CONDUCTIVE FABRIC MEDICAL TUBE USING CONDUCTIVE INK

FIELD OF INVENTION

The present invention relates to the field of electrically conductive fabric being applied on the medical flexible tubing. More particularly, the invention relates to method of making the electrically conductive fabric before it is being over-molded at both ends in order to connect with other medical devices.

BACKGROUND OF THE INVENTION

For medical applications, flexible tubing with helically wound heating conductor is commonly found in devices such as breathing equipment, CPAP (Continuous Positive Airway Pressure) machine, etc. Flexible tubing with helically wound heating conductor can be found in the prior art PCT/SG2022/050368 that relates to the Method of Making Flexible Tubing with Embedded Wire Conductor. This present invention proposes another alternative to having an extruded flexible tubing with embedded wire conductor whereby it involves using fabric that has the electrically conductive properties, thus eliminating the need to use embedded wire conductor.

There are some benefits to using fabric-based material for the flexible extruded tubing. The current common material for the flexible tubing that has helically wound heating conductor is to use polymeric-based material. The present invention proposed an alternative method in the use of fabric instead of polymeric-based material. Fabric is insulating and it is suitable for use in cold country regions whereby it is able to provide good thermal control of the heated air within the flexible tubing. In addition, fabric-based material is more comfortable to the skin as compared to polymeric material. Having a

soft fabric-like material such as a nylon coming into contact with the human skin can provide some added benefits. Such fabric-like materials serve to provide the required softness and comfort to the human skin which can be hard to be replicated on a polymeric material (such as plastic). Moreover, the fabric-like materials exhibit other properties such as good abrasion resistance and tear strength, yet comfortable and offer infinite aesthetics opportunities. In addition, fabric can come in many different color, patterns and textures. Thus, this highlights the benefits of using fabric-based materials.

Currently there are various ways available in the prior art that is able to enable the fabric to be electrically conductive in nature. First and foremost, the material for the fabric substrate has to exhibit good stretchability so that it is easily stretchable and can easily be fabricated into a tube form. In addition, the fabric also needs to be specially treated or converted so that no water can enter from the outside environment and no air can permeate in and out of the fabric. For the fabric to be electrically conductive, one way is to use **conductive ink** via silk screen printing on the fabric. Alternatively, for the present invention, the use of **stretchable conductive ink** is more appropriate since such stretchable ink is being optimised for repeated elongations and are designed to be highly durable. It is also highly compatible with stretchable fabrics. Conductive ink is a type of ink that is specially infused with silver, graphene, carbon nanotubes, metal nanoparticles, conductive polymers or other electrically conductive material or nano-particles/materials that are also soluble in nature in order to facilitate ease of silk screen printing onto the fabric material. The stretchable conductive ink can be silk-screen printed onto the fabric and then cured dried. Silk screen printing of the stretchable conductive ink is one of the more commonly used techniques that is available in the prior art and is to coat a fabric substrate with conductive ink.

Prior to the actual silk screen printing, the user would first need to prepare the substrate (i.e., the specially treated or converted fabric), the stencil and the screen, including other accessories such as squeegee, rollers and the press bed, subject to the type of printing assembly being used. During the actual silk screen printing, the conductive inks are applied onto the specially treated or converted fabric substrate through a specially designed or customized stencil, in which the stencil is actually a thin sheet of mesh material (either made of fabric, special fibres, etc.). The conductive inks are “forced” through the unfilled pores with the aid of a device equivalent such as squeegee. The silk-screening process can then be repeated consistently in order to get a uniform even layer of conductive ink on the fabric. After printing, the printed conductive ink is then sent for curing so that the conductive ink can be dried. The printing process is then repeated again, if necessary, in order to obtain the desired coating printed on the fabric.

After silk screen printing, the fabric is now electrically conductive with the conductive ink. The next stage would be to have the electrically conductive fabric rolled up using a cylindrical-like jig or mandrel. Once rolled up, the edges or seams of the electrically conductive fabric are then heat sealed so that it is in a tube-like form with the conductive ink on the internal surface of the tubing. The fabric tube-like form has specially customized electrically conductive links / linkages that are joined to the individual lining of the electrically conductive ink.

Next, the fabric tube-like form has two ends in which each of these two ends are then separately over-molded with a polymeric-based external enclosure with a certain diameter. The diameter of the stretchable fabric tube is smaller than the enclosure, thus ensuring a tight and nice fit on the enclosure after over-molding. Once over-molded, the electrically conductive links / linkages on the fabric tube can then connect to the clip-on

lead frame connector at the enclosure portion. At each end on the fabric tube, the external enclosure is specially mated to fit into an individual opening in a medical device whereby the external enclosure has grooves that can dovetail with the electrically conductive pins on the medical device side. This entire arrangement will enable the fabric tube to connect from one medical device to another medical device. Hence this helps to ensure proper electrical connectivity in order for the medical devices to work accordingly. Since the fabric is already specially customized or converted, water from the exterior would not be able to penetrate through the fabric and air is also not able to permeate in and out of the fabric. And at the same time, the conductivity of the ink inside the fabric tube helps to conduct data across from one (1) medical device to another.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings attached here are to aid comprehension of the description of the invention here. The drawings are not to scale and they are to be used for merely illustrating the principles and concepts of the invention only.

To aid in comprehension of the invention, the drawings are separated into the various Figures as described below:

Figure 1 illustrates an overall perspective view of the various key components and functions for the embodiment of the present invention.

Figure 2 illustrates a view of the key components for another embodiment of the present invention.

Reference numbers

1 Conductive Fabric setup
2 Conductive Fabric Tube
3 Enclosure A with lead frame connector to Medical Device A
4 Enclosure B with lead frame connector to Medical Device B
5 Medical Device A
6 Medical Device B
7 Links / Linkages to conductive ink on fabric tube
8 Conductive Ink (printed on internal surface of tube)
9 Electrically Conductive Pins

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT OF THE PRESENT INVENTION

In the following description, details are provided to describe the embodiment of the application. It shall be apparent to the person skilled in the art, however, that the embodiments may be practiced without such details.

The present invention relates to the field of electrically conductive fabric being applied on the medical flexible tubing. More particularly, the invention relates to method of making the electrically conductive fabric (via electrically conductive ink) before it is being over-molded at both ends in order to connect with other medical devices.

Figure 1 illustrates an overall perspective view of the various key components and functions for the embodiment of the present invention. It illustrates the conductive fabric setup **1** which includes the conductive fabric tube **2** having each end connected to enclosure **3** and **4** respectively as illustrated in **Figure 1**. These enclosures **3** and **4** are directly connected to medical device A and B (denoted as **5** and **6**) respectively.

The conductive fabric tube **2** as illustrated in **Figure 1** is already silk-screen printed with a layer of conductive ink **8** using a specially treated or converted fabric substrate as illustrated in **Figure 2**. The specially treated or converted fabric substrate will then be rolled up to form into a conductive fabric-like tube structure **2** (as illustrated in **Figure 1**) followed by heat sealing on the edges or seams of the fabric-like form. The layer of conductive ink **8** is on the inner facing of the conductive fabric tube **2.** As illustrated in **Figure 2**, there are links / linkages (denoted as **7**) that are joined to the individual lining of the electrically conductive ink on the conductive fabric tube **2**.

Next, as illustrated in **Figure 1**, the conductive fabric tube **2** has two ends in which each of these two ends are then separately over-molded with an external enclosure (denoted as **3** and **4**) that is made of polymeric-based material with a certain diameter. The diameter of the stretchable fabric tube **2** is smaller than the enclosure **3** and **4**, thus ensuring a tight and nice fit on the enclosure **3** and **4** after over-molding. Once over-molded, the electrically conductive links / linkages **7** on the fabric tube **2** can then connect to the clip-on lead frame connector at the enclosure portion (denoted as **3** and **4**). At each end on the fabric tube **2** as illustrated in **Figure 1**, the external enclosure (denoted as **3** and **4**) is specially mated to fit into an individual opening in medical device denoted as **5** and **6** respectively whereby the enclosure **3** and **4** has grooves that can dovetail with the electrically conductive pins (denoted as **9**) on the medical device side **5** and **6**. This entire arrangement will enable the fabric tube **2** to connect from one medical device **5** to another medical device **6**. Hence this helps to ensure proper electrical connectivity in order for the medical devices to work accordingly. Since the fabric is already specially customized or converted, water from the exterior would not be able to penetrate through the fabric and air is also not able to permeate in and out of the fabric. Therefore, the present invention presented an innovative method of making an electrically conductive fabric tube (using conductive ink) that is suitable for use in medical applications whereby air will flow through the fabric tube from one medical device to another with data and thermal control.

While what has been described hereinabove is the preferred embodiment of the invention, those skilled in the art will understand that numerous modifications may be made without departing from the spirit and scope of the invention. The embodiments described herein are meant to be illustrative only and should not be taken as limiting the invention, which can be expressly set forth in the following claims.

CLAIMS

What is claimed is:

1. A **method** for manufacturing an electrically conductive fabric tube that is suitable for use in medical applications, whereby it comprises of the following:
   (a) selecting a unique fabric material that is specially treated or converted so that no water can enter from the outside environment and no air can permeate in and out of the fabric, plus with good stretchability for the fabric; followed by
   (b) preparing the stretchable electrically conductive ink which is infused with silver, graphene, carbon nanotubes, metal nanoparticles, conductive polymers or other electrically conductive material or nano-particles/materials; followed by
   (c) silk-screen printing of the electrically conductive ink onto the internal surface of the fabric material; and followed by
   (d) rolling up the fabric material using a cylindrical-like jig or mandrel; followed by
   (e) joining the seams or edges of the fabric together via heat sealing so that it forms a fabric tube-like form factor with the electrically conductive ink on the internal surface of the fabric material; followed by
   (f) incorporating links / linkages to the individual lining of the electrically conductive ink on the conductive fabric tube; followed by
   (g) selecting an external enclosure that is made of polymeric-based material with a certain diameter; followed by
   (h) over-molding each end of the fabric tube with the external enclosure respectively; such that
      i. once over-molded, the electrically conductive links / linkages on the fabric tube can then connect to the clip-on lead frame connector at the

enclosure portion; and wherein

ii. at each end of the fabric tube, the external enclosure is specially mated to fit into an individual opening in a medical device; and wherein

iii. the enclosure has grooves that can dovetail with the electrically conductive pins on the medical device side.