FLEXIBLE TUBING
WITH DOUBLE HELIXES

FIELD OF INVENTION

The present invention relates to the field of flexible polymeric tubing with a focus on the double helixes with or without embedded electrically conductive wire/s. More particularly, the invention relates to different possible usage of the helixes that are presented in the extruded flexible polymeric tubing.

BACKGROUND OF THE INVENTION

The use of flexible tubing with helically wound heated electrically conductive wires is commonly found in medical applications such as breathing and respiratory equipment, etc. where transparency and the ability to be heated using heating wires provide a solution to control not only the presence of moisture but also to suitably heat-up and adjust the air in the device to the desired temperature. Heated tubing also reduces condensation from forming inside the tube which can then overflow towards the user connected to the tubing, causing discomfort and irritation. For such flexible tubing, the electrically conductive wire itself is typically encapsulated by polymeric material and is termed as the “helix” throughout this writeup. Next the word “ribbon” refers to the polymeric film for the flexible tubing and shall be used throughout this writeup to mean as such. Flexible tubing with helically wound heated electrically conductive wires usually involves having at least one (1) electrically conductive wire encapsulated within a polymeric helix. The helix overlaps the polymeric ribbon where the ribbon is wound along an axis into a tube with one edge of each lap overlapping another and bonded by heat.

In the current Prior Art, there have been various enhancements to the method of fabrication of these flexible tubing. Examples of such prior art include US5637168A and PCT/SG2022/050368, wherein these patents disclosed various methods of making flexible tubing with helically wound heated electrically conductive wires using extrusion.

There are some similarities in the Prior Art which will be highlighted here. As highlighted in the prior art, the electrically conductive wires are integrated via external guides to facilitate the wires to sit in and maintain a certain distance between each wire, i.e., the pitch size, followed by overlaying onto the extruded polymeric ribbon. Subsequently this is then followed by having the electrically conductive wires to be covered by a helix which is also made of polymeric material. Within the encapsulated helix, the helically wound heated electrically conductive wires can range from minimum of at least one (1) or more e.g. four (4). Do take note that the helix can be extruded from a polymeric resin that is different (but compatible) in chemical composition, color, and other properties as compared to the polymeric resin used for the ribbon portion during extrusion.

The embodiment of the present invention disclosed an extruded flexible tubing utilizing the “double encapsulated helix” concept. The extruded flexible tubing consists of the polymeric film or ribbon which forms the main body of the tubing, followed by having another polymeric helix that overlaps the polymeric ribbon where the ribbon is wound along an axis into a tube with one edge of each lap overlapping another and bonded by heat during the extrusion process. Depending on the design, the helixes are usually embedded with electrically conductive wires, ranging from at least one (1) or more wires. This process is as per what has been disclosed in the current prior art such as PCT/SG2022/050368.

For the present invention, instead of a single helix being extruded and turned, it is now two (2) helixes being extruded out and turned as compared to the prior art. One of the main intentions of this proposed “double encapsulated helix” concept is to have the electrically conductive wires passing through one helix or every second winding, thereby reducing the total length and cost of the electrically conductive wires required. The unique features of the double encapsulated helix concept will be illustrated in **Figures 5, 6 and 7** while **Figure 8** highlights the various different configurations of the double-helix concept versus the current single helix. The description for these **Figures 5 to 8** can be found under the section “Detailed Description of Preferred Embodiment of the Present Invention” which is after the “Brief Description of Drawings”.

For the embodiment of the present invention, it can have various different configurations of the double-helix concept versus the current single helix, namely:

1. Current Single Helix;
2. Double Helix Baseline Embodiment;
3. Double Helix Alternate Embodiment – copper wire insulation not required;
4. Double Helix Alternate Embodiment – additional wire(s) / circuit(s) for sensors etc.
5. Double Helix Alternate Embodiment – minimal helix profile for improved flexibility and drag resistance.
6. Double Helix Alternate Embodiment – hollow helix supported by a central rib / wall for carrying supplementary gas.

The embodiment of the present invention can be manufactured using either of the manufacturing processes being disclosed in the patent application PCT/SG2022/050368. However, some minor modifications would be needed to fine-tune the manufacturing process in order to suit the embodiment of the present invention. The modifications can

be adapted to either of the manufacturing process being disclosed in the patent application PCT/SG2022/050368. There are **four (4)** possible manufacturing configurations being disclosed in the present invention:

1. Having three (3) different and separate extruders position on the same side of the mandrel but using three (3) separate independent tool dies with each tool die having an individual orifice, i.e. one tool die with orifice for extruding the polymeric ribbon whereby the polymeric ribbon itself is helically wrapped such that its edges overlap and is simultaneously bonded by heat together to form the wall of the flexible tubing. The second tool die is to create the 1st helix. The second tool die allows for feeding the electrically conductive wire/s through a wire insert at different angles from the top of the tool die followed by overlaying the electrically conductive wire/s onto the extruded polymeric ribbon. The second tool die also has an orifice for extruding the 1st polymeric helix and overlaying the polymeric helix onto the electrically conductive wire/s such that there is precise positioning of the wire/s within the extruded helix embedded with at least one or more conductive wires. The third tool die aids in creating the 2nd helix. It will also follow and perform the same function as the second tool die as described earlier. Hence using the process described in this paragraph, it serves to fulfil the following 2 forms, i.e.
   (a) Double Helix Alternate Embodiment – copper wire insulation removed);
   (b) Double Helix Alternate Embodiment-- additional wires / circuits for sensors etc.
2. Having two (2) different and separate extruders position on the same side of the mandrel but using one tool die for the polymeric ribbon and a single combined tool die with two (2) separate orifices for the helixes. There will be one tool die with orifice for extruding the polymeric ribbon whereby the polymeric ribbon itself

is helically wrapped such that its edges overlap and is simultaneously bonded by heat together to form the wall of the flexible tubing. The second tool die provides the possibility of creating two (2) helixes, whereby one helix is embedded with electrically conductive wires ranging from minimum one or more wires, while the other helix is just solid polymeric material without any electrically conductive wires embedded inside. Hence using the process described in this paragraph, it serves to fulfil the following 2 forms i.e.

(a) Double Helix Baseline Embodiment – whereby the 2nd helix is just a solid polymeric material without any electrically conductive wires);

(b) Double Helix Alternate Embodiment – minimal helix profile for improved flexibility and drag resistance.

Alternatively, the 2nd helix besides being a solid polymeric material, it can also be a hollow helix supported by a central rib / wall for carrying supplementary gas. This central supporting rib / wall is added to prevent the hollow section from collapsing during the extrusion process. This hollow section in the 2nd helix to carry supplementary gas such as oxygen to the user's mask for the breathing and respiratory device.

3. Similar to the setup described in the previous paragraph. Having <u>two (2) different and separate extruders position on the same side of the mandrel but using one tool die for the polymeric ribbon and a single combined tool die with two (2) separate orifices for the helixes.</u> The difference between this setup and the earlier setup described in the previous paragraph 2 is that there will be two (2) sets of electrically conductive wires that can be inserted onto the single combined tool die. The output from this setup is the same as the output mentioned in paragraph 1 (which comes as part of the 3 manufacturing

processes as per earlier highlighted.). Hence using the process described in this paragraph, it can achieve the following 2 forms**,** i.e.

(a) Double Helix Alternate Embodiment – copper wire insulation removed;

(b) Double Helix Alternate Embodiment-- additional wires / circuits for sensors etc.

4. For this last configuration, it is similar to the first configuration described earlier, i.e. having three (3) different and separate extruders position on the same side of the mandrel but using three (3) separate independent tool dies with each tool die having an individual orifice, i.e. one tool die with orifice for extruding the polymeric ribbon whereby the polymeric ribbon itself is helically wrapped such that its edges overlap and is simultaneously bonded by heat together to form the wall of the flexible tubing. The second tool die is to create the 1st helix. But this time round is different from the first configuration. There is no electrically conductive wire/s to feed via the second tool die. However, the second tool die also has an orifice for extruding the 1st polymeric helix and overlaying the polymeric helix (without any electrically conductive wire/s inside) onto the polymeric ribbon. The third tool die aids in creating the 2nd helix. It allows for feeding the electrically conductive wire/s through a wire insert at different angles from the top of the tool die followed by overlaying the electrically conductive wire/s onto the extruded polymeric ribbon. Hence using the process described in this paragraph, this time round the 1st helix just a solid polymeric material without any electrically conductive wires or the 1st helix can be a minimal helix profile for improved flexibility and drag resistance.

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 first (1st) manufacturing configuration highlighting the various key components and functions for the embodiment of the present invention.

Figure 2 illustrates an overall perspective view of the second (2nd) manufacturing configuration highlighting the various key components and functions for the embodiment of the present invention.

Figure 3 illustrates an overall perspective view of the third (3rd) manufacturing configuration highlighting the various key components and functions for the embodiment of the present invention.

Figure 4 illustrates the overall perspective view of the fourth (4th) manufacturing configuration highlighting the various key components and functions for the embodiment of the present invention.

Figure 5 illustrates the various abbreviations in a typical helix.

Figure 6 illustrates the calculation comparing the current single helix versus double helix as proposed in the present invention.

Figure 7 illustrates a “double helix” concept versus single helix, highlighting the helix winding angle (denoted as X^{o}).

Figure 8 illustrates the various different configurations of the double-helix concept versus the current single helix.

Reference numbers

1	Flexible Tubing Extrusion Setup
2	Ribbon
3a	1st Helix
3b	2nd Helix
4a	Electrically Conductive Wire
4b	Electrically Conductive Wire
5a	Wire Insert
5b	Wire Insert
6	Flexible Tubing
7	Winding Rolls
8	Rotating Shaft
9	Die (for Ribbon)
10a	Die (for 1st Helix)
10b	Die (for 2nd Helix)

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 here relates to the field of extruded flexible tubing utilizing the "double encapsulated helix" concept. More particularly, the invention discloses four (4) possible arrangements of manufacturing the flexible polymeric tubing with the "double encapsulated helix" concept. The unique features of the double encapsulated helix concept are highlighted in **Figure 5** to **7** and its different configurations will be illustrated in **Figure 8.**

Figure 1 illustrates an overall perspective view of the first (1st) manufacturing configuration with the various key components and functions for the embodiment of the present invention. It illustrates the flexible tubing extrusion setup **1** which includes the rotating shaft **8** having winding rolls **7** that are spaced evenly for winding and rotationally advancing the helically wound flexible tubing **6**. The winding rolls **7** typically consists of rollers or mandrels that are spaced evenly for rotation. For the setup described here, the winding rolls **7** rotate in unison in a certain manner, i.e., in an anti-clockwise direction with advancing forward vector force to drive the helically wound flexible tubing **6** forward in order to facilitate the ease of winding the polymeric ribbon **2**.

Figure 1 illustrates having three (3) different and separate extruders position on the same side of the mandrel but using three (3) separate independent tool dies with each tool die having an individual orifice, i.e. one tool die (denoted as **9**) with orifice for

extruding the polymeric ribbon **2** whereby the polymeric ribbon **2** itself is helically wrapped such that its edges overlap and is simultaneously bonded by heat together to form the wall of the flexible tubing **6**. As for the 1st helix **3a** portion, the second tool die **10a** allows for feeding the electrically conductive wire/s **4a** (i.e. consisting of at least one or more conductive wires) through a wire insert (denoted as **5a)** at different angles from the top of the tool die **10a** followed by overlaying the electrically conductive wire/s **4a** onto the extruded polymeric ribbon **2**. The second tool die **10a** also has an orifice for extruding the 1st polymeric helix and overlaying the polymeric helix **3a** onto the electrically conductive wire/s such that there is precise positioning of the wire/s within the extruded helix **3a**. As for the 2nd helix **3b** portion, the third tool die **10b** allows for feeding the electrically conductive wire/s **4b** (i.e. consisting of at least one or more conductive wires) through a wire insert (denoted as **5b)** at different angles from the top of the tool die **10b** followed by overlaying the electrically conductive wire/s **4b** onto the extruded polymeric ribbon **2**. The third tool die **10b** also has an orifice for extruding the 2nd polymeric helix and overlaying the polymeric helix **3b** onto the electrically conductive wire/s such that there is precise positioning of the wire/s within the extruded helix **3b**. Hence using the process described in this paragraph, it can achieve the following 2 forms that will be illustrated and described in **Figure 8**, i.e.

(a) <u>Double Helix Alternate Embodiment – copper wire insulation removed (illustrated as **3** in **Figure 8**);</u>

whereby two (2) of the electrically conductive wires can be embedded in one (1) helix and the other two (2) wires in the second helix. This would allow the two (2) wires to be spaced further apart inside the helix, thereby removing the need for an insulative coating that can prevent the wires from short-circuit if they are embedded fairly close together. Thus this reduces the costs and

weight of the raw copper electrically conductive wires conducting from one end to another end of the flexible tubing.

(b) Double Helix Alternate Embodiment-- additional wires / circuits for sensors etc. (illustrated as **4** in **Figure 8**);

whereby the 2nd helix can be embedded with additional wires or circuitry for newly added sensors to transmit data / information from one end of the tubing to the other end, or to provide power for auxiliary functionality such as lighting.

Figure 2 illustrates an overall perspective view of the second (2nd) manufacturing configuration. It illustrates another flexible tubing extrusion setup **1** having different and separate extruders position on the same side of the mandrel but using one tool die **9** for the polymeric ribbon **2** and a single combined tool die **10** with two (2) separate orifices for the helixes. There will be one tool die **9** with orifice for extruding the polymeric ribbon **2** whereby the polymeric ribbon **2** itself is helically wrapped such that its edges overlap and is simultaneously bonded by heat together to form the wall of the flexible tubing **6**. The second tool die **10** provides the possibility of creating two (2) helixes, whereby one helix **3a** is embedded with electrically conductive wires **4a** ranging from minimum one or more wires, while the other helix **3b** is just solid polymeric material without any electrically conductive wires embedded inside. Hence using the process described in this paragraph, it serves to fulfil the following 2 forms that will be illustrated and described in **Figure 8** i.e.

(a) Double Helix Baseline Embodiment (illustrated as **2** in **Figure 8)** – whereby the 2nd helix (in this case for **Figure 2** is denoted as **3b**) is just a solid polymeric material without any electrically conductive wires);

(b) Double Helix Alternate Embodiment – minimal helix profile for improved flexibility and drag resistance (illustrated as **5** in **Figure 8**).

Alternatively, the 2nd helix besides being a solid polymeric material, it can also be a hollow helix supported by a central rib / wall for carrying supplementary gas (denoted as **6** in **Figure 8**) – This central supporting rib / wall is added to prevent the hollow section from collapsing during the extrusion process. This hollow section in the 2nd helix is to facilitate flow of supplementary gas such as oxygen.

Figure 3 illustrates another overall perspective view of the third (3rd) manufacturing configuration. **Figure 3** illustrates another flexible tubing extrusion setup **1** having different and separate extruders position on the same side of the mandrel but using one tool die **9** for the polymeric ribbon **2** and a single combined tool die **10** with two (2) separate orifices for the helixes. The difference between this setup in **Figure 3** and the earlier setup in **Figure 2** is that there are two (2) sets of electrically conductive wires (denoted as **4a** and **4b**) that can be inserted onto the single combined tool die **10** via the wire insert **5.** The output from this setup in **Figure 3** is the same as the output mentioned in the description for **Figure 1** (which comes as one of the 3 manufacturing configurations as per earlier highlighted). Hence using the process described in this paragraph, it can achieve the following 2 forms that were illustrated and described in the earlier paragraphs for **Figure 1** and **Figure 8**, i.e.

(a) Double Helix Alternate Embodiment – copper wire insulation removed (illustrated as **3** in **Figure 8)**;

(b) Double Helix Alternate Embodiment -- additional wires / circuits for sensors etc. (illustrated as **4** in **Figure 8**).

Figure 4 illustrates an overall perspective view of the fourth (4th) manufacturing configuration that is similar in setup to the components described in **Figure 1**. Similar in setup mentioned to **Figure 1**, **Figure 4** illustrates having three (3) different and separate extruders position on the same side of the mandrel but using three (3) separate independent tool dies with each tool die having an individual orifice, i.e. one tool die (denoted as **9**) with orifice for extruding the polymeric ribbon **2** whereby the polymeric ribbon **2** itself is helically wrapped such that its edges overlap and is simultaneously bonded by heat together to form the wall of the flexible tubing **6**. As for the 1st helix **3a** portion, unlike in **Figure 1** which has electrically conductive wire being fed into the second tool die **10a**, for **Figure 4**, there is no electrically conductive wire being fed into the second tool die **10a.** The second tool die **10a** also has an orifice for extruding the 1st polymeric helix and overlaying the polymeric helix **3a** onto the polymeric ribbon **2**. As for the 2nd helix **3b** portion, the third tool die **10b** allows for feeding the electrically conductive wire/s **4b** (i.e. consisting of at least one or more conductive wires) through a wire insert (denoted as **5b)** at different angles from the top of the tool die **10b** followed by overlaying the electrically conductive wire/s **4b** onto the extruded polymeric ribbon **2**. The third tool die **10b** also has an orifice for extruding the 2nd polymeric helix and overlaying the polymeric helix **3b** onto the electrically conductive wire/s such that there is precise positioning of the wire/s within the extruded helix **3b**. Hence using the process described in this paragraph, this time round the 1st helix just a solid polymeric material without any electrically conductive wires or the 1st helix can be a minimal helix profile for improved flexibility and drag resistance.

Figure 5 illustrates the various abbreviations in a typical helix for the present invention. It proposed “double encapsulated helix” concept is to have the electrically conductive

wires passing through one helix or every second winding, thereby reducing the total length and cost of the electrically conductive wires required.

Figure 6 illustrates the calculation comparing the current single helix versus double helix as proposed in the present invention. As illustrated in the calculation in **Figure 6**, having a “double helix” concept can have potential savings in the entire copper wire (i.e. electrically conductive wires) since the length used is shorter as compared to single helix. Depending on the design and the intended function of the flexible tubing, the extra second helix can be a solid polymeric material without any electrically conductive wires inside, which means that lesser wire is utilized per tubing manufactured, thus reducing the overall weight and cost to manufacture the flexible tubing, as well as requiring less electrical current and therefore energy to heat the tubing. Alternatively, the extra second helix can also carry electrically conductive wires to support additional sensing devices from one end of the tubing to the other end, or to provide power for auxiliary functionality such as lighting.

Figure 7 illustrates a “double helix” concept versus single helix, highlighting the helix winding angle (denoted as X^{o}). As illustrated in **Figure 7** having a “double helix” concept, the helix winding angle (denoted as X^{o}) must be increased or made steeper, whereby increasing the angle of the helical winding can reduce the potential for tube drag. Tube drag is the effect of the helix on the outside of the flexible tubing rubbing and getting caught against any external surface. For the current extruded flexible tubing with single extruded helix for every turn, every revolution of the helix has electrically conductive wires being embedded inside. Apart from housing the wires, the other key purpose of the helix is to provide structure and rigidity to the flexible tubing and to prevent it from kinking and blocking the air flow from one end to the other end of the tubing.

Figure 8 illustrates the various different configurations whereby the double helix can be extruded with the following forms as compared to the current single helix design:

(a) **Current Single Helix** (denoted as **1** in **Figure 8**) – it illustrates the current single helix concept that has up to four (4) electrically conductive wires embedded in each helix, with each wire having the insulative coating that can prevent the wires from short-circuit if they are embedded fairly close together.

(b) **Double Helix Baseline Embodiment** (denoted as **2** in **Figure 8**) – the 2nd helix can be a solid polymeric material without any electrically conductive wires being embedded inside the helix. This solid helix can act to reinforce the flexible tubing so that it would not collapse so easily, thus making it more kink-resistant.

(c) **Double Helix Alternate Embodiment – copper wire insulation not required** (denoted as **3** in **Figure 8**) -- another potential cost saving concept whereby two (2) of the electrically conductive wire can be embedded in one (1) helix and the other two (2) wires in the second helix. This would allow the two (2) wires to be spaced further apart inside the helix, thereby removing the need for an insulative coating that can prevent the wires from short-circuit if they are embedded fairly close together. Thus this reduces the costs and weight of the raw copper electrically conductive wires conducting from one end to another end of the flexible tubing.

(d) **Double Helix Alternate Embodiment – additional wire(s) / circuit(s) for sensors etc**. (denoted as **4** in **Figure 8**) – as illustrated in **Figure 8**, the 2nd helix can be embedded with additional wires or circuitry for new added sensors to transmit data / information from one end to the other, or to provide power for auxiliary functionality such as lighting.

(e) **Double Helix Alternate Embodiment – minimal helix profile for improved flexibility and drag resistance** (denoted as **5** in **Figure 8**) - the 2nd helix can be modified such that when it is extruded out, the shape profile can be slightly flatter or lower in height such that the flexibility of the tubing is improved. Also, with such a profile, the drag resistance of the flexible tube is lower. Tube drag is from the helix bumps that catches slightly on any external surface such that the tube does not move freely with the user's body movements. For the double helix concept mentioned in this paragraph, the helix winding angle is steeper / bigger compared to current single helix. Hence the drag resistance force is lesser, i.e. less horizontal force is being exerted as compared to vertical force vector.

(f) **Double Helix Alternate Embodiment – hollow helix supported by a central rib / wall for carrying supplementary gas** (denoted as **6** in **Figure 8**) – for this illustration, the 2nd helix has a central supporting rib / wall added to prevent the hollow section from collapsing during the extrusion process. This hollow section in the 2nd helix is to carry supplementary gas such as oxygen to the user's mask for the breathing and respiratory device.

Therefore, the present invention presented different possible configurations of manufacturing the flexible tubing with embedded electrically conductive wire/s using the double encapsulated helix format.

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 **flexible tubing** made of polymer material, whereby it comprises of the following:
   (a) a polymeric film or ribbon forming the main body of the tubing, followed by
   (b) having a polymeric helix that overlaps the polymeric ribbon where the ribbon is wound along an axis into a tube with one edge of each lap overlapping another and bonded by heat during the extrusion process; and
   (c) having another polymeric helix being extruded out that overlaps the polymeric ribbon, wherein
   (d) depending on the design, one helix is embedded with electrically conductive wires, ranging from at least one (1) or more wires; and
   (e) having the other helix that can incorporate either of the following:
      i. solid polymeric material without any electrically conductive wires being embedded inside; or
      ii. embedded with equal number of electrically conductive wire(s) as the other helix such that it eliminates the need for insulative coating that can prevent the wires from short-circuit if they are embedded fairly close together; or
      iii. embedded with additional wires or circuitry for new added sensors to transmit data / information from one end to the other end of the tubing or to provide power for auxiliary functionality such as lighting; or
      iv. the shape profile can be modified to be slightly flatter such that the flexibility and drag resistance of the tubing is improved; or

v. it can be hollow but supported by a central rib / wall to prevent the hollow section from collapsing during the extrusion process.

2. A **method** for manufacturing of a flexible polymeric tubing using **three (3) separate tool dies with each tool die having an individual orifice,** whereby it comprises of the following steps:

(a) one tool die with an orifice for extruding polymeric ribbon, with the polymeric ribbon helically wrapped around the winding rolls / mandrel such that its edges overlap and is simultaneously bonded by heat together to form the wall of the flexible tubing, and concurrently

(b) second tool die to allow for feeding the electrically conductive wire/s through a wire insert at different angles from the top via the second tool die in the extruder, and followed by

(c) overlaying the electrically conductive wire/s onto the extruded polymeric ribbon; and followed by

(d) extruding the polymeric helix from the orifice in the second tool die and overlaying the polymeric helix onto the electrically conductive wire/s such that there is precise positioning of the wire/s within the extruded helix, hence forming one helix; and concurrently

(e) third tool die to allow for feeding the electrically conductive wire/s through a wire insert at different angles from the top via the second tool die in the extruder, and followed by

(f) overlaying the electrically conductive wire/s onto the extruded polymeric ribbon; and followed by

(g) extruding the polymeric helix from the orifice in the third tool die and overlaying the polymeric helix onto the electrically conductive wire/s such

that there is precise positioning of the wire/s within the extruded helix, hence forming the other helix.

3. A **method** for manufacturing of a flexible polymeric tubing using **two (2) separate tool dies with one tool die for polymeric ribbon and another combined tool die with two (2) separate orifices,** whereby it comprises of the following steps:

(a) one tool die with an orifice for extruding polymeric ribbon, with the polymeric ribbon helically wrapped around the winding rolls / mandrel such that its edges overlap and is simultaneously bonded by heat together to form the wall of the flexible tubing, and concurrently

(b) second tool die to allow for feeding the electrically conductive wire/s through a wire insert at different angles from the top via the second tool die in the extruder, and followed by

(c) overlaying the electrically conductive wire/s onto the extruded polymeric ribbon; and followed by

(d) extruding the polymeric helix from the orifice in the second tool die and overlaying the polymeric helix onto the electrically conductive wire/s such that there is precise positioning of the wire/s within the extruded helix, hence forming one helix; and concurrently

(e) on the same second tool die but without any electrically conductive wires being inserted, and followed by

(f) extruding the polymeric helix from the other orifice in the second tool die and overlaying the polymeric helix onto the polymeric ribbon, hence forming the other helix.

4. A **method** for manufacturing of a flexible polymeric tubing using **two (2) separate tool dies with one tool die for polymeric ribbon and another combined tool die with two (2) separate orifices,** whereby it comprises of the following steps:

   (a) one tool die with an orifice for extruding polymeric ribbon, with the polymeric ribbon helically wrapped around the winding rolls / mandrel such that its edges overlap and is simultaneously bonded by heat together to form the wall of the flexible tubing, and concurrently

   (b) second tool die to allow for feeding the electrically conductive wire/s through a wire insert at different angles from the top via the second tool die in the extruder, and followed by

   (c) overlaying the electrically conductive wire/s onto the extruded polymeric ribbon; and followed by

   (d) extruding the polymeric helix from the orifice in the second tool die and overlaying the polymeric helix onto the electrically conductive wire/s such that there is precise positioning of the wire/s within the extruded helix, hence forming one helix; and concurrently

   (h) on the same second tool die but on a different orifice to allow for feeding the electrically conductive wire/s through a wire insert at different angles from the top via the second tool die in the extruder, and followed by

   (i) overlaying the electrically conductive wire/s onto the extruded polymeric ribbon; and followed by

   (j) extruding the polymeric helix from the orifice in the same second tool die and overlaying the polymeric helix onto the electrically conductive wire/s such that there is precise positioning of the wire/s within the extruded helix, hence forming the other helix.

5. A **method** for manufacturing of a flexible polymeric tubing using **three (3) separate tool dies with each tool die having an individual orifice,** whereby it comprises of the following steps:

   (a) one tool die with an orifice for extruding polymeric ribbon, with the polymeric ribbon helically wrapped around the winding rolls / mandrel such that its edges overlap and is simultaneously bonded by heat together to form the wall of the flexible tubing, and concurrently

   (b) second tool die but without any electrically conductive wires being inserted, and concurrently

   (c) extruding the polymeric helix from the other orifice in the second tool die and overlaying the polymeric helix onto the polymeric ribbon, hence forming one helix; and concurrently

   (d) third tool die to allow for feeding the electrically conductive wire/s through a wire insert at different angles from the top via the second tool die in the extruder, and followed by

   (e) overlaying the electrically conductive wire/s onto the extruded polymeric ribbon; and followed by

   (f) extruding the polymeric helix from the orifice in the third tool die and overlaying the polymeric helix onto the electrically conductive wire/s such that there is precise positioning of the wire/s within the extruded helix, hence forming the other helix.