacy of a shock decreases significantly as time from the cardiac arrest increases. It is therefore important to use a defibrillator to apply electrical signals to the patient's heart as quickly as possible. This being the case, defibrillators are now frequently found in various public locations, not just in hospitals.

The defibrillator electrodes are generally housed in a pouch to protect them. Each electrode has a connecting wire which is connected to a plug in the defibrillator. In many locations, a defibrillator may not be used for substantial periods of time. It is crucial that the connectivity of the defibrillator electrodes, connecting wires and defibrillator plug, and the electrical integrity of the defibrillator electrodes, is maintained over these periods, or, if compromised, that this information is made available to a potential user of the defibrillator. This is particularly the case when a defibrillator may be used by a member of the public with little or no experience of defibrillator technology or operation. It is therefore desirable to provide defibrillators with a means by which the electrodes connectivity and integrity may be tested.

According to a first aspect of the invention there is provided an electrode test system of a defibrillator comprising

electrodes in a face-to-face test arrangement forming a capacitor,

an impedance measurement signal generator connected to the electrodes and configured to send an ac signal to the electrodes, an impedance measurement signal processor connected to the electrodes which is placeable in an electrode test state and configured to receive an electrode test ac signal from the electrodes and process the electrode test ac signal to obtain a processed electrode test ac signal,

a defibrillator processor connected to the impedance measurement signal generator and the impedance measurement signal processor configured to place the impedance measurement signal processor in the electrode test state and to receive the processed electrode test ac signal, analyse the processed electrode test ac signal to obtain an electrode test impedance signal and analyse the electrode test impedance signal to determine a pass condition or a fail condition of the electrodes.

The defibrillator processor may be configured to send at least one control signal to the impedance measurement signal generator to cause the impedance measurement signal generator to send the ac signal to the electrodes.

The defibrillator processor may be configured to send at least one control signal to the impedance measurement signal processor to place the impedance measurement signal processor in the electrode test state. The defibrillator processor may be configured to send at least one control signal to the impedance measurement signal processor to adjust one or more characteristics thereof to place the impedance measurement signal processor in the electrode test state.

The impedance measurement signal processor may comprise an amplifier module and the defibrillator processor may be configured to send at least one control signal to the impedance measurement signal processor to adjust one or more characteristics of the amplifier module to place the impedance measurement signal processor in the electrode test state. The defibrillator processor may be configured to send at least one control signal to the impedance measurement signal processor to adjust a gain characteristic of the amplifier module to place the impedance measurement signal processor in the electrode test state.

The impedance measurement signal processor may comprise a signal conditioning module and the defibrillator processor may be configured to send at least one control signal to the impedance measurement signal processor to adjust one or more characteristics of the signal conditioning module to place the impedance measurement signal processor in the electrode test state. The defibrillator processor may be configured to send at least one control signal to the impedance measurement signal processor to adjust one or more conditioning function characteristics of the signal conditioning module to place the impedance measurement signal processor in the electrode test state. The signal conditioning module may comprise conditioning function characteristics for carrying out conditioning functions comprising any of filtering, analogue to digital conversion, signal processing.

The impedance measurement signal processor may comprise a memory unit and the defibrillator processor may be configured to send at least one control signal to the impedance measurement signal processor to adjust one or more control characteristics stored in the memory unit to place the impedance measurement signal processor in the electrode test state. The defibrillator processor may be configured to send at least one control signal to the impedance measurement signal processor to adjust one or more control characteristics stored in the memory unit which adjusts one or more characteristics of the amplifier module to place the impedance measurement signal processor in the electrode test state. The defibrillator processor may be configured to send at least one control signal to the impedance measurement signal processor to adjust one or more control characteristics stored in the memory unit which adjusts one or more characteristics of the signal conditioning module to place the impedance measurement signal processor in the electrode test state.

The amplifier module of the impedance measurement signal processor may be implemented in hardware. The signal conditioning module of the impedance measurement signal processor may be implemented in hardware. The amplifier module of the impedance measurement signal processor may be implemented in software. The signal conditioning module of the impedance measurement signal processor may be implemented in software. The amplifier module and the signal conditioning module may be implemented in separate software modules or the same software module.

Each electrode may be substantially planar and comprise at least one face. The at least one face of each electrode may be placed in the face-to-face test arrangement to form the capacitor. Each electrode may be substantially planar and comprise a first face and a second face. The first face of each electrode may be placed in the face-to-face test arrangement to form the capacitor. The first face of each electrode may be provided by a dielectric liner of the electrode. The dielectric liners of the electrodes may be substantially adjacent in the electrodes face-to-face test arrangement to form the capacitor. A further dielectric may be provided by one or more air gaps between the substantially adjacent dielectrics in the electrodes face-to-face test arrangement.

Alternatively, the second face of each electrode may be placed in the face-to-face test arrangement to form the capacitor. The second face of each electrode may be provided by a substrate of the electrode. Alternatively, the first face of a first electrode and the second face of a second electrode may be placed in the face-to-face test arrangement to form the capacitor.

A first electrode may comprise a conductor and a dielectric liner and a second electrode may comprise a conductor. The second electrode conductor may be substantially adjacent to the first electrode dielectric liner in the electrodes face-to-face test arrangement to form the capacitor. The electrodes may each comprise a conductor. A dielectric may be placed between the conductors in the electrodes face-to-face test arrangement to form the capacitor.

Each electrode may comprise a substrate having a first face and a second face, a conductor having a first face attached to the second face of the substrate and a second face, a gel element having a first face attached to the second face of the conductor and a second face, and a dielectric liner having a first face attached to the second face of the gel element and a second face.

The substrate may comprise a plastic material, particularly a substantially transparent plastic material. The substrate may comprise a foam material.

The conductor may be printed onto the second face of the substrate. The conductor may comprise silver ink. The conductor may comprise tin.

The dielectric liner may be a release liner which is removed on use of the electrode. The dielectric liner of each electrode may be joined together and folded to be substantially adjacent in the electrodes face-to-face test arrangement.

The electrodes may be located in a face-to-face test arrangement within a pouch.

The impedance measurement signal generator may be configured to generate the ac signal at a pre-determined voltage. The ac signal may comprise any of a sine wave, a square wave. The ac signal may have a frequency in the range of approximately 30kHz to approximately 64kHz, preferably approximately 32kHz.

The defibrillator processor may be configured to determine a pass condition if the electrode test impedance signal is within a pre-determined pass range and a fail condition if the electrode test impedance signal is above the pre-determined pass range. The pass range may be pre-determined by assessing an expected range of values of the electrode test impedance signal when connectivity and electrical integrity of the electrodes is acceptable. The pre-determined pass range may be approximately 1kΩ to approximately 5kΩ. The pre-determined pass range may be determined by testing of defibrillator electrodes in various states of connectivity and electrical integrity. The pre-determined pass range may be different for different types of defibrillator electrodes. When the electrodes are in a fail condition, a signal indicating an open circuit may be received by the defibrillator processor.

The defibrillator may comprise a protection circuit connected between the electrodes and the impedance measurement signal generator and the impedance measurement signal processor to protect them against receiving a defibrillator shock signal.

An electrode test may be carried out as part of an automatic defibrillator self-test process. An electrode test may be carried out at regular intervals. The regular intervals may comprise any of once a day, once a week, once a month. An electrode test may be carried out on power-up of the defibrillator. An electrode test may be carried out before application of a shock to a patient. An electrode test may be carried out on initiation by a user of the defibrillator, for example by activating a switch on the defibrillator.

After an electrode test, when the defibrillator processor determines a pass condition for the electrodes, the defibrillator processor may be configured to further analyse the electrode test impedance signal to determine an approximate age of the electrodes.

The defibrillator processor may compare the electrode test impedance signal with pre-determined ranges for the electrode test impedance signal to determine an approximate age of the electrodes. The pre-determined ranges may indicate, for example, electrodes of less than approximately 1 year of age, electrodes between approximately 1 year and approximately 2 years of age, electrodes between approximately 2 years and approximately 3 years of age, electrodes between approximately 3 years and approximately 4 years of age, electrodes of over approximately 4 years of age. Determination of an approximate age of the electrodes is possible because, as the electrodes get older, their gel dries out and capacitance of the electrodes changes.

The defibrillator may issue a message indicating an electrode pass condition or an electrode fail condition. This may comprise any of an audible message, a visible message.

According to a second aspect of the invention there is provided a method of testing electrodes of a defibrillator comprising

placing electrodes in a face-to-face test arrangement to form a capacitor,

using an impedance measurement signal generator to send an ac signal to the electrodes,

using an impedance measurement signal processor placeable in an electrode test state to receive an electrode test ac signal from the electrodes and to process the electrode test ac signal to obtain a processed electrode test ac signal,

using a defibrillator processor to place the impedance measurement signal processor in the electrode test state and to receive the electrode test ac signal, to analyse the processed electrode test ac signal to obtain an electrode test impedance signal and to analyse the electrode test impedance signal to determine a pass condition or a fail condition of the electrodes.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic representation of an electrode test system of a defibrillator according to the first aspect of the invention, and

Figure 2 is a schematic representation of electrodes of the defibrillator of Figure 1.

Referring to Figure 1, this shows a defibrillator 1 comprising electrodes 3, a defibrillation signal generator 5, an impedance measurement signal generator 7, a protection circuit 9, an impedance measurement signal processor 11 and a defibrillator processor 13.

The impedance measurement signal generator 7 is configured to generate an ac signal at a pre-determined voltage. The ac signal comprises a sine wave or a square wave and has a frequency in the range of approximately 30kHz to approximately 64kHz, preferably approximately 32kHz. The ac signal is sent to the electrodes 3 and is used to test the electrodes 3. Signals having the same characteristics can be sent to the electrodes 3 in the measurement of an impedance of a patient connected to the electrodes 3.

The protection circuit 9 is a defibrillator signal protection circuit. This is configured to protect the impedance measurement signal generator 7 and the impedance measurement signal processor 11 against receiving a defibrillator shock signal, which would otherwise damage them.

The impedance measurement signal processor 11 comprises an amplifier module, a signal conditioning module and a memory unit (not shown). The amplifier module comprises a gain characteristic which is adjustable to place the impedance measurement signal processor 11 in an electrode test state. The signal conditioning module comprises conditioning function characteristics, such as filtering ranges, ADC sample rate, resolution etc., which are adjustable to place the impedance measurement signal processor in the electrode test state. The signal conditioning module carries out conditioning functions comprising, at least, filtering, analogue to digital conversion and signal processing. The memory unit stores control characteristics which are adjustable for the adjustment of the characteristics of the amplifier module and the signal conditioning module.

In this embodiment of the invention, the amplifier module and the signal conditioning modules of the impedance measurement signal processor 11 are implemented in hardware.

The defibrillator processor 13 comprises a microprocessor. The defibrillator processor 13 is configured to send at least one control signal to the impedance measurement signal generator 7 to cause the generator 7 to send the ac signal to the electrodes 3. The defibrillator processor 13 is further configured to send control signals to the memory unit of the impedance measurement signal processor 11 to control adjustment of the characteristics of the modules of the impedance measurement signal processor 11.

In this embodiment, the defibrillator 1 further comprises a battery (not shown) which provides power for the components of the defibrillator. The various components of the defibrillator 1 are connected together as shown in the drawing, for sending and receiving signals between the components. It will be appreciated that other connections which are not shown may be provided between the components of the defibrillator 1.

Referring to Figure 2, each of the electrodes 3 of the defibrillator 1 of Figure 1 is substantially planar and comprises a substrate 40, a conductor 42, a gel element 44 and a dielectric liner 46. The substrate 40 has a first face and a second face, the conductor 42 has a first face attached to the second face of the substrate 40 and a second face, the gel element 44 has a first face attached to the second face of the conductor 42 and a second face, and the dielectric liner 46 has a first face attached to the second face of the gel element 44 and a second face, as shown.

The substrate 40 comprises a substantially transparent plastic material. The conductor 42 comprises silver ink printed onto the second face of the substrate 40. The dielectric liner 46 of the electrodes is joined together and folded, as shown. The dielectric liner 46 is a release liner which is removed on use of the electrodes 3.

The electrodes 3 are located within a pouch (not shown). Each electrode 3 comprises a connector stud 50 and a connecting wire 52, for connection of the electrode to a plug of the defibrillator 1.

In this embodiment, the electrodes 3 each comprise a conductor 42 and a dielectric in the form of a folded dielectric liner 46. Each electrode comprises a first face provided by the dielectric liner 46 of the electrodes and a second face provided by a substrate 40 of the electrodes. The first face of each electrode, comprising the second face of the dielectric liner 46, is placed in the face-to-face test arrangement to form the capacitor. The electrodes 3 are in a face-to-face test arrangement, with parts of the dielectric liner 46 substantially adjacent to form the capacitor. A further dielectric is provided in the form of an air gap 48 between the substantially adjacent dielectric liner 46 in the electrodes face-to-face test arrangement. It will be appreciated that the air gap may be replaced by air pockets or may not be present. It will be appreciated that the second face of each electrode, provided by the substrate of the electrode, may be placed in the face-to-face test arrangement to form the capacitor. It will further be appreciated that the first face of a first electrode and the second face of a second electrode may be placed in the face-to-face test arrangement to form the capacitor.

In order to use the defibrillator 1 to apply defibrillation signals to a patient's heart, the electrodes 3 must have adequate connectivity and electrical integrity, i.e. the ability to conduct an electrical signal. This is determined by testing the electrodes 3 by applying an ac signal to the electrodes 3, receiving an electrode test ac signal from the electrodes 3, analysing the electrode test ac signal to obtain the electrode test impedance signal and processing the electrode test impedance signal to determine a pass condition or a fail condition of the electrodes. Testing of the electrodes 3 is carried out using the impedance measurement signal generator 7 and the impedance measurement signal analyser 11, i.e. equipment already present in the defibrillator 1.

When an electrode test is carried out, in this embodiment, the electrodes 3 are in their pouch, in a face-to-face test arrangement forming a capacitor.

The defibrillator processor 13 sends at least one control signal to the memory unit of the impedance measurement signal processor 11. This adjusts, or sets, one or more control characteristics stored in the memory unit to place the impedance measurement signal processor 11 in the electrode test state. Adjustment of the one or more control characteristics stored in the memory unit causes adjustment of the gain characteristic of the amplifier module and adjustment of the conditioning function characteristics of the signal conditioning module to place the impedance measurement signal processor 11 in the electrode test state.

The defibrillator processor 13 sends at least one control signal to the impedance measurement signal generator 7 to cause it to generate an ac signal at a pre-determined voltage comprising a sine wave or a square wave and having a frequency in the range of approximately 30kHz to approximately 64kHz, preferably approximately 32kHz. The ac signal is sent to the electrodes 3, and, as these form a capacitor, the ac signal passes through the electrodes 3. The electrodes 3 act to effect a change in the ac signal and the resultant changed ac signal, referred to as the electrode test ac signal, is passed to the protection circuit 9 and on to the impedance measurement signal processor 11.

The amplifier module of the impedance measurement signal processor 11 receives the electrode test ac signal from the electrodes 3 via the protection circuit 9, amplifies the signal and passes it to the signal conditioning module of the impedance measurement signal processor 11. The signal conditioning module carries out a number of conditioning functions, such as filtering and analogue to digital conversion, on the amplified electrode test ac signal. The electrode test ac signal is passed to the defibrillator processor 13.

The defibrillator processor 13 receives the electrode test ac signal from the impedance measurement signal processor 11 and analyses the electrode test ac signal to obtain an electrode test impedance signal. The defibrillator processor 13 then analyses the electrode test impedance signal to determine a pass or fail condition of the electrodes 3. Various methods may be used to determine a pass or fail condition of the electrodes 3. The defibrillator processor 13 may determine a pass condition if the electrode test impedance signal is within a pre-determined pass range and a fail condition if the electrode test impedance signal is above the pre-determined pass range. The pass range may be pre-determined by assessing an expected range of values of the electrode test impedance signal when the connectivity and electrical integrity of the electrodes is acceptable. The pre-determined pass range may be approximately 1kΩ to approximately 5kΩ. When the electrodes 3 are in a fail condition, a signal indicating an open circuit may be received by the defibrillator processor 13.

An electrode pass condition determines that the connectivity of the electrodes 3 via the connector studs 50 and the connecting wires 52 to a plug of the defibrillator 1 is intact and that the electrical integrity of each electrode 3 is within specification. An electrode fail condition may indicate inadequate connectivity of one or more of the electrodes 3. This may be due to, for example, improper connection between or a fault on any of the electrodes, electrode connecting wires and a plug of the defibrillator. A fail test result for the electrodes may indicate inadequate electrical integrity of one or more of the electrodes. This may be due to, for example, breakdown of gel of one or more of the electrodes, which is referred to as discontinuity of an electrode, or damage to one or more of the electrodes e.g. due to incorrect storage.

After an electrode test, when a pass condition for the electrodes 3 is determined, the defibrillator processor 13 may further process the electrode test impedance signal to determine an approximate age of the electrodes 3.

The defibrillator 1 may issue a message indicating an electrode pass condition or an electrode fail condition, such as an audible message and/or a visible message e.g. activation of a light, such as a light emitting diode (LED) indicator, provided on the defibrillator 1.

CLAIMS

1. An electrode test system of a defibrillator comprising

electrodes in a face-to-face test arrangement forming a capacitor,

an impedance measurement signal generator connected to the electrodes and configured to send an ac signal to the electrodes,

an impedance measurement signal processor connected to the electrodes which is placeable in an electrode test state and configured to receive an electrode test ac signal from the electrodes and process the electrode test ac signal to obtain a processed electrode test ac signal,

a defibrillator processor connected to the impedance measurement signal generator and the impedance measurement signal processor configured to place the impedance measurement signal processor in the electrode test state and to receive the processed electrode test ac signal, analyse the processed electrode test ac signal to obtain an electrode test impedance signal and analyse the electrode test impedance signal to determine a pass condition or a fail condition of the electrodes.

2. An electrode test system of a defibrillator according to claim 1 in which the defibrillator processor is configured to send at least one control signal to the impedance measurement signal generator to cause the impedance measurement signal generator to send the ac signal to the electrodes.

3. An electrode test system of a defibrillator according to claim 1 or claim 2 in which the defibrillator processor is configured to send at least one control signal to the impedance measurement signal processor to place the impedance measurement signal processor in the electrode test state.

4. An electrode test system of a defibrillator according to claim 3 in which the defibrillator processor is configured to send at least one control signal to the impedance

measurement signal processor to adjust one or more characteristics thereof to place the impedance measurement signal processor in the electrode test state.

5. An electrode test system of a defibrillator according to claim 4 in which the impedance measurement signal processor comprises an amplifier module and the defibrillator processor is configured to send at least one control signal to the impedance measurement signal processor to adjust one or more characteristics of the amplifier module to place the impedance measurement signal processor in the electrode test state.

6. An electrode test system of a defibrillator according to claim 5 in which the defibrillator processor is configured to send at least one control signal to the impedance measurement signal processor to adjust a gain characteristic of the amplifier module to place the impedance measurement signal processor in the electrode test state.

7. An electrode test system of a defibrillator according to any of claims 4 to 6 in which the impedance measurement signal processor comprises a signal conditioning module and the defibrillator processor is configured to send at least one control signal to the impedance measurement signal processor to adjust one or more characteristics of the signal conditioning module to place the impedance measurement signal processor in the electrode test state.

8. An electrode test system of a defibrillator according to claim 7 in which the defibrillator processor is configured to send at least one control signal to the impedance measurement signal processor to adjust one or more conditioning function characteristics of the signal conditioning module to place the impedance measurement signal processor in the electrode test state.

9. An electrode test system of a defibrillator according to claim 9 in which the signal conditioning module comprises conditioning function characteristics for carrying out

conditioning functions comprising any of filtering, analogue to digital conversion, signal processing.

10. An electrode test system of a defibrillator according to any of claims 4 to 9 in which the impedance measurement signal processor comprises a memory unit and the defibrillator processor is configured to send at least one control signal to the impedance measurement signal processor to adjust one or more control characteristics stored in the memory unit to place the impedance measurement signal processor in the electrode test state.

11. An electrode test system of a defibrillator according to claim 10 as dependent from claim 5 or claim 6 in which the defibrillator processor is configured to send at least one control signal to the impedance measurement signal processor to adjust one or more control characteristics stored in the memory unit which adjusts one or more characteristics of the amplifier module to place the impedance measurement signal processor in the electrode test state.

12. An electrode test system of a defibrillator according to claim 10 as dependent from any of claims 7 to 9 in which the defibrillator processor is configured to send at least one control signal to the impedance measurement signal processor to adjust one or more control characteristics stored in the memory unit which adjusts one or more characteristics of the signal conditioning module to place the impedance measurement signal processor in the electrode test state.

13. An electrode test system of a defibrillator according to any preceding claim in which each electrode is substantially planar and comprises at least one face, placed in the face-to-face test arrangement to form the capacitor.

14. An electrode test system of a defibrillator according to any preceding claim in which each electrode is substantially planar and comprises a first face and a second face

and the first face of each electrode is provided by a dielectric liner of the electrode and is placed in the face-to-face test arrangement to form the capacitor.

15. An electrode test system of a defibrillator according to claim 14 in which a further dielectric is provided by one or more air gaps between the dielectric liners in the electrodes face-to-face test arrangement.

16. An electrode test system of a defibrillator according to any of claims 1 to 13 in which each electrode is substantially planar and comprises a first face and a second face and the second face of each electrode is provided by a substrate of the electrode and is placed in the face-to-face test arrangement to form the capacitor.

17. An electrode test system of a defibrillator according to any of claims 1 to 13 in which each electrode is substantially planar and comprises a first face and a second face and the first face of a first electrode is provided by a dielectric liner of the electrode and a second face of a second electrode is provided by a substrate of the electrode and the first face of the first electrode and the second face of second electrode are placed in the face-to-face test arrangement to form the capacitor.

18. An electrode test system of a defibrillator according to any preceding claim in which the electrodes are located in a face-to-face test arrangement within a pouch.

19. An electrode test system of a defibrillator according to any preceding claim in which the defibrillator processor determines a pass condition if the electrode test impedance signal is within a pre-determined pass range and a fail condition if the electrode test impedance signal is above the pre-determined pass range.

20. An electrode test system of a defibrillator according to claim 19 in which the pass range is pre-determined by assessing an expected range of values of the electrode test

impedance signal when connectivity and electrical integrity of the electrodes is acceptable.

21. An electrode test system of a defibrillator according to claim 19 or claim 20 in which the pre-determined pass range is determined by testing of defibrillator electrodes in various states of connectivity and electrical integrity.

22. An electrode test system of a defibrillator according to any preceding claim in which when the electrodes are in a fail condition, a signal indicating an open circuit is received by the defibrillator processor.

23. An electrode test system of a defibrillator according to any preceding claim in which an electrode test is carried out on the defibrillator as part of an automatic defibrillator self-test process.

24. An electrode test system of a defibrillator according to any preceding claim in which after an electrode test, when the defibrillator processor determines a pass condition for the electrodes, the defibrillator processor further analyses the electrode test impedance signal to determine an approximate age of the electrodes.

25. A method of testing electrodes of a defibrillator comprising

placing electrodes in a face-to-face test arrangement to form a capacitor,

using an impedance measurement signal generator to send an ac signal to the electrodes,

using an impedance measurement signal processor placeable in an electrode test state to receive an electrode test ac signal from the electrodes and to process the electrode test ac signal to obtain a processed electrode test ac signal,

using a defibrillator processor to place the impedance measurement signal processor in the electrode test state and to receive the electrode test ac signal, to analyse the processed electrode test ac signal to obtain an electrode test impedance signal and to analyse the electrode test impedance signal to determine a pass condition or a fail condition of the electrodes.

Intellectual Property Office

Application No:	GB1808541.5	**Examiner:**	Dr Elinor Styles-Davis
Claims searched:	1 to 25	**Date of search:**	19 November 2018

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-8 and 12-24	US 2003/055478 A1 (KONINKL PHILIPS ELECTRONICS) See especially the abstract, Figures 20, 27 and 31, alongside paragraphs [0002], [0006]-[0008], [0193]-[0200], [0235]-[0237], [0242]-[0248] and claims 164 and 165
X	1, 2, 7, 8, 12-24	US 6253103 B (KIMBERLEY CLARKE) See especially the abstract, Figure 1 and [col 3. lines 6-18], [col. 4 lines 21-26], [col. 9, lines 10-15] and [col.16, lines 50-55]
A	--	US 2008/140171 A1 (KONINK PHILIPS ELECTRICS) See especially the abstract, Figure 1 and paragraphs [0017], [0018], [0026], [0032] and [0033]
A	--	WO 2016/092800 A1 (NIHON KOHDEN CORP) See especially the abstract and paragraphs [0029], [0032] and [0033]
A	--	US 2005/277991 A1 (MEDTRONIC) See especially paragraphs [0006], [0009], [0013] and [0077]-[0080]

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

A61N

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI, Patent Fulltext, BIOSIS, MEDLINE, SPRINGER, XPESP

Intellectual Property Office

International Classification:

Subclass	Subgroup	Valid From
A61N	0001/39	01/01/2006