

TITLE OF THE INVENTION

A SYSTEM AND METHOD FOR DELIVERING REDUCED PRESSURE TO SUBCUTANEOUS TISSUE

5 CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 61/098,164, filed September 18, 2008, which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

10 [0002] The present invention relates generally to tissue treatment systems and in particular to a system for delivering reduced pressure to subcutaneous tissue.

2. Description of Related Art

[0003] Clinical studies and practice have shown that providing a reduced pressure in proximity to a tissue site augments and accelerates the growth of new tissue at the tissue site. The applications of this phenomenon are numerous, but one particular application of reduced pressure involves treating wounds. This treatment (frequently referred to in the medical community as “negative pressure wound therapy,” “reduced pressure therapy,” or “vacuum therapy”) provides a number of benefits, including migration of epithelial and subcutaneous tissues, improved blood flow, and micro-deformation of tissue at the wound site. Together these benefits result in increased development of granulation tissue and faster healing times. Typically, reduced pressure is applied by a reduced pressure source to tissue through a porous pad or other manifold device. In many instances, wound exudate and other liquids from the tissue site are collected within a canister to prevent the liquids from reaching the reduced pressure source.

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BRIEF SUMMARY OF THE INVENTION

[0004] The problems presented by existing reduced pressure systems and reduced pressure dressings are solved by the systems and methods of the illustrative embodiments described herein. In one illustrative embodiment, a reduced pressure treatment system includes a first fluid pathway and a second fluid pathway, the first fluid pathway being in communication with a reduced pressure source. The system further includes a reduced pressure manifold having a substantially gas impermeable barrier and at least one outer conduit defining a lateral edge of an interior region. The outer conduit and the substantially gas impermeable barrier enclose a portion of the interior region. The outer conduit is in fluid communication with one of the first and second fluid pathways and has at least one opening in fluid communication with the interior region. An inner conduit is at least partially disposed within the interior region and is in fluid communication with another of the first and second fluid pathways. The inner conduit has at least one opening in fluid communication with the interior region.

[0005] In another illustrative embodiment, a reduced pressure manifold for applying reduced pressure treatment to a tissue site includes a substantially gas impermeable barrier. An outer conduit is positioned on the first side of the barrier and defines a perimeter around an interior region and is adapted to be fluidly connected to one of a reduced pressure source and a vent source. The outer conduit has at least one opening that is in fluid communication with the interior region. An inner conduit is positioned on a first side of the barrier and extends into the interior region. The inner conduit is adapted to be fluidly connected to another of the reduced pressure source and the vent source and has at least one opening in fluid communication with the interior region.

[0006] In another illustrative embodiment, a reduced pressure treatment system includes a reduced pressure source and a vent source. The system further includes a reduced pressure manifold having a first conduit shaped to define an interior region. The first conduit is in fluid communication with one of the reduced pressure source and the vent source. The first conduit has at least one opening in fluid communication with the interior region. A second conduit is at least partially disposed within the interior region and is in fluid communication with another of the reduced pressure source and the vent source. The second conduit has at least one opening in fluid communication with the interior region.

[0007] In yet another illustrative embodiment, a manifold for applying a reduced pressure treatment to a subcutaneous tissue site is provided. The manifold includes a first conduit shaped to define an interior region and being adapted to be fluidly connected to one of a reduced pressure source and a vent source. The first conduit has at least one opening in fluid communication with the interior region. A second conduit is at least partially disposed within the interior region and is adapted to be fluidly connected to another of the reduced pressure source and the vent source. The second conduit has at least one opening that is in fluid communication with the interior region.

[0008] In still another illustrative embodiment, a method for delivering reduced pressure to a tissue site is provided. The method includes delivering a fluid to the tissue site through a loop-shaped, first conduit, the first conduit defining a perimeter around an interior region. A reduced pressure is applied to the interior region through a second conduit positioned in the interior region, and tissue healing by products are removed from the interior region through the second conduit.

[0009] In another illustrative embodiment, a method for delivering reduced pressure to a tissue site includes applying a reduced pressure to the tissue site through a loop-shaped, first conduit, the first conduit defining a perimeter around an interior region. A fluid is delivered to the interior region through a second conduit positioned in the interior region. Tissue healing by-products are removed from the interior region through the first conduit.

[0010] Other features and advantages of the illustrative embodiments will become apparent with reference to the drawings and detailed description that follow.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 illustrates a perspective view of a reduced pressure treatment system having a reduced pressure manifold according to an illustrative embodiment;

5 [0012] FIG. 2 illustrates a schematic top view of the reduced pressure treatment system of FIG. 1, a barrier of the reduced pressure manifold not shown for purpose of clarity;

[0013] FIG. 3 illustrates a cross-sectional view of the reduced pressure treatment system of FIG. 2 taken along line 3-3 positioned at the tissue site;

10 [0014] FIG. 4 illustrates a cross-sectional view of the reduced pressure treatment system of FIG. 2 taken along line 4-4 positioned at the tissue site;

[0015] FIG. 5 illustrates a cross-sectional view of the reduced pressure treatment system of FIG. 2 taken along line 5-5 positioned at the tissue site;

15 [0016] FIG. 6 illustrates a schematic top view of a reduced pressure treatment system for providing reduced pressure and fluid to a tissue site according to an illustrative embodiment, the reduced pressure treatment system having a valve for reversing flow of fluid and reduced pressure;

[0017] FIG. 7 illustrates a cross-sectional view of the reduced pressure treatment system of FIG. 6 taken along the line 7-7 positioned at the tissue site;

20 [0018] FIG. 8 illustrates a schematic top view of a reduced pressure treatment system for providing reduced pressure and fluid to a tissue site according to an illustrative embodiment;

[0019] FIG. 9 illustrates a schematic top view of a reduced pressure treatment system for providing reduced pressure and fluid to a tissue site according to an illustrative embodiment; and

25 [0020] FIG. 10 illustrates a schematic top view of a reduced pressure treatment system for providing reduced pressure and fluid to a tissue site according to an illustrative embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0021] In the following detailed description of several illustrative embodiments, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration specific preferred embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is understood that other embodiments may be utilized and that logical structural, mechanical, electrical, and chemical changes may be made without departing from the spirit or scope of the invention. To avoid detail not necessary to enable those skilled in the art to practice the embodiments described herein, the description may omit certain information known to those skilled in the art. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the illustrative embodiments are defined only by the appended claims.

[0022] Referring now primarily to FIG. 1, an illustrative reduced pressure treatment system 100 includes a reduced pressure manifold 102 to apply a reduced pressure to a tissue site 104. The reduced pressure manifold 102 serves as a manifold for distributing reduced pressure. The term “manifold” as used herein generally refers to a substance or structure that is provided to assist in applying reduced pressure to, delivering fluids to, or removing fluids from a tissue site. The manifold typically includes a plurality of flow channels or pathways to improve distribution of fluids provided to and removed from the tissue site. The reduced pressure manifold 102 that serves as a manifold may include a number of layers as will be described further below.

[0023] The tissue site 104 may be the bodily tissue of any human, animal, or other organism, including bone tissue, adipose tissue, muscle tissue, neural tissue, dermal tissue, vascular tissue, connective tissue, cartilage, tendons, ligaments, or any other tissue. While the tissue site 104 may include a wound, diseased tissue, or defective tissue, the tissue site 104 may also be healthy tissue that is not wounded, diseased, or defective. Although the reduced pressure manifold 102 may be used with any tissue site, including open wounds, the reduced pressure manifold 102 is particularly useful when used on subcutaneous tissue sites such as, for example, the subcutaneous cavity and tissue site illustrated in FIG. 1.

[0024] The application of reduced pressure to the tissue site 104 may be used to promote the drainage of exudate and other liquids from the tissue site 104, as well as to stimulate the growth of additional tissue. In the case in which the tissue site 104 is a wound

site, the growth of granulation tissue and removal of exudates and bacteria promotes healing of the wound. The application of reduced pressure to non-wounded or non-defective tissue, including healthy tissue, may be used to promote the growth of tissue that may be harvested and transplanted to another tissue location.

5 **[0025]** As used herein, “reduced pressure” generally refers to a pressure less than the ambient pressure at a tissue site that is being subjected to treatment. In most cases, this reduced pressure will be less than the atmospheric pressure at which the patient is located. Alternatively, the reduced pressure may be less than a hydrostatic pressure associated with tissue at the tissue site. The reduced pressure delivered may be static or varied (patterned or
10 random) and may be delivered continuously or intermittently. Although the terms “vacuum” and “negative pressure” may be used to describe the pressure applied to the tissue site, the actual pressure reduction applied to the tissue site may be significantly less than the pressure reduction normally associated with a complete vacuum. Reduced pressure may initially generate fluid flow in the area of the tissue site. As the hydrostatic pressure around the tissue
15 site approaches the desired reduced pressure, the flow may subside, and the reduced pressure is then maintained. Unless otherwise indicated, values of pressure stated herein are gauge pressures. Consistent with the use herein, increases in reduced pressure or vacuum pressure typically refer to a relative reduction in absolute pressure, while decreases in reduced pressure typically refer to an increase in absolute pressure.

20 **[0026]** Unless otherwise indicated, as used herein, “or” does not require mutual exclusivity.

[0027] The reduced pressure is provided to the reduced pressure manifold 102 by a reduced-pressure delivery conduit 112. The reduced-pressure delivery conduit 112 receives reduced pressure from a reduced-pressure source 114. The reduced-pressure source 114 may
25 be any device or subsystem for supplying reduced pressure, including but not limited to a manually operated pump, a powered vacuum pump, a wall vacuum source, or any other device or system capable of supplying a reduced pressure. While the amount and nature of reduced pressure applied to a site will typically vary according to the application, the reduced pressure will typically be between about -5 mm Hg and about -500 mm Hg and more typically between
30 about -100 mm Hg and about -200 mm Hg. In one illustrative embodiment, the reduced pressure source 114 may be a battery-driven vacuum pump. In this example, the pump may use low amounts of power and be capable of operating for an extended period of time on a single charge of the battery.

[0028] One or more devices may be fluidly coupled between the reduced pressure manifold 102 and the reduced-pressure source 114. For example, representative device 116 is shown fluidly coupled on a portion of the reduced-pressure delivery conduit 112. The representative device 116 may be a fluid reservoir, or collection member, to hold exudates and other fluids removed. Other illustrative, non-limiting examples of devices 116 that may be included on the reduced-pressure delivery conduit 112 or otherwise fluidly coupled to the reduced-pressure delivery conduit 112 include, without limitation, a pressure sensing or feedback device, a volume detection system, a blood detection system, an infection detection system, a flow monitoring system, or a temperature monitoring system. Some of these devices may be integrally associated with the reduced-pressure source 114 or other aspects of the system 100.

[0029] The reduced pressure manifold 102 is adapted to contact or cover the tissue site 104 that is to be treated. As used herein, the term “cover” includes partially or fully covering. Also, a first object that covers a second object may directly or indirectly touch the second object, or may not touch the second object at all.

[0030] The reduced pressure manifold 102 is illustrated in FIG. 1 as being positioned at a subcutaneous tissue site. The reduced pressure manifold 102 may be placed at the tissue site either surgically or percutaneously by the use of, for example, laproscopic or endoscopic equipment. When the reduced pressure manifold 102 is placed at a subcutaneous tissue site, the presence of tissue surrounding the cavity in which the reduced pressure manifold 102 is positioned results in a substantially sealed tissue site without the need for a drape or cover as may be required by open-wound, reduced pressure treatment. In the embodiment illustrated in FIG. 1, the reduced pressure delivery conduit 112 passes percutaneously to the reduced pressure manifold 102.

[0031] The reduced-pressure delivery conduit 112 may be any tube, conduit, or flow path through which a gas, liquid, gel, or other fluid may flow. The possible embodiments of the reduced-pressure delivery conduit 112 are numerous, and non-limiting examples follow. The reduced-pressure delivery conduit 112 may have any cross-sectional shape, such as a circle, oval, polygon, or any other shape. In addition, the reduced-pressure delivery conduit 112 may be made from any material, and may be either flexible or inflexible. In FIG. 1, the reduced-pressure delivery conduit 112 fluidly couples the reduced pressure manifold 102 to the representative device 116 and the reduced-pressure source 114. However, reduced-pressure delivery conduit 112 may instead directly couple reduced pressure source 114 to the

reduced pressure manifold 102. Also, the reduced-pressure delivery conduit 112 may include one or more paths or lumens through which fluid may flow. For example, the reduced-pressure delivery conduit 112 may include two lumens with one lumen being used to deliver reduced pressure and one to monitor pressure to determine the amount of reduced pressure at the tissue site 104.

[0032] If the reduced pressure manifold 102 is used with an open wound or tissue site, a sealing member (not illustrated), such as a cover or drape, may be used to seal the reduced pressure manifold 102 at the tissue site. The sealing member may be any material that provides a fluid seal over the reduced pressure manifold 102 and a portion of a patient's epidermis 118 or the tissue surrounding the tissue site 104. The sealing member may, for example, be an impermeable or semi-permeable, elastomeric material. "Elastomeric" means having the properties of an elastomer. Generally, an elastomer is a polymeric material that has rubber-like properties. More specifically, most elastomers have elongation rates greater than 100% and a significant amount of resilience. The resilience of a material refers to the material's ability to recover from an elastic deformation. Examples of elastomers, which may be used in a sealing member, include, but are not limited to, natural rubbers, polyisoprene, styrene butadiene rubber, chloroprene rubber, polybutadiene, nitrile rubber, butyl rubber, ethylene propylene rubber, ethylene propylene diene monomer, chlorosulfonated polyethylene, polysulfide rubber, polyurethane, EVA film, co-polyester, and silicones. In an illustrative embodiment, the sealing member may be a drape such as those drapes used with surgical and other medical procedures.

[0033] If a sealing member is used to secure and seal the reduced pressure manifold 102 at an open tissue site, the sealing member may be secured to the surrounding epidermis 118 or tissue using an adhesive, gasket, or other attachment device. A connection member or other tubing adapter may also be used with the sealing member to permit connection with the reduced pressure delivery conduit 112 and to allow communication through the sealing member.

[0034] The reduced pressure treatment system 100 further includes a vent source 140 and a fluid delivery conduit 142 fluidly connecting the vent source 140 to reduced pressure manifold 102. A control unit 160 may be operably connected to either or both of the reduced pressure source 114 and the vent source 140 to control delivery of reduced pressure and fluid to the reduced pressure manifold 102. A filter 170 may be fluidly connected between the vent source 140 and the reduced pressure manifold to filter fluid delivered through the fluid

delivery conduit 142. More specifically, the filter 170 may prevent ingress of particulates or microbes from the atmosphere from entering the reduced pressure manifold 102 if the vent source 140 is opened to the atmosphere as described below.

[0035] In one illustrative embodiment, the vent source 140 is a valve that allows venting of the fluid delivery conduit 142 to atmosphere. Since the tissue site 104 and reduced pressure manifold 102 are typically exposed to a reduced pressure, opening the vent source 140 to atmosphere results in fluid (e.g. air) flowing through a vent port 141 of the vent source 140 and into the fluid delivery conduit 142 toward the reduced pressure manifold 102. The vent source 140 may be any type of valve, but in one illustrative embodiment, the vent source 140 is a valve that is capable of being opened or closed by the control unit 160. In another embodiment, the vent source 140 may be a pump or any other device that is capable of delivering a fluid to the reduced pressure manifold 102. While the vent source 140 may be operated or controlled by electrical means, the vent source 140 instead could be operated by purely mechanical means. For example, the vent source 140 may operate or be controlled based on a differential pressure similar to a relief valve. Alternatively, the vent source 140 may operate or be controlled according to a rate of change in pressure. In one embodiment, the vent source 140 may also be operated or controlled manually by a user.

[0036] Similar to the reduced pressure delivery conduit 112, the fluid delivery conduit 142 may be any tube, conduit, or flow path through which a gas, liquid, gel, or other fluid may flow. The fluid delivery conduit 142 may have any cross-sectional shape, such as a circle, oval, polygon, or any other shape. In addition, the fluid delivery conduit 142 may be made from any material, and may be either flexible or inflexible. The fluid delivery conduit 142 may further include one or multiple lumens.

[0037] Referring still to FIG. 1, but also to FIGS. 2-5, the reduced pressure manifold 102 is described in more detail. The reduced pressure manifold 102 includes an inner conduit 230 and an outer conduit 250 that may have a loop-shaped configuration. In one embodiment, the outer conduit 250 may be physically arranged or formed to create a closed loop that defines a perimeter of an interior region 290. The interior region 290 is positioned adjacent the tissue site 104 when the reduced pressure manifold 102 is used to administer reduced pressure treatment to the tissue site 104.

[0038] A proximal end 235 of the inner conduit 230 may extend outside the interior region 290 to allow fluid connection with the reduced pressure delivery conduit 112 or the fluid delivery conduit 142. A distal end 234 of the inner conduit 230 extends into the interior

region 290. The distal end 234 may be open, but in one illustrative embodiment, the distal end 234 is a capped or closed end. The inner conduit 230 includes openings 236, 238 which may be, for example, holes, perforations, or a single slit through the inner conduit 230 within the interior region 290. The outer conduit 250 includes a proximal end 255 to allow fluid connection with the fluid delivery conduit 142 or the reduced pressure delivery conduit 112. The outer conduit 250 includes openings 286, 288, through the outer conduit 250 adjacent the interior region 290.

[0039] In the embodiment illustrated in FIGS. 2-5, the inner conduit 230 is fluidly connected to the reduced pressure source 114 and the outer conduit 250 is fluidly connected to the vent source 140. The direction of fluid flow, either gas, liquid, or both, through the conduits 230, 250 is indicated generally by fluid flow arrows. Fluid flow through the inner conduit 230 is indicated by arrows 239, while fluid flow through the outer conduit 250 is indicated by arrows 289. When reduced pressure is applied to the inner conduit 230 and fluid is provided by the vent source 140 to the outer conduit 250, fluid flows through the interior region 290 from the outer conduit 250 to the inner conduit 230. More specifically, fluid flows through the openings 286, 288 of the outer conduit 250 as indicated by fluid flow arrows 286', 288'. Fluid flows through the interior region 290 into the opening 236, 238 of the inner conduit 230 as indicated by fluid flow arrows 236', 238'.

[0040] Referring more specifically to FIGS. 3-5, the reduced pressure manifold 102 includes a barrier 320 having a first side 322 and a second side 324. The inner conduit 230 and outer conduit 250 are positioned on the first side 322 of the barrier 320. The presence of barrier 320 may separate the interior region 290 from other areas of tissue near the reduced pressure manifold. In one embodiment, the interior region 290 is defined and bordered by the outer conduit 250, the barrier 320, and the tissue site 104. For fluid that flows through the interior region 290 (i.e. fluid that enters through the inner conduit 230 or outer conduit 250, or fluid that is drawn from the tissue site 104), the barrier 320 acts to substantially constrain fluid flow to the area of the interior region 290 and the vicinity around the tissue site 104. The barrier 320 substantially reduces or prevents fluid flow on the second side 324 of the barrier 320. In one embodiment, the barrier may be made of a substantially gas impermeable material. In another embodiment, the barrier 210 may be semi-permeable to gas flow. Examples of materials that could be used for the barrier 320 include without limitation silicone, polyurethane, or any other substantially gas impermeable material.

[0041] In operation, the reduced pressure manifold 102 is positioned adjacent or in contact with the tissue site 104. Reduced pressure is supplied to the tissue site 104 and interior region 290 by the reduced pressure source 114. The reduced pressure is delivered through reduced pressure delivery conduit 112 and inner conduit 230 of reduced pressure manifold 102. Due to the relatively confined nature of the subcutaneous tissue site, as well as the presence of the barrier 320, reduced pressure may be maintained at the tissue site 104 such that reduced pressure treatment or therapy is provided. As treatment progresses, granulation tissue growth is stimulated. Wound exudate and other fluids are removed from the tissue site 104 and interior region 290 through the inner conduit 230 and may be collected within a canister such as that represented by representative device 116.

[0042] The growth of new tissue and production of exudate and other by-products at the tissue site 104 are capable of hindering treatment if not successfully removed. For example, if wound exudate or blood were to collect within the conduits or at the tissue site 104, the delivery of reduced pressure to the tissue site 104 may be interrupted. The presence of the outer conduit 250 assists in minimizing or preventing the collection of fluids, solids, and other by-products at the tissue site and within the inner conduit 230. By delivering air or other fluids from the vent source 140 to the outer conduit 250 and the interior region 290, fluids, solids, and other by-products may be better dislodged and carried to the inner conduit 230. As illustrated in FIG. 3, the fluid flow represented by arrows 286', 288' assists in carrying wound healing by-products 340 to the inner conduit 230 where the by-products 340 may be removed.

[0043] In one embodiment, it may be desired to apply either the reduced pressure, the fluid flow (from the vent source 140), or both intermittently to the reduced pressure manifold 102. Modulation of the flow may be achieved by varying both the upstream and downstream pressures, either manually or automatically through the control unit 160. This modulation, and any induced fluid momentum effects, may further increase the fluidic force applied to the by-products 340.

[0044] The barrier 320 of the reduced pressure manifold 102 may further assist in dislodging by-products 340. As previously described, the barrier 320 substantially constrains fluid flow to the area of the interior region 290 and the vicinity around the tissue site 104, which reduces the amount of fluid leaking outside of the interior region 290. This minimization of leakage optimizes flow within the interior region 290 from the outer conduit 250 to the inner conduit 230 as depicted by the fluid flow arrows illustrated in FIG. 3.

[0045] Referring more specifically to FIG. 5, in one embodiment, the opening 288 in the outer conduit 250 is one of several holes spaced along the length of the outer conduit 250 for delivering the fluid from the vent source 140. The other openings may be evenly spaced along the length of the outer conduit 250 in order to evenly distribute fluid to the interior region 290 and the tissue site 210. Alternatively, the spacing between the openings may be of varying distances or random. In one illustrative embodiment, the openings may have diameters that generally increase in diameter as further removed from the source of the fluid such as, for example, openings 587 and 589, to more evenly distribute the flow of fluid into the interior region 290.

[0046] Referring to FIG. 6, a reduced pressure treatment system 600 sharing some similar elements of reduced pressure treatment system 100 is illustrated. Reduced pressure treatment system 600 includes reduced pressure manifold 102, reduced pressure source 114, representative device 116, reduced pressure delivery conduit 112, vent source 140, filter 170, fluid delivery conduit 142, and control unit 160, all of which may be similar in structure and function to those elements previously described. The reduced pressure treatment system 600 further includes a switching unit or valve 695 fluidly connected between the reduced pressure manifold 102 and both the reduced pressure source 114 and the vent source 140. The switching unit 695 is capable of reversing the flow of fluid within the inner conduit 230 and the outer conduit 250 relative to the flow directions previously described with reference to FIGS. 1-5. As illustrated in FIG. 6, fluid flow within the outer conduit 250 may be such that fluid is removed toward the reduced pressure source 114 as indicated by fluid flow arrows 689. Fluid from the interior region 290 flows into the openings 286, 288 of the outer conduit 250 as indicated by arrows 686', 688', respectively. Fluid flow within the inner conduit 230 may be provided by the vent source 140 and flow toward the interior region 290 as indicated by fluid flow arrows 639. Fluid enters the interior region 290 through the openings 236, 238 of the inner conduit 230 as indicated by arrows 636', 638', respectively.

[0047] FIG. 7 represents a cross-section view of the reduced pressure treatment system 600 and demonstrates the removal of by-products 340 may occur through the outer conduit 250 as fluid is supplied by the vent source 140 through the inner conduit 230. While the flow of fluids in FIGS. 6 and 7 is illustrated as moving from the inner conduit 230 to the outer conduit 250, the presence of the switching unit 695 permits the fluid flow to be reversed, which in some instances may assist in dislodging or removing by-products 340. In one

embodiments, it may be desirable to regularly or intermittently reverse the flow of fluids through the reduced pressure manifold 102.

[0048] Referring to FIG. 8, a reduced pressure treatment system 800 includes some similar elements to that of reduced pressure treatment system 100. Reduced pressure treatment system 800 includes a reduced pressure manifold 802, which is a modified version of the reduced pressure manifold 102. The reduced pressure manifold 802 includes an inner conduit 830 having a distal end in a closed-loop configuration. The distal end of the inner conduit 830 extends into the interior region 290, and the looped configuration of the inner conduit 830 defines a second interior region 890. The inner conduit 830 includes a proximal end 831 that may be fluidly connected to either reduced pressure source 114 or vent source 140 through switching unit 695. As described above, the fluid flow through the inner conduit 830 and the outer conduit 180 may be switched to cause fluid to flow in either direction within the interior region 290. The inner conduit 830 includes openings 832, 833 which may be, for example, holes, perforations, or a single slit through the inner conduit 830 adjacent either or both of the interior region 290 and the second interior region 890. The openings 832 in the closed-loop conduit generally face the openings 286, 288 in the outer conduit 250, thereby creating a flow of fluids through the interior region 290 as described previously with reference to FIGS. 1-5. The openings 833 of the inner conduit 830 function in a similar manner with the openings 286, 288 of the outer conduit 250, but create a flow of fluids over a longer path extending more deeply into the center of the second interior region 890.

[0049] Referring to FIG. 9, a reduced pressure treatment system 900 includes some similar elements to that of reduced pressure treatment system 100. Reduced pressure treatment system 900 includes a reduced pressure manifold 902, which is a modified version of the reduced pressure manifold 102. Instead of only including a single inner conduit and a single outer conduit, the reduced pressure manifold 902 illustrated in FIG. 9 includes a first conduit 905 defining a first interior region 910, a second conduit 915 positioned within the first interior region 910 and defining a second interior region 920, a third conduit 925 positioned within the second interior region 920 and defining a third interior region 930, and a fourth conduit 935 positioned within the third interior region 930 and defining a fourth interior region 940. Each of the first, second, third, and fourth conduits 905, 915, 925, 935 includes a closed-loop configuration. Each of the first, second, third, and fourth conduits 905, 915, 925, 935 also includes holes, apertures, or openings 950, 952, 954, 956, respectively, as previously

described to allow fluid communication with holes in adjacent conduits and with the interior regions 910, 920, 930, 940.

[0050] In the embodiment illustrated in FIG. 9, the first conduit 905 and the third conduit 925 are both individually connected to one of the reduced pressure source 114 and the vent source 140. The second conduit 915 and the fourth conduit 935 are both individually connected to another of the reduced pressure source 114 and the vent source 140. The particular configuration involving which conduit is connected to which of the reduced pressure source and the vent source could vary. A switching unit similar to switching unit 695 may also be used to reverse fluid flow within one or more of the conduits.

[0051] The reduced pressure manifold 902 is configured as a plurality of nested tubes to provide increased fluid communication within the interior regions 910, 920, 930, 940. The reduced pressure manifold 902 doubles the number of conduits used in reduced pressure manifold 802, and additional conduits could be added as desired. By increasing the number of conduits used with the reduced pressure manifold 902, the manifold 902 is capable of covering a larger tissue site or providing greater fluid control in a smaller tissue site.

[0052] Referring to FIG. 10, the reduced pressure manifold 902 of FIG. 9 is illustrated with one principal modification. Instead of the conduits 905, 915, 925, 935 each being individually connected to the reduced pressure source 114 or the vent source 140, in the embodiment illustrated in FIG. 10, certain conduits are connected by bridging conduits. For example, the first conduit 905 is connected by a bridging conduit 965 to the third conduit 925. This allows reduced pressure or fluids delivered to the first conduit 905 to also be delivered to the third conduit 925. The second conduit 915 is connected by a bridging conduit 970 to the fourth conduit 935. This allows reduced pressure or fluids delivered to the second conduit 915 to also be delivered to the fourth conduit 935.

[0053] As shown, the embodiments described above contemplate a reduced pressure manifold for delivering reduced pressure to tissue, particularly subcutaneous tissue. Moreover, these embodiments contemplate such a reduced pressure manifold that uses a connecting conduit that may be used to create a pressure gradient that moves fluid into an inner conduit and facilitates removal of tissue healing by-products, such as blood and coagulum. Such a reduced pressure manifold, when integrally attached to a barrier sheet further isolates reduced pressure on one side of the barrier sheet. Application of controlled, varying pressure in the inner conduit and the connecting conduit induces stronger pressure gradients and fluid

forces that further facilitate removal of tissue healing by-products. An optional filter in the connecting conduit pathway may be useful to prevent microbes from infiltrating a tissue site.

[0054] Alternative or additional embodiments may include interleaved vent and pressure conduits, or surface features on a barrier sheet that further direct flow toward a inner
5 conduit. Multiple, independent connecting conduits may be activated and controlled separately to redistribute fluid flow along a barrier sheet. Medicinal fluids may also be introduced into the connecting conduit to facilitate tissue growth or treatment.

[0055] It should be apparent from the foregoing that an invention having significant advantages has been provided. While the invention is shown in only a few of its forms, it is
10 not just limited but is susceptible to various changes and modifications without departing from the spirit thereof.

CLAIMS

We claim:

- Claim 1. A reduced pressure treatment system comprising:
- 5 a first fluid pathway in communication with a reduced pressure source;
a second fluid pathway; and
a reduced pressure manifold comprising:
a substantially gas impermeable barrier;
at least one outer conduit defining a lateral edge of an interior region, the outer
10 conduit and the substantially gas impermeable barrier enclosing a
portion of the interior region, the outer conduit being in fluid
communication with one of the first and second fluid pathways, the
outer conduit having at least one opening in fluid communication with
the interior region; and
15 an inner conduit at least partially disposed within the interior region, the inner
conduit being in fluid communication with another of the first and
second fluid pathways, the inner conduit having at least one opening in
fluid communication with the interior region.
- Claim 2. The reduced pressure treatment system of claim 1, wherein the interior region
20 includes an open end opposite the substantially gas impermeable barrier that is capable of
being positioned adjacent a tissue site.
- Claim 3. The reduced pressure treatment system of claim 2, wherein the substantially gas
impermeable barrier substantially constrains fluid flow to the interior region when the
interior region is positioned adjacent the tissue site.
- 25 Claim 4. The reduced pressure treatment system of claim 1, wherein:
the outer conduit is fluidly connected to the second fluid pathway;
the inner conduit is fluidly connected to the first fluid pathway; and
fluid flows through the interior region from the outer conduit to the inner conduit.

Claim 5. The reduced pressure treatment system of claim 4 further comprising surface features on the substantially gas impermeable barrier that direct flow of fluid to the at least one opening of the inner conduit.

Claim 6. The reduced pressure treatment system of claim 1, wherein:
5 the inner conduit is fluidly connected to the second fluid pathway;
the outer conduit is fluidly connected to the first fluid pathway; and
fluid flows through the interior region from the inner conduit to the outer conduit.

Claim 7. The reduced pressure treatment system of claim 6 further comprising surface features on the substantially gas impermeable barrier that direct flow of fluid to the at least
10 one opening of the outer conduit.

Claim 8. The reduced pressure treatment system of claim 1 further comprising a controller to control an introduction of fluid through the second fluid pathway to the interior region.

Claim 9. The reduced pressure treatment system of claim 1 further comprising a
15 controller to control the removal of fluid from the interior region by the reduced pressure source.

Claim 10. The reduced pressure treatment system of claim 1, wherein the second fluid pathway fluidly communicates with a valve that selectively permits venting of the interior region to atmosphere.

20 Claim 11. The reduced pressure treatment system of claim 1, wherein the second fluid pathway fluidly communicates a pump capable of introducing fluid to the interior region.

Claim 12. The reduced pressure treatment system of claim 1, wherein the inner conduit is substantially straight and includes a capped end.

Claim 13. The reduced pressure treatment system of claim 1, wherein the at least one
25 opening of the outer conduit includes a plurality of openings, each of the plurality of openings disposed on a side of the outer conduit adjacent the interior region.

Claim 14. The reduced pressure treatment system of claim 13, wherein each of the plurality of openings of the outer conduit is angled away from the substantially gas impermeable barrier.

Claim 15. The reduced pressure treatment system of claim 1, wherein the at least one opening of the inner conduit includes a plurality of openings.

Claim 16. The reduced pressure treatment system of claim 15, wherein each of the plurality of openings of the inner conduit is angled away from the substantially gas impermeable barrier.

Claim 17. The reduced pressure treatment system of claim 1 further comprising a switching unit fluidly connected to the inner conduit and the outer conduit to reverse fluid flow within the inner conduit and the outer conduit.

Claim 18. A reduced pressure manifold for applying reduced pressure treatment to a tissue site, the manifold comprising:

a substantially gas impermeable barrier;

an outer conduit positioned on a first side of the barrier and defining a perimeter around an interior region, the outer conduit adapted to be fluidly connected to one of a reduced pressure source and a vent source, the outer conduit having at least one opening in fluid communication with the interior region; and

an inner conduit positioned on a first side of the barrier and extending into the interior region, the inner conduit adapted to be fluidly connected to another of the reduced pressure source and the vent source, the inner conduit having at least one opening in fluid communication with the interior region.

Claim 19. The reduced pressure manifold of claim 18, wherein fluid is adapted to flow through the interior region from the outer conduit to the inner conduit when the outer conduit is fluidly connected to the vent source and the inner conduit is fluidly connected to the reduced pressure source.

Claim 20. The reduced pressure manifold of claim 18, wherein fluid is adapted to flow through the interior region from the inner conduit to the outer conduit when the inner conduit is fluidly connected to the vent source and the outer conduit is fluidly connected to the reduced pressure source.

5 Claim 21. The reduced pressure manifold of claim 18 further comprising surface features on the substantially gas impermeable barrier to direct flow of fluid.

Claim 22. The reduced pressure manifold of claim 18, wherein the inner conduit is substantially straight and includes a capped end.

Claim 23. The reduced pressure manifold of claim 18, wherein the inner conduit is a loop.

10 Claim 24. The reduced pressure manifold of claim 18, wherein the at least one opening of the outer conduit includes a plurality of openings, each of the plurality of openings disposed on a side of the outer conduit adjacent the interior region.

Claim 25. The reduced pressure manifold of claim 24, wherein each of the plurality of openings of the outer conduit is angled away from the substantially gas impermeable
15 barrier.

Claim 26. The reduced pressure manifold of claim 18, wherein the at least one opening of the inner conduit includes a plurality of openings.

Claim 27. The reduced pressure manifold of claim 26, wherein each of the plurality of openings of the inner conduit is angled away from the substantially gas impermeable
20 barrier.

Claim 28. A reduced pressure treatment system comprising:

a reduced pressure source;

a vent source; and

a reduced pressure manifold comprising:

- 5 a first conduit shaped to define an interior region and being in fluid communication with one of the reduced pressure source and the vent source, the first conduit having at least one opening in fluid communication with the interior region; and
- 10 a second conduit being at least partially disposed within the interior region, the second conduit being in fluid communication with another of the reduced pressure source and the vent source, the second conduit having at least one opening in fluid communication with the interior region.

Claim 29. The reduced pressure treatment system of claim 28, wherein the reduced pressure manifold further comprises:

- 15 a barrier; and
- wherein the first conduit, the second conduit, and the interior region are positioned on a first side of the barrier.

Claim 30. The reduced pressure treatment system of claim 29 further comprising surface features on the barrier that direct flow of fluid.

- 20 Claim 31. The reduced pressure treatment system of claim 28, wherein:
- the first conduit is fluidly connected to the vent source;
- the second conduit is fluidly connected to the reduced pressure source; and
- fluid flows through the interior region from the first conduit to the second conduit.

- Claim 32. The reduced pressure treatment system of claim 31 further comprising a filter
- 25 between the vent source and the at least one opening of the first conduit.

Claim 33. The reduced pressure treatment system of claim 28, wherein:
the second conduit is fluidly connected to the vent source;
the first conduit is fluidly connected the reduced pressure source; and
fluid flows through the interior region from the second conduit to the first conduit.

5 Claim 34. The reduced pressure treatment system of claim 33 further comprising a filter
between the vent source and the at least one opening of the second conduit.

Claim 35. The reduced pressure treatment system of claim 28 further comprising a
controller to control the introduction of fluid by the vent source to the interior region.

10 Claim 36. The reduced pressure treatment system of claim 28 further comprising a
controller to control the removal of fluid from the interior region by the reduced pressure
source.

Claim 37. The reduced pressure treatment system of claim 28, wherein the vent source is
a valve that selectively permits venting of the interior region to atmosphere.

15 Claim 38. The reduced pressure treatment system of claim 28, wherein the vent source is
a pump.

Claim 39. The reduced pressure treatment system of claim 28, wherein the second conduit
is substantially straight and includes a capped end.

20 Claim 40. The reduced pressure treatment system of claim 28, wherein the at least one
opening of the first conduit includes a plurality of openings, each of the plurality of
openings disposed adjacent the interior region.

Claim 41. The reduced pressure treatment system of claim 28, wherein the at least one
opening of the second conduit includes a plurality of openings.

25 Claim 42. The reduced pressure treatment system of claim 28 further comprising a
switching unit fluidly connected to the first conduit and the second conduit to reverse fluid
flow within the first conduit and the second conduit.

Claim 43. The reduced pressure treatment system of claim 28, wherein the second conduit is loop-shaped to define a second interior region and the reduced pressure manifold further comprises:

a third conduit positioned within the second interior region and being loop-shaped to define a third interior region, the third conduit being in fluid communication with one of the reduced pressure source and the vent source, the third conduit having at least one opening in fluid communication with the third interior region; and

a fourth conduit positioned within the third interior region, the fourth conduit being in fluid communication with one of the reduced pressure source and the vent source, the fourth conduit having at least one opening in fluid communication with the third interior region.

Claim 44. The reduced pressure treatment system of claim 28, wherein the second conduit is loop-shaped to define a second interior region and the reduced pressure manifold further comprises:

a third conduit positioned within the second interior region and being loop-shaped to define a third interior region, the third conduit being in fluid communication with the one of the reduced pressure source and the vent source that is in fluid communication with the first conduit, the third conduit having at least one opening in fluid communication with the third interior region; and

a fourth conduit positioned within the third interior region, the fourth conduit being in fluid communication with the another of the reduced pressure source and the vent source that is in fluid communication with the second conduit, the fourth conduit having at least one opening in fluid communication with the third interior region.

Claim 45. The reduced pressure treatment system of claim 28, wherein the second conduit is loop-shaped to define a second interior region and the reduced pressure manifold further comprises:

a third conduit positioned within the second interior region and being loop-shaped to define a third interior region, the third conduit being in fluid communication with the first conduit, the third conduit having at least one opening in fluid communication with the third interior region; and

a fourth conduit positioned within the third interior region, the fourth conduit being in fluid communication with the second conduit, the fourth conduit having at least one opening in fluid communication with the third interior region.

Claim 46. A manifold for applying a reduced pressure treatment to a subcutaneous tissue site, the manifold comprising:

a first conduit shaped to define an interior region and being adapted to be fluidly connected to one of a reduced pressure source and a vent source, the first conduit having at least one opening in fluid communication with the interior region; and

a second conduit being at least partially disposed within the interior region, the second conduit adapted to be fluidly connected to another of the reduced pressure source and the vent source, the second conduit having at least one opening in fluid communication with the interior region.

Claim 47. The manifold of claim 46 further comprising:

a barrier; and

wherein the first conduit, the second conduit, and the interior region are positioned on a first side of the barrier.

Claim 48. The manifold of claim 47 further comprising surface features on the barrier to direct flow of fluid.

Claim 49. The manifold of claim 46, wherein fluid is adapted to flow through the interior region from the first conduit to the second conduit when the first conduit is fluidly connected to the vent source and the second conduit is fluidly connected to the reduced pressure source.

Claim 50. The manifold of claim 46, wherein fluid is adapted to flow through the interior region from the second conduit to the first conduit when the second conduit is fluidly connected to the vent source and the first conduit is fluidly connected to the reduced pressure source.

5 Claim 51. The manifold of claim 46, wherein the second conduit is substantially straight and includes a capped end.

Claim 52. The manifold of claim 46, wherein the second conduit is a loop.

10 Claim 53. The manifold of claim 46, wherein the at least one opening of the first conduit includes a plurality of openings, each of the plurality of openings disposed adjacent the interior region.

Claim 54. The manifold of claim 46 further comprising:
a barrier; and
wherein the first conduit, the second conduit, and the interior region are positioned
on a first side of the barrier;
15 wherein the at least one opening of the first conduit includes a plurality of openings,
each of the plurality of openings disposed adjacent the interior region; and
wherein each of the plurality of openings of the first conduit is angled away from
the barrier.

20 Claim 55. The manifold of claim 46, wherein the at least one opening of the second conduit includes a plurality of openings.

Claim 56. The manifold of claim 46 further comprising:

a barrier; and

wherein the first conduit, the second conduit, and the interior region are positioned
on a first side of the barrier;

5 wherein the at least one opening of the second conduit includes a plurality of
openings; and

wherein each of the plurality of openings of the second conduit is angled away from
the barrier.

Claim 57. The manifold of claim 46, wherein the second conduit is loop-shaped to define
10 a second interior region and the reduced pressure manifold further comprises:

a third conduit positioned within the second interior region and being loop-shaped
to define a third interior region, the third conduit being adapted to be fluidly
connected to one of the reduced pressure source and the vent source, the
third conduit having at least one opening in fluid communication with the
15 third interior region; and

a fourth conduit positioned within the third interior region, the fourth conduit being
adapted to be fluidly connected to one of the reduced pressure source and
the vent source, the fourth conduit having at least one opening in fluid
communication with the third interior region.

Claim 58. The manifold of claim 46, wherein the second conduit is loop-shaped to define a second interior region and the reduced pressure manifold further comprises:

a third conduit positioned within the second interior region and being loop-shaped to define a third interior region, the third conduit being adapted to be fluidly connected to the one of the reduced pressure source and the vent source that is in fluid communication with the first conduit, the third conduit having at least one opening in fluid communication with the third interior region; and a fourth conduit positioned within the third interior region, the fourth conduit being adapted to be fluidly connected to the another of the reduced pressure source and the vent source that is in fluid communication with the second conduit, the fourth conduit having at least one opening in fluid communication with the third interior region.

Claim 59. The manifold of claim 46, wherein the second conduit is loop-shaped to define a second interior region and the reduced pressure manifold further comprises:

a third conduit positioned within the second interior region and being loop-shaped to define a third interior region, the third conduit being in fluid communication with the first conduit, the third conduit having at least one opening in fluid communication with the third interior region; and a fourth conduit positioned within the third interior region, the fourth conduit being in fluid communication with the second conduit, the fourth conduit having at least one opening in fluid communication with the third interior region.

Claim 60. A method for delivering reduced pressure to a tissue site, the method comprising:

delivering a fluid to the tissue site through a loop-shaped, first conduit, the first conduit defining a perimeter around an interior region; applying a reduced pressure to the interior region through a second conduit positioned in the interior region; and removing tissue healing by products from the interior region through the second conduit.

Claim 61. The method of claim 60, wherein the tissue site is a subcutaneous tissue site.

Claim 62. The method of claim 60, wherein the second conduit is looped shaped and defines a second interior region.

Claim 63. The method of claim 62 further comprising:
delivering the fluid to the tissue site through a loop-shaped, third conduit positioned
5 within the second interior region, the third conduit defining a perimeter
around a third interior region;
applying the reduced pressure to the third interior region through a fourth conduit
positioned in the third interior region; and
removing tissue healing by products from the third interior region through the fourth
10 conduit.

Claim 64. The method of claim 60 further comprising:
varying the amount of the fluid delivered through the first conduit.

Claim 65. The method of claim 63 further comprising:
varying the amount of the fluid delivered through the first conduit and the third
15 conduit.

Claim 66. The method of claim 60 further comprising:
intermittently ceasing delivery of the fluid through the first conduit.

Claim 67. The method of claim 63 further comprising:
intermittently ceasing delivery of the fluid through the first conduit and the third
20 conduit.

Claim 68. The method of claim 60, further comprising filtering the fluid delivered through
the first conduit.

Claim 69. The method of claim 60, further comprising switching the delivery of the fluid
and the application of the reduced pressure such that the fluid is delivered through the
25 second conduit and the reduced pressure is applied through the first conduit.

Claim 70. A method for delivering reduced pressure to a tissue site, the method comprising:

applying a reduced pressure to the tissue site through a loop-shaped, first conduit,
the first conduit defining a perimeter around an interior region;
5 delivering a fluid to the interior region through a second conduit positioned in the
interior region; and
removing tissue healing by-products from the interior region through the first
conduit.

Claim 71. The method of claim 70, wherein the tissue site is a subcutaneous tissue site.

10 Claim 72. The method of claim 70, wherein the second conduit is looped shaped and
defines a second interior region.

Claim 73. The method of claim 72 further comprising:

applying the reduced pressure to the tissue site through a loop-shaped, third conduit
positioned within the second interior region, the third conduit defining a
15 perimeter around a third interior region;
delivering the fluid to the third interior region through a fourth conduit positioned in
the third interior region; and
removing tissue healing by products from the third interior region through the third
conduit.

20 Claim 74. The method of claim 70 further comprising:
varying the amount of the fluid delivered through the second conduit.

Claim 75. The method of claim 73 further comprising:
varying the amount of the fluid delivered through the second conduit and the fourth
conduit.

25 Claim 76. The method of claim 70 further comprising:
intermittently ceasing delivery of the fluid through the second conduit.

Claim 77. The method of claim 73 further comprising:
intermittently ceasing delivery of the fluid through the second conduit and the
fourth conduit.

Claim 78. The method of claim 70, further comprising filtering the fluid delivered through the second conduit.

Claim 79. The method of claim 70, further comprising switching the delivery of the fluid and the application of the reduced pressure such that the fluid is delivered through the first
5 conduit and the reduced pressure is applied through the second conduit.