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(54) ELECTRICAL WOUND HEALING SYSTEM

ELEKTRISCHES WUNDHEILUNGSSYSTEM

SYSTÈME ÉLECTRIQUE POUR LA CICATRISATION DES PLAIES

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Description

Field of the Invention

[0001] The present invention relates to electrical wound healing systems.

Background to the Invention

[0002] It is believed that the rate of wound healing can be enhanced by electrostimulation, i.e. the application of a therapeutic electrical signal, or waveform, to the wound. Conventionally, the electrical signal is applied by two electrodes, one placed on either side of the wound. A problem with this approach is that the electrical signal is applied across the whole of the wound regardless of tissue type or stage of healing. It is also believed that healing is enhanced if the two electrodes are placed one on either side of a wound boundary, the electrodes being shaped to closely follow the contours of the wound. In this way, the two electrodes create an optimal wound- healing electrical field across the wound edge. However, achieving suitably shaped electrodes is not feasible with standard electrode systems.

[0003] It would be desirable to mitigate the problems outlined above.

[0004] WO 2004/049937 discloses a tissue mapping system comprising a two dimensional array of test electrodes 10 for application to the surface of tissue under investigation and circuit means 50-66 for measuring an electrical characteristic of the tissue underlying each test electrode. In one embodiment the electrical characteristics is the impedance of the tissue underlying each test electrode.

[0005] US 7 177 696 discloses a method and apparatus for speeding the healing process of soft tissues, bone fractures, cancerous tissue, nerve pathways and other body tissues wherein a portable base comprising a plurality of cells is applied with the cells facing or encircling the wound.

Summary of the Invention

[0006] A first aspect of the invention provides a wound healing system according to claim 1.

[0007] The preferred creating means creates said composite electrodes by electrically connecting together the, or each, electrode of the array that is to form part of the respective composite electrode. To this end, the creating means may include a switching device arranged to selectably connect (at least electrically) each array electrode to one or other of a positive and a negative terminal by which said electrical signal is applied in use to the composite electrodes.

[0008] The system typically also comprises a controller arranged to control the setting of said switch device, for example by means of a multiplexer. The controller may also be arranged to cause said electrical signal to be applied to said composite electrodes and, preferably, also to generate said electrical signal (in association with other circuitry if necessary, e.g. a pulse generating circuit, or other signal generating circuit).

[0009] Preferably, the system is arranged to cause a respective one or more electrodes to form the respective first and second composite electrodes depending on a desired shape, size and/or location of the respective composite electrodes.

[0010] The system may include means for selecting said respective one or more electrodes for forming the respective first and second composite electrodes. The selection is advantageously based on information concerning the state of the wound. This information may for example be provided to the system by a user via a user interface, and/or by a wound monitoring system.

[0011] In preferred embodiments, the system includes, or is in communication with, a wound monitoring system. The wound monitoring system may comprise means for measuring one or more electrical characteristics of the wound; and means for analysing the, or each, measured electrical characteristics to determine the state of the wound. Conveniently, the measuring means includes, or at least employs, the electrode array. A suitable wound monitoring system is disclosed in International PCT patent application WO 2004/049937. Alternative wound monitoring systems may be employed and do not necessarily need to use the electrode array.

[0012] In such embodiments, the system may operate in a first mode of operation, in which said electrical signal is applied to the composite electrodes for the purpose of enhancing wound healing, and a second mode of operation, in which the state of the wound is monitored.

[0013] The controller may be arranged to perform some or all of the processing mentioned above, e.g. the selection of electrodes, the measuring of electrical characteristics and/or the analysing of the measured electrical characteristics. In preferred embodiments, however, the controller is in communication with a computer arranged to perform some or all of these tasks.

[0014] In preferred embodiments, the system is arranged to create one of said composite electrodes from one or more array electrodes that are determined to be located, in use, over one or more wounded portions of the tissue and/or skin underlying the array in use, e.g. portions that are determined to be relatively damaged or unhealthy. Preferably, said one composite electrode is created to substantially fill the, or each, wounded portion.

[0015] Conveniently, the other of said composite electrodes is created from one or more array electrodes that are determined to be located, in use, outside of said one or more wounded portions. Preferably, said other of the composite electrodes is created only from electrodes that are determined to be located at, or substantially at, an edge of the, or each, wounded portion.

[0016] Alternatively, the system is arranged to create one of said composite electrodes from one or more array electrodes that are determined to be located, in use, at

one side of one or more wounded portions of the tissue and/or skin underlying the array in use, the other of said composite electrodes being created from one or more array electrodes that are determined to be located, in use, at the opposite side of said one or more wounded portions.

[0017] Preferably, the system is arranged to adjust the electrode composition of said composite electrodes depending on determined changes in the state of the wound.

[0018] The polarity of the applied electrical signal, and/or one or more other characteristics of the applied electrical signal may also be selected and/or changed depending on the determined state of the wound and/or on determined changes in the state of the wound.

[0019] The array typically comprises a two dimensional array electrodes, preferably arranged in a substantially rectangular shape. The array should comprise at least three electrodes, but typically comprises at least twenty five electrodes. In typical embodiments, the electrode array is incorporated into a wound dressing.

[0020] The present invention is particularly concerned with treating and monitoring wounds in a subject's skin, and therefore also in the tissue that forms the skin, not just the outer layer of skin. Accordingly, references herein to skin are intended to embrace also any tissue that may be damaged or exposed when skin is wounded.

[0021] Further advantageous aspects of the invention will become apparent to those ordinarily skilled in the art upon review of the following description of a specific embodiment and with reference to the accompanying drawings.

Brief Description of the Drawings

[0022] An embodiment of the invention is now described by way of example and with reference to the accompanying drawings in which:

Figure 1 is a block diagram of a wound healing system embodying one aspect of the invention;

Figures 2A to 2D are schematic diagrams of an electrode array suitable for use in the system of Figure 1, the array of each Figure being shown in a different configuration and superimposed on a wound; and

Figure 3 is a schematic representation of the effect of inter electrode distance on the depth of penetration of the applied electrical field.

Detailed Description of the Drawings

[0023] Referring now to Figure 1 of the drawings, there is shown, generally indicated as 10, a wound healing system embodying one aspect of the invention. The system is particularly concerned with healing wounds formed in the skin of a patient (typically human), the wound area typically comprising one or more portions of relatively damaged or unhealthy tissue and relatively undamaged or intact skin. The system 10 comprises at least one electrode array 12 (only one shown) comprising a plurality of electrodes 14. The electrodes 14 are arranged in a two dimensional array. In the illustrated embodiment, the array 12 is a 7 x 7 array, although the array 12 may alternatively have more or fewer electrodes 14. The illustrated array 12 is rectangular, or more particularly square, but may take alternative shapes, e.g. substantially circular or polygonal. The distribution of the electrodes 14 within the array 12 may be regular or irregular. The electrodes 14 themselves are shown as rectangular but may take any suitable shape.

[0024] Each electrode 14 is electrically connected to a respective lead 16, or other suitable signal conductor(s), by which electrical signals may be supplied to or from the electrode 14 during use. For convenience, the leads 16 are brought together at an edge of the array 12 and incorporated into a connector 20 by which electrical signals can be sent to, or received from, the array 12. In Figure 1, for clarity the individual leads 16 are not shown connected to each electrode 14, although some of them are shown as part of the connector 20.

[0025] Typically, the electrodes 14 are carried by a substrate 18. This may be achieved by any suitable means, for example screen printing. The electrodes 14 and leads 16 may be formed from any suitable electrically conductive material, especially conductive inks that are amenable to screen printing. The substrate 18 may be formed from any suitable material, typically an electrically insulating material, e.g. polyester. The substrate 18 may be comprised of one continuous sheet (as illustrated) or may be provided in strips, each strip carrying one or more electrodes. In either case, the electrodes 14 in the array 12 are physically, or spatially, close to one another such that they form part of a common device for applying electrical signals to a localised area, in particular a wound.

[0026] By way of example, further details concerning the formation of a suitable electrode array may be found in International PCT patent application WO 2004/049937, which discloses a 'smart dressing' system that enables the monitoring of a wound site using a multi-electrode array incorporated into the dressing. The system of WO 2004/049937 differentiates between intact skin and a wound by measuring, for example, the impedance under each electrode on the array. The resulting data can be used to generate a wound map according to, for example, the relative magnitudes of the measured skin impedances.

[0027] Optionally, one or more reference electrodes 22 (only one present in the illustrated embodiment) may be provided. The, or each, reference electrode 22 is conveniently provided on the array 12, in any suitable manner, preferably adjacent the array 12. The reference electrode 22 may be used to provide a reference signal for impedance measurements as, for example, is described in more detail in WO 2004/049937.

[0028] The array 12, including the substrate 18 and, when present, the reference electrode(s) may be incorporated into a wound dressing. This may be achieved in any suitable manner, for example as described in WO 2004/049937.

[0029] The electrodes 14, 22 are electrically connected to the rest of the system 10 via the connector 20. Any other suitable means for electrical communication between the electrodes 14, 22 and the system 10 may be used in which case some or all of the leads 16 may be dispensed with.

[0030] The system 10 includes means for applying an electrical signal to one or more of the electrodes 14 simultaneously. In one mode of use, the electrical signal comprises a therapeutic signal, for example an iontophoretic signal, or other signal used in the electrostimulation of wounds. The signal is generated by a signal generating apparatus which, in the illustrated embodiment, comprises a signal generating circuit 27 under the control of a controller 26. In this example, the controller 26 conveniently takes the form of a suitably programmed microcontroller, although it may alternatively take other forms. The illustrated signal generating circuit 27 comprises a signal generator 29, a voltage booster 30, a current controller 32, and a DC controller 28. A power supply 31, e.g. in the form of a battery, is also provided to supply electrical power to the circuit.

[0031] The signal generating circuit 27 is advantageously capable of generating a range of adjustable waveforms (e.g. continuous, pulsed, square wave current/voltage etc.). By way of example, the signal generating circuit may comprise a pulse generating circuit that enables the adjustment of amplitude, frequency and/or duty cycle. It will be understood that the circuit 27 of Figure 1 is not limiting and that a variety of alternative signal generating circuits could be used instead.

[0032] The signal is provided to a switching device 24, the setting of which determines to which electrode(s) 14 the signal is supplied. The switching device 24 typically comprises a respective switch (not shown) for each electrode 14, the setting of which determines whether the respective electrode 14 is electrically connected to the signal generator 27 in order to receive the electrical signal, or connected to a return line 40 in order to complete the circuit, i.e. the setting of the switches in the device 24 determines whether the respective electrodes 14 act as an anode or a cathode (although depending on the composition of the composite electrodes, some of the individual electrodes 14 may not be involved in the circuit). In the present embodiment, the switching device 24 is controlled by the controller 26 using a demultiplexer 34 that allows each of the respective switches to be set individually.

[0033] In the illustrated embodiment, the controller 26 is adapted for communication with a computer 36. The computer 36 is arranged to receive data from the controller 36 (and/or via a user interface (not shown)), to analyse the received data and to determine how to configure the electrodes 14 in the array 12 (as is described in more detail hereinafter). The computer 36 may also determine the characteristics of the electrical signal to be generated by the system 10. The computer 36 then instructs the controller 36 to cause the array 12 to be configured accordingly (by means of the switching device 24) and to cause the selected electrical signal to be sent to the array 12. In this embodiment, the computer 36 and controller 26 together provide means for controlling the system 10 and, in particular, means for determining how the electrodes 14 in the array 12 are configured. To this end, the computer 36 supports appropriate computer software.

[0034] In the preferred embodiment, the computer 36 is programmed to determine, for example from data received from the array 12, the state of the tissue beneath the array 12 (e.g. which portions are damaged, which are intact and relative states in between). This allows the computer 36 to determine how to configure the array 12. By way of example, this may be achieved by a method the same or similar to that disclosed in WO 2004/049937, i.e. by differentiating between intact skin and a wound by measuring, for example, the impedance (or other electrical characteristic) under each electrode of the array. To this end, the system 10 may include an impedance analyser (not shown) the same or similar to the impedance analyser disclosed in WO 2004/049937. The impedance analyser may take the form of computer software supported by the computer 36, or may be a separate unit (not illustrated) in communication with the computer 36. It will be understood that alternative means for controlling the system 10 other than the computer 36 and controller 26 may be used. For the purposes of impedance measurement, the system 10 may also include a back electrode 33, which may be arranged and used as described in WO 2004/049937.

[0035] Communication between the controller 26 and the rest of the system 10 may be implemented by any convenient means and is indicated by broken lines in Figure 1. In the illustrated embodiment, the controller 26 is in communication with the DC control 28 to control the circuitry 27, and with the switching device 24 to receive signals from the relevant electrodes 14 depending on the setting of the switches.

[0036] In one mode of use, the electrodes 14 are arranged into one or more groups, each group comprising one or more electrode 14. The electrodes 14 in each group are electrically connected together, or at least arranged to carry a common electrical signal. Hence, each electrode group acts as a respective single electrode and may be referred to as a composite electrode. Electrostimulation signals may then be applied via the composite electrode(s). Typically, first and second composite electrodes are defined. In typical modes of use, d.c. signals are applied to the wound and so one of the composite electrodes may be designated as the anode, and the other may be designated as the cathode. In alternative embodiments, the electrical signals applied to the wound

may comprise pulses or a.c. signals.

[0037] For example, in a mode of use where the "wound" composite electrode (i.e. a composite electrode positioned in use over a wounded area of tissue and/or skin) is designated as the negative electrode, the system 10 is arranged to simultaneously supply a common electrical signal to all of the electrodes 14 in the composite cathode (positive composite electrode), the composite anode providing a signal return path to the system 10. In the illustrated embodiment, the electrical grouping, or connection, of the electrodes 14 is achieved by the switching device 24. For example, the respective switch for each electrode 14 forming part of the composite cathode is set to connect its respective electrode 14 to the signal generator 27, while the respective switch for each electrode 14 forming part of the anode is set to connect its respective electrode 14 to the return line 40.

[0038] In the preferred embodiment, one of the composite electrodes is arranged for positioning, in use, over healthy or relatively healthy skin and/or tissue and is referred to hereinafter as the "healthy electrode". The other composite electrode is arranged for positioning, in use, over damaged, or relatively damaged, skin and/or tissue and is referred to hereinafter as the "wound electrode". Advantageously, the wound electrode is shaped and dimensioned to substantially fill the, or each, portion of wounded tissue beneath the array 12. The healthy electrode may be shaped and dimensioned to substantially surround the, or each, portion of wounded tissue. The shape and dimensions of the composite electrodes are determined by the electrode(s) 14 of which they are composed. The typical arrangement is such that the composite anode is the healthy electrode, while the composite cathode is the wound electrode, although the reverse arrangement is possible.

[0039] During use, the electrode composition of the composite electrodes may be changed by the system 10. In particular, the computer 36 determines which electrode(s) 14 are to form part of the respective composite electrodes and instructs the controller 26 to cause the array 12 to be configured accordingly. For example, one or more of the respective electrode(s) 14 that make up one or both of the composite electrodes may be changed, and/or the polarity of the composite electrodes may be changed. Advantageously, changing the composition of the composite electrodes is performed in response to detected changes in the state of the wound. For example, as the wound heals, the portions of tissue that are regarded as damaged or healthy may change and so it may be desired to change the shape, size and/or position of the healthy and/or wound electrodes.

[0040] In the preferred embodiment, the system 10 is arranged to perform the wound monitoring technique described in WO 2004/049937, or a similar method of monitoring a wound. To this end, the system 10 is operable in a second mode of operation in which it measures one or more electrical characteristics of the wound, e.g. impedance, in order to provide a map of the wound. In the second mode of operation, the array 12 may for example be used in the manner described in WO 2004/049937. For example, in conjunction with the computer 36, the controller 26 configures some or all of the electrodes 14, 22, 33 (as applicable), the switch device 24, and the signal generating circuit 27, to implement any one of the wound mapping methods disclosed by WO2004/049937. Hence, the computer 36 is able to determine the state of the wound from the data provided to it by the array 12. This allows the computer 36 to determine which portions of the tissue under the array 12 are to be regarded as healthy and which are to be regarded as damaged. This in turn allows the computer 36 to select a corresponding composition for the respective composite electrodes in the first mode of operation. The selection of the composition of the composite electrodes may be achieved by any other method, for example manual selection by a user.

[0041] It will be seen therefore that it is possible to use the electrode array 12 in a wound mapping mode to locate the wound and determine its shape, and then to use this information to group electrically subsets of the array's electrodes 14 to form an optimally shaped and sized composite wound electrode and healthy electrode. In particular, electrodes 14 that are identified as being located over healthy intact skin are connected together electrically to form a single composite electrode (the healthy electrode). Electrodes 14 that are identified as being located over the wound are connected together electrically and thus form a second composite electrode (the wound electrode). This is the simplest case and assumes that the wound forms a single 'island' surrounded by healthy skin.

[0042] Given that the position, shape and size of the wound can be monitored by the wound mapping measurements, a further advantage of this approach is that the composite electrodes can be continuously or intermittently reshaped (manually or automatically by the system 10) as wound healing occurs and the wound area decreases and/or changes shape. This allows optimal targeted delivery of the therapeutic signals, i.e. a 'responsive' electrode system incorporating feedback control is provided.

[0043] Figure 2A shows an example of how electrodes 14 in the array 12 on either side of a wound 50 (indicated in broken outline) can be grouped together electrically to form composite stimulation electrodes. In Figure 2A, the electrodes 14A (shown hatched) to the left of the wound 50 are grouped electrically to form one composite stimulation electrode, while the electrodes 14B (shown with solid fill) on the right are grouped electrically to form the other composite stimulation electrode. In this case, the electrical signal is applied, in use, across substantially the entire wound 50.

[0044] Figure 2B shows an example of how the electrodes in the array 12 may be configured to form a "wound" composite electrode and a "healthy" composite electrode. In Figure 2B, it is assumed that, based on im-

pedance or potential, or related measurements made at the electrodes 14 in the second mode of operation (or by manual inspection), the wound 50 is determined to be under a group of central electrodes 14C (shown hatched). The electrodes 14C are connected electrically together in the first mode of operation to form the composite "wound" electrode. The electrodes 14D (shown with solid fill) located over intact, or relatively healthy, skin in this simplistic example, are also grouped together electrically to form the composite "healthy" electrode.

[0045] It is noted that the electrode(s) used to apply the therapeutic electrical signal, or waveform, (denoted 'healthy' electrode in the example above) could be located on any remote skin site on the patient and do not necessarily have to be formed from the array electrodes 14 located over healthy tissue. More generally, the "healthy" electrode, irrespective of polarity, may be located elsewhere on the patient and need not necessarily be implemented by the electrodes 14.

[0046] It is also noted that it is not necessary to use all of the electrodes 14 in the array 12 to form the composite electrodes. For example, only those electrodes 14 that are closest to the wound edge (on either or both sides of the wound edge) may be used to form the composite electrodes. This is illustrated in Figure 2C where electrodes 14E (shown hatched) are those located over the wound 50 and are electrically grouped together to form the composite wound electrode. The electrodes 14H (shown with no fill) are located over intact skin and do not form part of a composite electrode in this instance. The electrodes 14F (shown in solid fill) are located at the edges of the wound 50 on the side of intact tissue. The electrodes 14F can be electrically grouped together to form a composite 'healthy' electrode that is smaller than the one shown in Figure 2B.

[0047] Choosing only some of the electrodes that are suitable for creating the composite stimulation electrodes has the advantage of enabling the focusing of electrical current (density) in specific areas, for example under the composite cathode (electrodes 14E in this example) for increased effect, while ensuring that the current density under the composite anode (electrodes 14F in this example) is at a lower level to minimise the potentially adverse reactions which can take place.

[0048] A further advantage of only using specific subsets of the electrodes that are eligible to create the composite stimulation electrodes is the ability to set the distance between the composite stimulation electrodes. For example, the inter-composite electrode distance can be set to be very close, with just the wound edge in between, to accentuate the field in this region. This is believed to be beneficial in accelerating wound healing. However, wounds vary not only in area but also in depth. The depth of penetration of the applied therapeutic electrical field can be influenced by the distance between the two composite electrodes used to apply the therapeutic signal. If the electrodes are located relatively far apart, the field penetrates more deeply than if they are relatively close together. This is illustrated in Figure 3, which shows a first pair of relatively close electrodes E1, E2 placed on a skin surface 60. The penetration of the electrical field F1 produced by the application of an electrical signal to the electrodes E1, E2 is relatively shallow. In contrast, the electrical field F2 produced by a second pair of electrodes E4, E5, which are relatively far apart, penetrates deeper into the tissue 62.

[0049] In embodiments of the present invention, the individual electrodes 14 forming the composite 'wound 'and 'healthy' electrodes can be selected to be as far apart or as close together as is necessary to set the required penetration of the electrical field into the wound to enhance healing. The selection can for example be performed by the computer 36, or may be manually selected via, for example, a user interface.

[0050] In the main body of a wound there may be 'islands' or patches of healing. In this case, combinations of electrodes 14 can be chosen manually or automatically to form appropriately sized, shaped and located composite 'wound' and 'healthy' electrodes. This allows the system 10 to produce the desired electrical field in the targeted patches. In this case, the healthy composite electrode comprises electrodes 14 located over intact skin or relatively healthy tissue that surrounds the patches of more severe wound. The wound composite electrode comprises all of the electrodes 14 located over the wound patches.

[0051] This is illustrated in Figure 2D, in which all of the electrodes 14G (shown hatched) that are located over the wound patches 50A, 50B are electrically connected together to form one composite wound electrode. Some or all of the electrodes 14I (shown in solid fill) over the surrounding, or remaining, healthy, or relatively healthy, tissue or skin can be connected together to form the composite healthy electrode. The electrodes shown with no fill do not form part of a composite electrode in this instance.

[0052] The preferred system 10 is arranged to apply, in the first mode of operation, a range of customised electrical waveforms (e.g. d.c. or a.c., continuous, or pulsed, or square wave current/voltage signals) to pairs or selected groups of electrodes 14 in the array 12, depending on the state of the wound at any given time. To generate the signals, a signal generator 29, for example as shown in the block diagram in Figure 1, which enables the adjustment of amplitude, frequency and/or duty cycle may be used. Different types of waveforms can be applied to different areas of the wound depending on the stage of wound healing using the controlling software supported by the computer 36. The combinations of electrodes 14 used can be varied during the healing process in order to direct the therapeutic waveforms/signals to the appropriate areas of the wound. Typically, it is a cathode that is placed over the wound and an anode placed off the wound. In embodiments of the present invention, combinations of electrodes 14 can be electrically grouped together to form the composite anode, and combinations

of electrodes 14 can be electrically grouped together to form the composite anode. These combinations can be chosen to best replicate the size and shape of the targeted area(s) of the wound and to produce the desired electrical field in the targeted area(s), including the desired depth of penetration in the target area(s).

[0053] Advantageously, in the second mode of operation, the system 10 performs wound monitoring to assess the state of the wound and so to provide data for use in the first mode of operation.

[0054] Although it is commonly accepted that electrical stimulation should be started with negative polarity to reduce the bacterial burden and clear the wound from sanies, there is evidence that a change in polarity is beneficial thereafter to promote further wound healing. This may in some cases be due to the wound reaching a different stage in healing which benefits more from the reversed polarity. Given that preferred embodiments of the present invention include a wound monitoring capability, the stage of healing of individual parts of the wound can be monitored in the second mode of operation and the polarity of the therapeutic signal reversed accordingly during the first mode of operation.

[0055] In the embodiment of Figure 1, the information (e.g. impedance, and/or potential, etc.) measured at the electrodes 14 in the array 12 during the second mode of operation is analysed by the computer 36 (which may for example be a personal computer or laptop) and the best stimulation parameters are determined via an appropriate software implemented algorithm (as for example taught by WO 2004/049937). The computer 36 may calculate one or more of the following parameters relating to the therapeutic electrical signal: waveform type, polarity, frequency, amplitude and/or duration of signal. In addition, the computer 36 calculates the optimal combinations of electrodes 14 for forming the composite electrodes. By way of example, the computer 36 may compare the measured impedance values (and/or other measured characteristics) against data stored in a database (not shown) to determine appropriate parameters for the signal and/or electrode composition.

[0056] This data is then communicated to the controller 26. If desired, some or all of these parameters, and/or the composition of the composite electrodes, can alternatively be chosen manually. The controller 26 causes the supporting circuitry 27 to generate the appropriate therapeutic signal, which is amplified and applied to the appropriate electrodes 14 via the array of switches 24 which is controlled by the demultiplexer 34. The desired therapeutic signal is simultaneously (in parallel) applied through the respective individual electrodes 14 that make up the composite stimulation electrodes. Several different patches within the wound can be treated simultaneously with the requisite polarity. Additionally, it is possible to administer different therapeutic electrical signals to different wound areas, although this would typically be implemented in sequence rather than simultaneously.

[0057] Optionally, once the treatment parameters and/or other data concerning the configuration of the system are received by the controller 26, the system 10 can optionally be disconnected from the computer 36. The controller 26 may be programmed to make some adjustments to the characteristics of the applied electrical signal and/or the composition of the composite electrodes based on the measured impedance values (and/or other measured characteristics) without communicating with the computer 36.

[0058] In an alternative embodiment, the computer 36 may perform the role of the controller 26 without the need for a separate microcontroller or other device. In any event, the computer 36 is arranged for communication with the system 10 by any conventional means, preferably a wireless connection in which case the system 10 and computer 36 are equipped with suitable transceiving devices.

[0059] Optionally, the system, or at least part of it, can be incorporated into a wound dressing. In such cases, at least the array 12 is incorporated into the wound dressing. For example, in the example of Figure 1, the signal generator 27, switches 24, electrode array 12 and power supply may be incorporated into the wound dressing. Other components, including the controller 26 and/or demultiplexer 34 and/or the computer 36, may also be incorporated into the wound dressing as appropriate. In preferred embodiments, the computer 36 is not incorporated into the dressing and communicates with the system 10 in the dressing via a wireless communication link, or other communication link, e.g. an optocoupler.

[0060] The system 10 may be incorporated into a wound dressing in the manner described in WO 2004/049937. For example, the substrate 18 may have its reverse face fixed, e.g. by means of an adhesive layer (not shown) to the dressing such that the electrodes face outwardly from the dressing. A conductive electrode gel, for example hydrogel (not shown) may be provided over the electrodes. The gel may comprise a single sheet covering all electrodes, or a plurality of gel pads, each pad covering a respective one or more of the electrodes. In the case where a sheet or pad of gel covers more than one electrode, the portions of the gel between electrodes may be rendered relatively non-conductive in order to electrically separate the relevant electrodes. The gel may also cover the leads 16, as appropriate, the leads 16 being suitably insulated.

[0061] It will be apparent from the foregoing that preferred embodiments of the invention enable the responsive and optimal targeting of wound healing electrotherapy by monitoring the wound's condition and location and using this information to select and modify the size, shape and/or location of composite electrotherapeutic electrodes and, optionally, to also modify the polarity and waveform characteristics of the applied electrotherapeutic signal. In particular, the shape of the or each composite electrode may be selected to substantially match the determined shape of the wound, especially the perimeter, or part of the perimeter of the wound. Similarly, the size

of the or each composite electrode may be selected to substantially match the determined size of the wound, or wound portion, and/or the location of the or each composite electrode may be selected to substantially match the determined location of the wound, or wound portion.

Claims

1. A wound healing system (10) comprising:

means (29) for generating an electrical signal;
an array (12) of electrodes (14) incorporated in a device for applying said electrical signal to a wound;
means for determining the state of the wound;
means (24, 26, 36) for creating at least two composite electrodes (14a-14l), each composite electrode being created from at least one of said electrodes (14) in the array (12) and acting as a single electrode, the system (10) being arranged to cause a respective one or more electrodes (14) of the array (12) to form the respective two composite electrodes (14a-14l) depending on desired shape, size and/or location of the respective composite electrodes (14a-14l), the size, the shape or location of each composite electrode being determined by which electrode or electrodes of the array, makes up said composite electrode; and
means (27) for causing said electrical signal to be applied to said wound (50) via said at least two composite electrodes (14a-14l), one composite electrode being designated as an anode and the other being designated as a cathode,
wherein said means for creating (24, 26, 36) are arranged to determine which electrode or electrodes of the array make up said at least two composite electrodes depending on the determined state of the wound and the wound healing system (10) includes means (24) for selecting said respective one or more electrodes (14) of the array (12) for forming the respective two composite electrodes (14a-14l) based on information concerning the state of the wound (50), the size, shape and/or location of said at least two composite electrodes (14a-14l) being determined respectively by the size, shape and /or location of the wound (50) with respect to the array (12), the composition of said at least two composite electrodes being adjustable in response to changes in the determined state of the wound.

2. A wound healing system (10) as claimed in claim 1, **characterized in that** said means for determining the state of the wound includes means for measuring one or more electrical characteristics of the wound; and means for analysing the, or each, measured electrical characteristics to determine the state of the wound.

3. A wound healing system (10) as claimed in claim 1 or 2, **characterized in that** said system is operable in one mode of operation in which said means for determining determines the state of the wound, and another mode of operation in which said means for creating determines which electrode, or electrodes, make up said at least two composite electrodes depending on the determined state of the wound, and in which said electrical signal is applied to said wound via said at least two composite electrodes.

4. A wound healing system (10) as claimed in any preceding claim, **characterized in that** said at least two composite electrodes comprises a first composite electrode that is created from one or more array electrodes that are determined to be in register with said wound, said wound comprising more than one wound portion, said first composite electrode being created from, in respect of each wound portion, one or more respective array electrodes that are determined to be in register with the respective wound portion, said one or more array electrodes being selected such that said first composite electrode fills said wound, or the respective wound portion.

5. A wound healing system (10) as claimed in any preceding claim, **characterized in that** said at least two composite electrodes comprise a first composite electrode and a second composite electrode, each composite electrode being comprised of a respective one or more of said array electrodes, said first composite electrode being composed of one or more respective electrodes that are determined to be located at one side of the wound, the second composite electrode being comprised of one or more respective electrodes that are determined to be located at another side of said wound, such that in use said electrical signal is applied across said wound, said wound comprising a plurality of wound portions and wherein, in respect of each wound portion, said first composite electrode is composed of one or more respective electrodes that are determined to be located at one side of the respective wound portion, the second composite electrode being composed of one or more respective electrodes that are determined to be located at another side of the respective wound portion, such that in use said electrical signal is applied across said respective wound portions.

6. A wound healing system (10) as claimed in claim 5, **characterized in that** the second of said composite electrodes is created from one or more array electrodes that are determined to be located outside of said wound, said wound comprising more than one

wound portion, said second composite electrode being created from, in respect of each wound portion, one or more respective array electrodes that are determined to be outside of the respective wound portion, said second composite electrode being created only from electrodes that are determined to be located at an edge of the wound, or respective wound portion.

7. A wound healing system (10) as claimed in claim 6, **characterized in that** said second composite electrode is created from a plurality of array electrodes that are determined to surround said wound or respective wound portion.

8. A wound healing system (10) as claimed in any preceding claim, **characterized in that**
it further includes means for allowing a user to input data concerning the state of a wound, and / or
it further includes means for allowing a user to select the electrode composition of said at least two composite electrode.

9. A wound healing system (10) as claimed in any preceding claim, **characterized in that** said means for creating creates said composite electrodes by electrically connecting together the, or each, electrode of the array that is to form part of the respective composite electrode.

10. A wound healing system (10) as claimed in claim 9, **characterized in that** the means for creating includes a switching device arranged to selectably connect, electrically, each array electrode to one or other of a positive and a negative terminal by which said electrical signal is applied in use to the composite electrodes.

11. A wound healing system (10) as claimed in any preceding claim, **characterized in that** the shape of said at least two composite electrodes is selected to match the determined shape of the wound, or wound portion, and/or the size of said at least two composite electrodes is selected to match the determined size of the wound, or wound portion, and/or the location of said at least two composite electrodes is selected to match the determined location of the wound, or wound portion.

12. A wound healing system (10) as claimed in any one of claims 2 to 11, **characterized in that** said means for determining the state of the wound employs said electrode array to apply an electrical signal to said wound in order to measure said one or more electrical characteristics of the wound.

13. A wound healing system (10) as claimed in any preceding claim, **characterized in that**
the polarity of the applied electrical signal is adjustable depending on the determined state of the wound and/or on determined changes in the state of the wound, and / or
at least said electrode array is incorporated into a wound dressing.

Patentansprüche

1. Wundheilsystem (10), das Folgendes umfasst:

Mittel (29) zum Erzeugen eines elektrischen Signals;
ein Array (12) von Elektroden (14), die in eine Vorrichtung integriert sind, zum Anlegen des elektrischen Signals an eine Wunde;
Mittel zum Bestimmen des Zustands der Wunde;
Mittel (24, 26, 36) zum Erstellen von mindestens zwei zusammengesetzten Elektroden (14a-14l), wobei jede zusammengesetzte Elektrode aus mindestens einer der Elektroden (14) im Array (12) erstellt wird und als einzelne Elektrode fungiert, wobei das System (10) angeordnet ist zu bewirken, dass eine jeweilige oder mehrere Elektroden (14) des Arrays (12) die jeweiligen zwei zusammengesetzten Elektroden (14a-14l) bilden, abhängig von der gewünschten Form, Größe und/oder Lage der jeweiligen zusammengesetzten Elektroden (14a-14l), wobei die Größe, die Form oder die Lage jeder zusammengesetzten Elektrode dadurch bestimmt wird, aus welcher Elektrode oder welchen Elektroden des Arrays die zusammengesetzte Elektrode besteht; und
Mittel (27) zum Bewirken, dass das elektrische Signal via die mindestens zwei zusammengesetzten Elektroden (14a-14l) an die Wunde (50) angelegt wird, wobei eine zusammengesetzte Elektrode als Anode benannt ist und die andere als Kathode benannt ist,
wobei die Mittel zum Erstellen (24, 26, 36) angeordnet sind, in Abhängigkeit vom bestimmten Zustand der Wunde zu bestimmen, aus welcher Elektrode oder welchen Elektroden des Arrays die mindestens zwei zusammengesetzten Elektroden bestehen, und das Wundheilsystem (10)
Mittel (24) zum Auswählen der jeweiligen einen oder mehreren Elektroden (14) des Arrays (12) zum Bilden der jeweiligen zwei zusammengesetzten Elektroden (14a-14l) auf Basis von Informationen, die den Zustand der Wunde (50) betreffen, beinhalten, wobei die Größe, die Form und/oder die Lage der mindestens zwei zusammengesetzten Elektroden (14a-14l) jeweils von der Größe, der Form und/oder der Lage der Wunde (50) mit Bezug auf das Array (12)

bestimmt werden, wobei die Zusammensetzung der mindestens zwei zusammengesetzten Elektroden in Reaktion auf Veränderungen am bestimmten Zustand der Wunde anpassbar ist.

2. Wundheilsystem (10) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Mittel zum Bestimmen des Zustands der Wunde Mittel zum Messen einer oder mehrerer elektrischer Eigenschaften der Wunde beinhalten; sowie Mittel zum Analysieren der oder jeder der gemessenen elektrischen Eigenschaften, um den Zustand der Wunde zu bestimmen.

3. Wundheilsystem (10) nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** das System in einem Betriebsmodus betreibbar ist, in dem die Mittel zum Bestimmen den Zustand der Wunde bestimmen, und einem anderen Betriebsmodus, in dem die Mittel zum Erstellen in Abhängigkeit vom bestimmten Zustand der Wunde bestimmen, aus welcher Elektrode oder welchen Elektroden die mindestens zwei zusammengesetzten Elektroden bestehen, und in dem das elektrische Signal via die mindestens zwei zusammengesetzten Elektroden an die Wunde angelegt wird.

4. Wundheilsystem (10) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die mindestens zwei zusammengesetzten Elektroden eine erste zusammengesetzte Elektrode umfassen, die aus einer oder mehreren Arrayelektroden erstellt wird, von denen bestimmt wird, dass sie mit der Wunde registerhaltig sind, wobei die Wunde mehr als einen Wundabschnitt umfasst, wobei die erste zusammengesetzte Elektrode mit Bezug auf jeden Wundabschnitt aus einer oder mehreren jeweiligen Arrayelektroden erstellt wird, von denen bestimmt wird, dass sie mit dem jeweiligen Wundabschnitt registerhaltig sind, wobei die eine oder die mehreren Arrayelektroden derart ausgewählt werden, dass die erste zusammengesetzte Elektrode die Wunde oder den jeweiligen Wundabschnitt füllt.

5. Wundheilsystem (10) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die mindestens zwei zusammengesetzten Elektroden eine erste zusammengesetzte Elektrode und eine zweite zusammengesetzte Elektrode umfassen, wobei jede zusammengesetzte Elektrode eine jeweilige eine oder mehrere der Arrayelektroden umfasst, wobei die erste zusammengesetzte Elektrode aus einer oder mehreren jeweiligen Elektroden zusammengesetzt ist, von denen bestimmt wird, dass sie sich auf einer Seite der Wunde befinden, wobei die zweite zusammengesetzte Elektrode eine oder mehrere jeweilige Elektroden umfasst, von denen bestimmt wird, dass sie sich auf einer anderen Seite der Wunde befinden, derart, dass das elektrische Signal im Gebrauch über die Wunde angelegt wird, wobei die Wunde eine Vielzahl von Wundabschnitten umfasst und wobei mit Bezug auf jeden Wundabschnitt die erste zusammengesetzte Elektrode aus einer oder mehreren jeweiligen Elektroden zusammengesetzt ist, von denen bestimmt wird, dass sie sich auf einer Seite des jeweiligen Wundabschnitts befinden, wobei die zweite zusammengesetzte Elektrode aus einer oder mehreren jeweiligen Elektroden zusammengesetzt ist, von denen bestimmt wird, dass sie sich auf einer anderen Seite des jeweiligen Wundabschnitts befinden, derart, dass das elektrische Signal im Gebrauch über die jeweiligen Wundabschnitte angelegt wird.

6. Wundheilsystem (10) nach Anspruch 5, **dadurch gekennzeichnet, dass** die zweite der zusammengesetzten Elektroden aus einer oder mehreren Arrayelektroden erstellt wird, von denen bestimmt wird, dass sie sich außerhalb der Wunde befinden, wobei die Wunde mehr als einen Wundabschnitt umfasst, wobei die zweite zusammengesetzte Elektrode mit Bezug auf jeden Wundabschnitt aus einer oder mehreren jeweiligen Arrayelektroden erstellt wird, von denen bestimmt wird, dass sie sich außerhalb des jeweiligen Wundabschnitts befinden, wobei die zweite zusammengesetzte Elektrode nur aus Elektroden erstellt wird, von denen bestimmt wird, dass sie sich an einem Rand der Wunde oder des jeweiligen Wundabschnitts befinden.

7. Wundheilsystem (10) nach Anspruch 6, **dadurch gekennzeichnet, dass** die zweite zusammengesetzte Elektrode aus einer Vielzahl von Arrayelektroden erstellt wird, von denen bestimmt wird, dass sie die Wunde oder den jeweiligen Wundabschnitt umgeben.

8. Wundheilsystem (10) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass**
es ferner Mittel beinhaltet, die es einem Benutzer erlauben, Daten einzugeben, die den Zustand einer Wunde betreffen, und/oder
es ferner Mittel beinhaltet, die es einem Benutzer erlauben, die Elektrodenzusammensetzung der mindestens zwei zusammengesetzten Elektroden auszuwählen.

9. Wundheilsystem (10) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Mittel zum Erstellen die zusammengesetzten Elektroden durch elektrisches Miteinanderverbinden der oder jeder Elektrode des Arrays erstellen, die einen Teil der jeweiligen zusammengesetzten Elektrode bilden soll.

10. Wundheilsystem (10) nach Anspruch 9, **dadurch**

gekennzeichnet, dass die Mittel zum Erstellen eine Schaltvorrichtung beinhalten, die angeordnet ist, jede Arrayelektrode mit einem oder einem anderen eines positiven und eines negativen Anschlusses, durch den das elektrische Signal im Gebrauch an die zusammengesetzten Elektroden angelegt wird, wählbar elektrisch zu verbinden.

11. Wundheilsystem (10) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Form der mindestens zwei zusammengesetzten Elektroden ausgewählt wird, um mit der bestimmten Form der Wunde oder des Wundabschnitts übereinzustimmen, und/oder die Größe der mindestens zwei zusammengesetzten Elektroden ausgewählt wird, um mit der bestimmten Größe der Wunde oder des Wundabschnitts übereinzustimmen, und/oder die Lage der mindestens zwei zusammengesetzten Elektroden ausgewählt wird, um mit der bestimmten Lage der Wunde oder des Wundabschnitts übereinzustimmen.

12. Wundheilsystem (10) nach einem der Ansprüche 2 bis 11,
dadurch gekennzeichnet, dass die Mittel zum Bestimmen des Zustands der Wunde das Elektrodenarray einsetzen, um ein elektrisches Signal an die Wunde anzulegen, um eine oder mehrere elektrische Eigenschaften der Wunde zu messen.

13. Wundheilsystem (10) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Polarität des angelegten elektrischen Signals in Abhängigkeit vom bestimmten Zustand der Wunde und/oder von bestimmten Änderungen des Zustands der Wunde anpassbar ist und/oder mindestens das Elektrodenarray in einen Wundverband integriert ist.

Revendications

1. Système de cicatrisation de plaie (10) comprenant :

un moyen (29) de génération d'un signal électrique ;
une matrice (12) d'électrodes (14) incorporée dans un dispositif d'application dudit signal électrique à une plaie ;
un moyen de détermination de l'état de la plaie ;
des moyens (24, 26, 36) de création d'au moins deux électrodes composites (14a à 14l), chaque électrode composite étant créée à partir d'au moins l'une desdites électrodes (14) de la matrice (12) et agissant comme une unique électrode, le système (10) étant agencé pour amener une ou plusieurs électrodes (14) respectives de la matrice (12) à former les deux électrodes composites (14a à 14l) respectives selon une forme, une taille et/ou un emplacement souhaités des électrodes composites (14a à 14l) respectives, la taille, la forme ou l'emplacement de chaque électrode composite étant déterminés par quelle électrode ou électrodes de la matrice constituent ladite électrode composite ; et
un moyen (27) pour provoquer l'application dudit signal électrique à ladite plaie (50) via lesdites au moins deux électrodes composites (14a à 14l), une électrode composite étant désignée en tant qu'anode et l'autre étant désignée en tant que cathode,
dans lequel lesdits moyens de création (24, 26, 36) sont agencés pour déterminer quelle électrode ou quelles électrodes de la matrice constituent lesdites au moins deux électrodes composites selon l'état déterminé de la plaie et le système de cicatrisation de plaie (10) comporte un moyen (24) de sélection desdites une ou plusieurs électrodes (14) respectives de la matrice (12) pour former les deux électrodes composites (14a à 14l) respectives d'après des informations concernant l'état de la plaie (50), la taille, la forme et/ou l'emplacement desdites au moins deux électrodes composites (14a à 14l) étant déterminés respectivement par la taille, la forme et/ou l'emplacement de la plaie (50) par rapport à la matrice (12), la composition desdites au moins deux électrodes composites étant ajustable en réponse à des changements de l'état déterminé de la plaie.

2. Système de cicatrisation de plaie (10) selon la revendication 1, **caractérisé en ce que** ledit moyen de détermination de l'état de la plaie comporte un moyen de mesure d'une ou de plusieurs caractéristiques électriques de la plaie ; et un moyen d'analyse de la ou de chaque caractéristique électrique mesurée pour déterminer l'état de la plaie.

3. Système de cicatrisation de plaie (10) selon la revendication 1 ou 2, **caractérisé en ce que** ledit système est opérationnel dans un mode de fonctionnement dans lequel ledit moyen de détermination détermine l'état de la plaie, et un autre mode de fonctionnement dans lequel ledit moyen de création détermine quelle électrode ou quelles électrodes constituent lesdites au moins deux électrodes composites selon l'état déterminé de la plaie, et dans lequel ledit signal électrique est appliqué à ladite plaie via lesdites au moins deux électrodes composites.

4. Système de cicatrisation de plaie (10) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** lesdites au moins deux électrodes composites comprenant une première électrode composite qui est créée à partir d'une ou de plusieurs

électrodes de matrice qui sont déterminées comme coïncidant avec ladite plaie, ladite plaie comprenant plus d'une portion de plaie, ladite première électrode composite étant créée, par rapport à chaque portion de plaie, à partir d'une ou de plusieurs électrodes de matrice respectives qui sont déterminées comme coïncidant avec la portion de plaie respective, lesdites une ou plusieurs électrodes de matrice étant sélectionnées de sorte que ladite première électrode composite remplisse ladite plaie, ou la portion de plaie respective.

5. Système de cicatrisation de plaie (10) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** lesdites au moins deux électrodes composites comprennent une première électrode composite et une seconde électrode composite, chaque électrode composite étant composée d'une ou de plusieurs électrodes respectives desdites électrodes de matrice, ladite première électrode composite étant composée d'une ou de plusieurs électrodes respectives qui sont déterminées comme étant situées d'un côté de la plaie, la seconde électrode composite étant composée d'une ou de plusieurs électrodes respectives qui sont déterminées comme étant situées d'un autre côté de ladite plaie, de sorte qu'en utilisation ledit signal électrique soit appliqué sur toute ladite plaie, ladite plaie comprenant une pluralité de portions de plaie et dans lequel, par rapport à chaque portion de plaie, ladite première électrode composite est composée d'une ou de plusieurs électrodes respectives qui sont déterminées comme étant situées d'un côté de la portion de plaie respective, la seconde électrode composite étant composée d'une ou de plusieurs électrodes respectives qui sont déterminées comme étant situées d'un autre côté de la portion de plaie respective, de sorte qu'en utilisation ledit signal électrique soit appliqué sur toutes lesdites portions de plaie respectives.

6. Système de cicatrisation de plaie (10) selon la revendication 5, **caractérisé en ce que** la seconde desdites électrodes composites est créée à partir d'une ou de plusieurs électrodes de matrice qui sont déterminées comme étant situées à l'extérieur de ladite plaie, ladite plaie comprenant plus d'une portion de plaie, ladite seconde électrode composite étant créée, par rapport à chaque portion de plaie, à partir d'une ou de plusieurs électrodes de matrice respectives qui sont déterminées comme étant à l'extérieur de la portion de plaie respective, ladite seconde électrode composite étant créée uniquement à partir d'électrodes qui sont déterminées comme étant situées au niveau d'un bord de la plaie, ou d'une portion de plaie respective.

7. Système de cicatrisation de plaie (10) selon la revendication 6, **caractérisé en ce que** ladite seconde électrode composite est créée à partir d'une pluralité d'électrodes de matrice qui sont déterminées comme entourant ladite plaie ou portion de plaie respective.

8. Système de cicatrisation de plaie (10) selon l'une quelconque des revendications précédentes, **caractérisé en ce que**
il comporte en outre un moyen pour permettre à un utilisateur d'entrer des données concernant l'état d'une plaie, et/ou
il comporte en outre un moyen pour permettre à un utilisateur de sélectionner la composition d'électrode desdites au moins deux électrodes composites.

9. Système de cicatrisation de plaie (10) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ledit moyen de création crée lesdites électrodes composites en raccordant électriquement ensemble la ou chaque électrode de la matrice qui doit faire partie de l'électrode composite respective.

10. Système de cicatrisation de plaie (10) selon la revendication 9, **caractérisé en ce que** le moyen de création comporte un dispositif de commutation agencé pour raccorder électriquement de façon sélectionnable chaque électrode de matrice à l'une ou à l'autre d'une borne positive et d'une borne négative grâce auxquelles ledit signal électrique est appliqué en utilisation aux électrodes composites.

11. Système de cicatrisation de plaie (10) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la forme desdites au moins deux électrodes composites est sélectionnée pour concorder avec la forme déterminée de la plaie, ou portion de plaie, et/ou la taille desdites au moins deux électrodes composites est sélectionnée pour concorder avec la taille déterminée de la plaie, ou portion de plaie, et/ou l'emplacement desdites au moins deux électrodes composites est sélectionné pour concorder avec l'emplacement déterminé de la plaie, ou portion de plaie.

12. Système de cicatrisation de plaie (10) selon l'une quelconque des revendications 2 à 11, **caractérisé en ce que** ledit moyen de détermination de l'état de la plaie emploie ladite matrice d'électrodes pour appliquer un signal électrique à ladite plaie afin de mesurer lesdites une ou plusieurs caractéristiques électriques de la plaie.

13. Système de cicatrisation de plaie (10) selon l'une quelconque des revendications précédentes, **caractérisé en ce que**
la polarité du signal électrique appliqué est ajustable selon l'état déterminé de la plaie et/ou des change-

ments déterminés de l'état de la plaie, et/ou
au moins ladite matrice d'électrodes est incorporée dans un pansement de plaie.

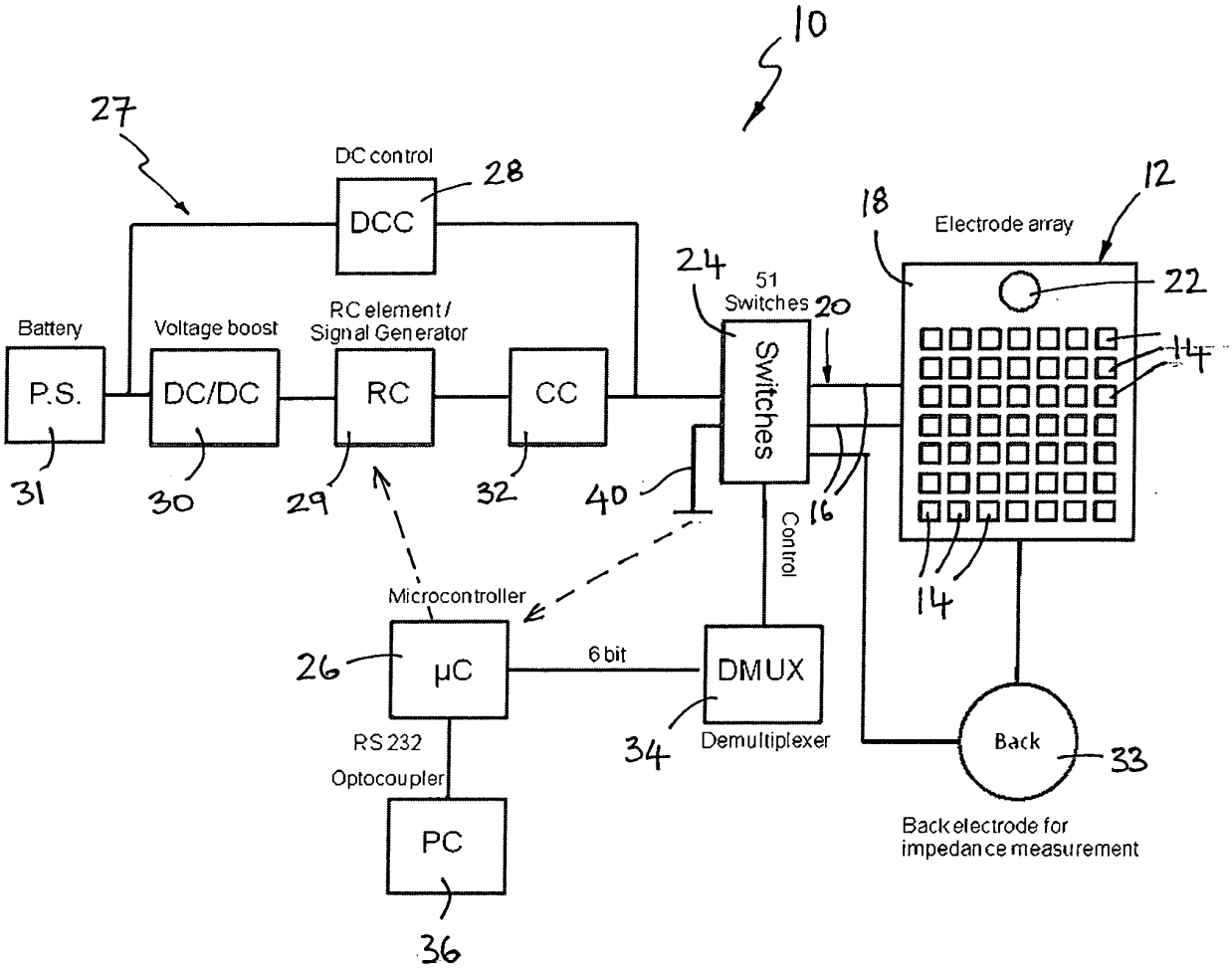
10
27
DC control
28
DCC
12
18
Electrode array
22
24
51
Switches
20
Battery
Voltage boost
RC element /
Signal Generator
P.S.
DC/DC
RC
CC
Switches
14
31
30
29
32
40
16
Control
Microcontroller
14
26
µC
6 bit
DMUX
RS 232
Optocoupler
34
Demultiplexer
Back
33
PC
Back electrode for
impedance measurement
36

Fig. 1

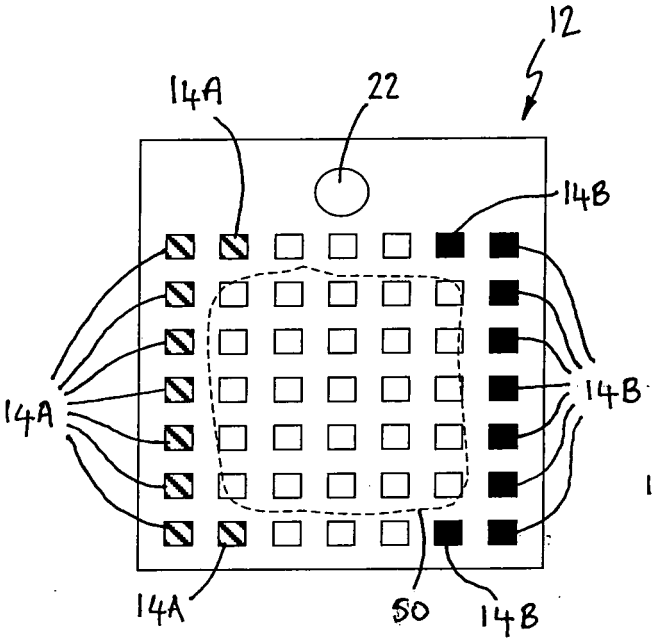

Fig. 2A

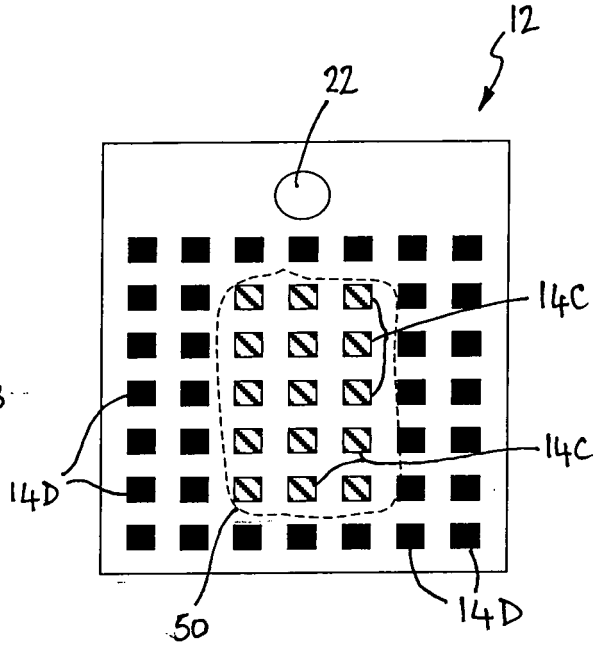

Fig. 2B

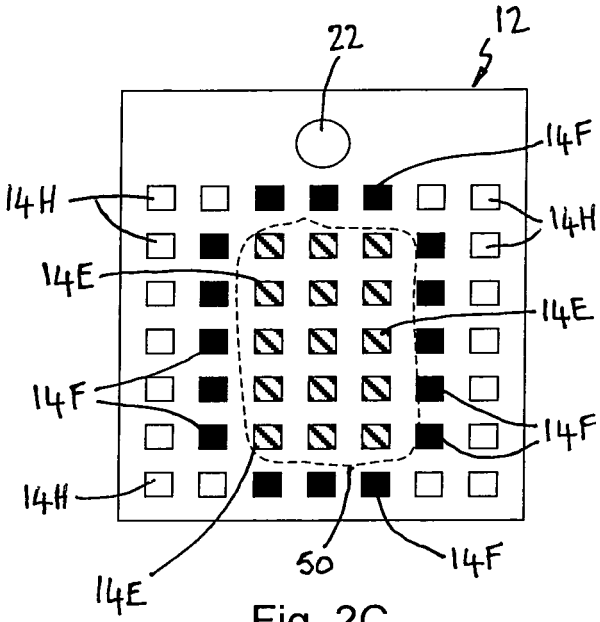

Fig. 2C

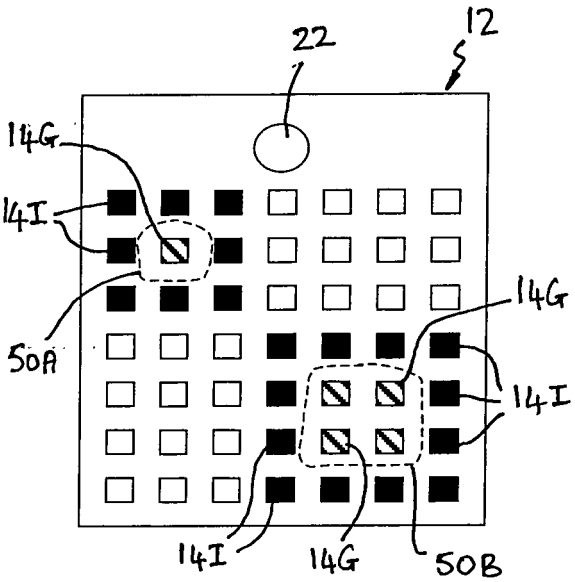

Fig. 2D

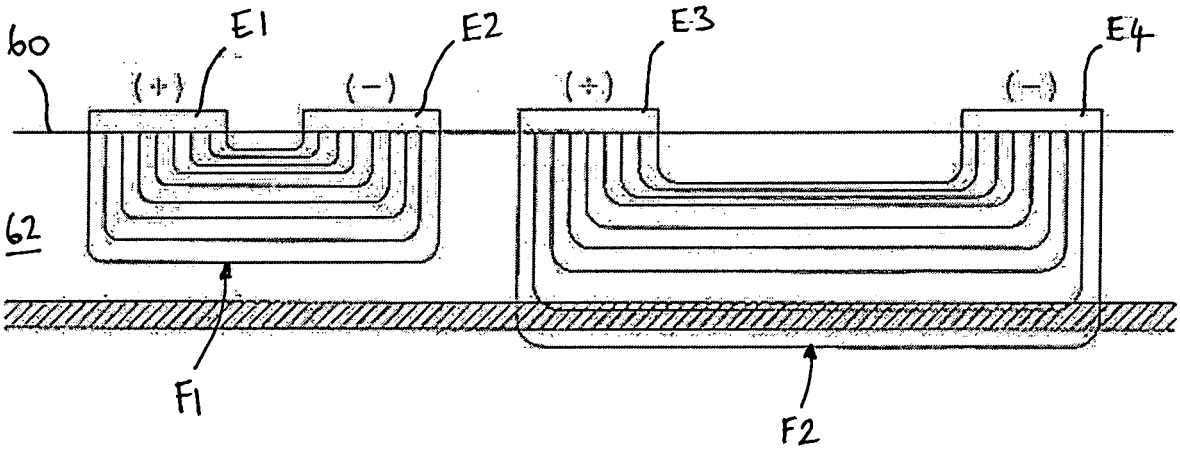

Fig. 3

REFERENCES CITED IN THE DESCRIPTION

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- US 7177696 B **[0005]**

专利名称(译)	电伤口愈合系统和方法		
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摘要(译)

一种伤口愈合系统，包括结合在用于向伤口施加电信号的装置中的电极阵列。电极可配置为形成至少一个复合电极，并且电信号通过复合电极施加到伤口。该系统优选包括用于确定伤口状态的装置，复合电极的电极组成取决于确定的伤口状态。有利地，复合电极的电极组合物可响应于确定的伤口状态的变化而调节。