

MASS MANUFACTURE OF LONG TUBE ASSEMBLY VIA MAGNETIC LEVITATION

FIELD OF INVENTION

The present invention relates to an assembly process that involves fabric tubes with silicone tubes in a mass manufacturing environment. This assembly process will involve a mandrel that is magnetically levitated in order for this assembly to take place.

BACKGROUND OF THE INVENTION

It is currently not known to use magnetic levitation for assembly processes in mass manufacturing factories. However, in the manufacture of certain elongated product designs, there are still existing challenges to overcome. And hence this is where magnetic levitation is applied.

There is a need to assemble an elongated silicone tube into a fabric tubular tube. Besides silicone and fabric, other materials are also applicable. One of the main challenges faced in manufacturing such a product would involve having an operator to single-handedly pull over a long tubular material, be it fabric, polymeric in nature, etc. but are non-metallic in nature over a long mandrel, where the outer layer of material is not supposed to touch or be in contact with the long mandrel. By having an operator to single-handedly pull the layer of material while at the same time not touching the long mandrel is by no means an easy feat. The other method of having the mandrel supported by an external body like a stand is not possible too as the stand would act as a form of obstruction while the outer layer of material is being pulled over the mandrel and yet without touching the mandrel.

Hence magnetic levitation is being introduced in order to overcome the challenges highlighted earlier. In line with the potential application described above, the embodiment of the present invention disclosed an assembly process that involves long cylindrical components in a manufacturing environment. Such assembly will involve a mandrel and tubes made of silicone and fabric. The mandrel for this application has to be of the same shape as the component for this process to be effective. The total length to be at least half a metre (0.5m) long depending on the design. Alternatively, the mandrel can also be more than one (1) metre long, depending on the design as well. The use of magnetic levitation is more useful and practical if the total length of the mandrel is very long as there is a limit to which a human can hold the mandrel using both hands as there is a limited outstretched arm span. Depending on the application, perforations on the mandrel are needed if the processing steps involved negative air pressure.

The mandrel can be magnetically levitated using current available known form or current prior art of electromagnetic technology. Magnetic poles with the same like poles are created so as to enable the mandrel to be magnetically levitated. As described earlier, depending on the intended design and the application required, relevant and appropriate sensors are also incorporated in order to maintain the desired position of the mandrel at the relevant elevated position during operation. The full operation will be automated and will have the appropriate jigs and fixtures in order to perform effectively.

For the embodiment of the present invention, the mandrel is perforated since negative air pressure is being utilised in its processing steps. For this present invention, the **key steps** are summarised as follows:

1. The mandrel is magnetically levitated.
2. The silicone tube is first pulled over the mandrel.

3. Negative air pressure is then applied to suck in the silicone tubes, pulling it close to the mandrel through the perforations of the mandrel.
4. A layer of adhesive agent is then applied on the silicone tube with the automated jig.
5. Fabric tube is then pulled over the silicone tube that is on the mandrel.
6. The negative air pressure air is reversed and followed by having positive pressurized air being blown to bring the silicone tube to adhere to the fabric tube.
7. Air pressure is then maintained throughout the levitated mandrel.
8. The whole set-up is then cured by means of heat such as hot air.
9. Once fully cured, the tube assembly with the silicone tube inside the fabric tube will be removed and then used for its intended design application.

The details of the tube assembly process are being described in the accompanying patent drawings portion of this patent writeup or disclosure.

The design and layout of the present invention has the following advantages:

1. ***Useful for Assembly Applications that has components more than one (1) metre long.***

When one needs to assemble separate components longer than one (1) metre long together, it then becomes useful to use a mandrel that is magnetically levitated. If the mandrel is magnetically levitated, this will eliminate the need to have additional manpower to support it manually. With magnetic levitation, it allows the whole assembly, otherwise cumbersome, to be automated, making operations much faster and easier.

2. ***Shorten Processing Steps, Increasing Productivity & Cost Savings***

As highlighted in the earlier paragraph in point 1 above, having the mandrel to be magnetically levitated would potentially shorten the processing steps needed and thus increasing the work productivity, as compared to an assembly that does not use magnetic levitation. Without magnetic levitation, it would require at least three (3) men to do the assembly. For this present invention, it allows the assembly to be fully automated, hence increasing productivity, which would in turn translate into potential costs savings.

3. *Applicable for all Shapes and Sizes and for Different Materials*

The mandrel to be magnetically levitated can be of different shapes and sizes, not just long cylindrical or circular in cross-section but can be squarish or other shapes that consist of more than four (4) sides etc. Besides the mandrel shape, the mandrel can also have perforations or is non-perforated, or it can also be non-perforated at certain parts of the mandrel.

The long tubular components are not limited to just fabric and silicone as described in the previous paragraphs but can be made of other materials such as polymer or wooden material. The above variable elements depend on the product tube design.

4. *Flexibility to work without the need of Applying an Adhesive Agent*

The present invention also allows silicone tube to adhere to the fabric tube without the need to apply an external adhesive agent. This means that either the silicone or the fabric tube can be manufactured with a layer of pre-coated form of adhesive being applied onto it first. Hence once both tubes are adhering to each other, the whole setup can then be cured by heat such as hot air.

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 2A illustrates the close-up perspective view of the mandrel and silicone tube.

Figure 2B illustrates the close-up perspective view of the mandrel, silicone and fabric tube.

Figure 2C illustrates the cross-sectional view of the present invention involving the mandrel, silicone tube, adhesive layer and fabric tube.

Reference numbers

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| 1 | Mandrel |
| 2 | Fixed Stand |
| 3 | Electromagnet |
| 4 | Controller |
| 5 | Sensors |
| 6 | Fabric Tube |
| 7 | Perforations |
| 8 | Silicone Tube |
| 9 | Adhesive Agent |
| 10 | Mandrel (without perforation) |

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT OF THE PRESENT INVENTION

In the following description, details and drawings are provided to describe the embodiment of the application. The embodiment of the present invention relates to the use of long cylindrical mandrel, with perforations, and is magnetically levitated to fabricate long tube assembly.

Figure 1 illustrates an overall perspective view of the various key components and functions for the embodiment of the present invention. It illustrates the mandrel **1** which is magnetically levitated via means of electromagnet as denoted by numeral **3** as per illustrated in **Figure 1**, with the other end fixed to a permanent fixed stand **2**. As mentioned earlier in this description, there are various shapes and sizes for the mandrel. For ease of explanation in this description, **Figure 1** highlights the mandrel **1** to be cylindrical in shape. The electromagnet **3** is configured to generate a magnetic field upon the passage of an electrical current, such that like magnetic poles repel in order for the mandrel **1** to be levitated. Appropriate controller **4** with the relevant sensors denoted as **5** in **Figure 1** are being utilized in order to create the electromagnetic levitation. Such sensors denoted by **5** in **Figure 1** can include, for example, position sensors in order to generate a feedback signal to the controller **4** to indicate the height displacement of the mandrel **1**. Under steady state condition, the controller **4** would ensure that the mandrel **1** is then safely magnetically levitated.

Also as illustrated in **Figure 1**, the mandrel **1** which is cylindrical in shape, is perforated with small holes or perforations **7** of similar diameter. These holes or perforations **7** are small enough to allow the negative air pressure to be applied during the tube assembly process involving the use of the mandrel **1**. If necessary, some parts of the mandrel can also be non-perforated **10** as illustrated in **Figure 1**.

And for ease of explanation, this material will be fabric in nature. **Figure 1** illustrates the silicone tube **8** that is inserted over the mandrel **1** that is magnetically levitated prior to the insertion. Besides **Figure 1**, **Figure 2A** illustrates a closed-up perspective view of the silicone tube **8** in contact with the mandrel **1**. Negative air pressure or air is then applied to suck in through the perforations **7** so that the silicone tube **8** adheres closely to the mandrel **1**. Next a layer of adhesive agent **9** is applied on the silicone tube **8** before having the fabric tube **6** pulled over the silicone tube **8**, which is also illustrated in the close-up perspective view in **Figure 2B**. In addition, **Figure 2C** illustrates the cross-sectional view of the present invention involving the mandrel **1**, silicone tube **8**, adhesive layer **9** and fabric tube **6**. As mentioned in the earlier description, the present invention is flexible enough whereby it also allows silicone tube **8** to adhere to the fabric tube **6** without the need to apply an external adhesive agent. This means that either the silicone or the fabric tube can be manufactured with a layer of pre-coated form of adhesive being applied onto it first.

Next, the fabric tube **6** is bonded to the layer of adhesive agent **9** that is being applied previously. After bonding, negative air pressure is then reversed and positive pressurized air is then applied via the perforations **7** in order to bring the silicone tube **8** to adhere closely to the fabric tube **6**. Air pressure is then maintained throughout the levitated mandrel **1**. The whole tube set-up is then cured using oven or by applying some form of heat evenly throughout by using, for example, by applying hot air all around it within a heating chamber or equivalent means. The heating temperature and heating time would need to be appropriate for the application. Once fully cured, the tube assembly with the silicone tube **8** inside the fabric tube **6** will then be easily removed and then be used for its intended application.

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 mass manufacture assembly of long tubular components via the use of a mandrel whereby:
 - (a) the mandrel has perforations; and
 - (b) the mandrel is magnetically-levitated using current available electromagnetic processes; and followed by
 - (c) inserting the silicone tube over the mandrel, followed by
 - (d) applying negative air pressure through the perforations to suck in the silicone tube, pulling it closer to the mandrel;
 - (e) applying a layer of adhesive agent on the silicone tube side; followed by
 - (f) pulling a fabric tube over the silicone tube such that it is bonded to the layer of adhesive agent on the silicone tube;
 - (g) reversing the negative air pressure and followed by having positive pressurized air being blown via the perforations in order to have silicone tube adhere closely to fabric tube;
 - (h) maintaining the air pressure throughout the levitated mandrel, followed by
 - (i) curing using some form of heat evenly throughout by applying hot air all around it within a heating chamber or equivalent means;
 - (j) removing the tube assembly with the silicone tube inside the fabric tube once it is fully cured, so as to be used for its intended application.
2. A **method** of **Claim 1** whereby:
 - (a) the long tubular components are more than 0.5metres long, and
 - (b) can be of different cross-sectional shapes and materials; wherein
 - (i) such materials are either fabric and/or polymeric in nature.

3. A **method** of **Claim 1** whereby

(a) the cross-sectional shape of the mandrel follows the cross-sectional shape of the tubular component to be processed or assembled, and whereby

(i) negative air pressure can be applied through the perforations in the mandrel; and whereby

(ii) positive pressurized air can also be applied via the perforations in order to have the silicone tube adhere closely to the fabric tube.