APPARATUS FOR DEPOSITING POWDERED SUBSTANCE ON THE INNER SURFACE OF INFLATION TUBE

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ABSTRACT
An apparatus for uniformly and thinly depositing finely powdered substance on the inner surface of an inflation tube, which is being shaped by an ascensional inflation method, by diffusing said powdered substance into gaseous atmosphere in the inflation tube by means of static electricity.

7 Claims, 3 Drawing Figures
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BACKGROUND OF THE INVENTION

This invention relates to an apparatus for uniformly depositing finely powdered substance on the inner surface of an inflation tube.

In general, in the continuous synthetic resin tube shaping process, particularly when an inflation method is employed, a tube such as for example a polyethylene tube extruded out in the form of a tube from an annular slit in the die is inflated with blowing air. At the same time the tube is cooled from the outside and held between pinch rolls, and the thus folded tube-shaped film lamination is taken up on a winder through a guide roll. In some cases, however, the two film sheets facing each other may be tightly stuck together for some reason or other, this causing great impediment to the succeeding operations.

Such impediment would be eliminated if finely powdered substance could be uniformly deposited over the inner surface of a sealed inflation tube formed between the die and the pinch roll.

However, admitted that the finely powdered substance could be introduced above the die by some mechanical means, it is extremely difficult to have these powdered substance uniformly deposited on the entire inner surface of the tube since the tube usually has inner diameter as large as 1 meter or more and also since a convection formed from an upward current in the central part and a downward current in the peripheral part is present in the interior of the inflation tube as the die temperature is usually as high as 200°C and the inflation tube is cooled from the outside. If the internal pressure of the inflation tube is not kept constant, the finished tube diameter may be varied, so that it is practically impossible to diffuse the finely powdered substance particles by using compressed air. The fact that the amount of such finely powdered substance to be deposited, although somewhat varied according to the purpose of use, is usually as small as about 0.15g/m² is an additional factor that increases the difficulties.

SUMMARY OF THE INVENTION

The present invention has eliminated the above mentioned conventional difficulties for diffusing the finely powdered substance by using an electro-static means.

An object of the present invention is to provide a new and improved apparatus for depositing finely powdered substance on the inner surface of an inflation tube.

Another object of the present invention is to provide an apparatus for depositing finely powdered substance uniformly and thinly over the entire inner surface of an inflation tube by diffusing said powdered substance by means of static electricity and fluctuation of said powdered substance.

According to the present invention, an annular member made of an insulating material is mounted at the end of a transporting tube which transports the finely powdered substance. The transporting tube passes through and extends uprightly above an ascensional inflation die along with a high tension cable electrically connected to a high voltage generator. A high voltage electrode member is secured externally at the top of said annular member and is applied with a high voltage of opposite polarity to that of the electric charge on the inflation tube by said high tension cable. Within said transporting tube is provided a flexible screw. Further, inside of said annular member, a rotary cutter means for breaking up the mass of the powdered substance which may have been formed during transportation may be mounted at an end of said flexible screw.

A complete understanding of the invention may be obtained from the following detailed description of an apparatus constituting a specific embodiment thereof, when read in conjunction with the appended drawings, in which:

FIG. 1 is an illustration showing the entire mechanism of the apparatus according to the present invention;

FIG. 2 is a sectional view of the essential parts of the apparatus, and

FIG. 3 is a plane view of the essential parts of the apparatus.

PREFERRED EMBODIMENT OF THE INVENTION

Referring first to FIG. 1, there is shown an ascensional inflation die, generally designated by numeral 1, which is of a known type. Molten synthetic resin is introduced through a coupling tube 2 connected to an extruder (not shown), then passed through a passage 4 formed along the peripheral wall of a mandrel 3 and finally forced out through an annular slit 5 to form an inflation tube 6 of thin film. The diameter of the tube 6 is determined according to the amount of air blown in from a hole 7. Although not shown, the tube is cooled with air from a cooling ring, then held between squeeze rolls and finally taken up on a winder. These operations are quite similar to those employed in the conventional devices.

The mandrel 3 has formed therein the through-holes 8 and 9 which are passed, respectively, a high tension cable 11 electrically connected to a high voltage generator 10 and a transporting tube 13 made of a metal, such as copper, connected to a feeder 12 of finely powdered substance. At the bottom ends of said holes 8 and 9, the plugs 14 and 15 are closely fixed, respectively. The portion of the transporting tube 13 that extends within the mandrel 3 is provided with a cooling jacket 17. A coolant is introduced from an inlet tube 16 of said cooling jacket 17 and passes through the jacket into an outlet tube 18.

The high voltage generator 10 may, for instance, be a full-wave, voltage doubler rectification type generator having rated input voltage of 100 V and output voltage of DC 30KV. The polarity of the output voltage can be optionally switched with ease. The high tension cable 11 is coated with an insulating layer of silicon rubber and is braided with glass fiber outside thereof. The feeder 12 includes a flexible screw 20 which is arranged to be rotated by a DC motor 21 and which is disposed in a transporting tube 13 for transferring the powdered substance in a tank 19 through said transporting tube 13. The number of rotations of said flexible screw can be adjusted by a controller 22. The flexible screw 20 is made from a bundle of plural steel wires on which another steel wire is spirally coiled at a suitable pitch. A breaker 23 rotated by the DC motor 21 is provided in the tank 19 to thereby inhibit the "bridge" phenomenon that otherwise tends to take place in said tank. Preferred examples of the finely powdered substance used in the present invention are
The metal-made transporting tube 13, which passes through and extends upright above the die 1, is electrically earthed and has mounted at its top end an annular member 24 made of an insulating material such as for example tetrafluoroethylene. As apparent in FIG. 2, the annular member 24 has formed therein three stepped holes, i.e., a lower hole 25, a middle hole 26 and an upper hole 27, and a tapered opening 28 extending upwardly from the end of the upper hole 27. In said middle holes 26 and upper hole 27 is fitted a brass-made receiving member 29, a tapped hole of which is threadedly engaged with the threaded end portion of the transporting tube 13 inserted through the lower hole 25. The bottom of the annular member 24 is pressed by a nut 30 which is threadedly engaged with the threaded portion of the transporting tube 13, thereby fixing said annular member in position.

A high voltage electrode member 31 made of brass is mounted over the external upper annular portion and around the external upper circumferential portion of the annular member. An upper inner circumferential portion 37 of the electrode member extends vertically from the upper end of the inner surface of the tapered opening 28. The annular member 24 and the high voltage electrode member 31 are fastened together by a machine screw 32 which also secures an end of the high tension cable 11 so as to impress a high voltage thereto.

A brass-made rotor 33 is mounted at the end of the flexible screw 20. A boss 34 of said rotor 33 is smaller in diameter than the central hole of the receiving member 29 in which said boss is inserted, so that an annular space 35 is formed therearound and hence the powdered substance transferred here through the transporting tube 13 by the flexible screw 20 may be exposed to the outside by passing through this space 35. As apparent in FIG. 3, the rotor 33 is provided with six pieces of cutter blades 36 which are freely rotatable on the upper surface of the receiving member 29 to break up the powdered substance transferred here in the form of masses.

Now, the operation of the present apparatus is described. First, an inflation tube 6 is shaped according to a known inflation method and then the high voltage generator 10 is adjusted such as to apply to the high voltage electrode 31 a high voltage of about 30,000 KV in case the tube diameter is less than 1 meter and about 50,000 to 80,000 KV if the tube diameter is larger than that. The electric voltage applied is of a polarity opposite to that of the static electricity (negative in many cases) of the inflation tube 6. Then, a coolant is passed through the jacket 17 and the DC motor 21 is operated to feed the powdery substance in the tank 19 upwardly of the rotor 33 through the transporting tube 13. The fine solid particles of the powdered substance broken up by the rotating cutter blades 36 are attracted by and fly toward the inner circumferential portions 37 of the high voltage electrode member 31, and upon contacting said inner circumferential portion 37 of the electrode member 31 the particles are charged with the same polarity as said electrode member 31. The charged particles repulse each other and are diffused by producing fluctuation. The electrode member 31 is positioned almost in the center of the inflation tube so that the charged particles diffused from the electrode member can be ridden on the ascending current of the convection in the inflation tube 6.

Thus, the fine solid particles of the powdered substance charged with a polarity opposite to that of the electric charge on the inflation tube can be uniformly deposited on the inner surface of the tube owing to the electrostatic attractive force irrespective of the convection in the inflation tube. Needless to say, there does not take place any leakage of the finely powdered substance diffused in the interior of the inflation tube which is sealed by the die and the squeeze rolls.

The cylindrical portion of the high voltage electrode member 31 covering around the external upper circumferential portion of the annular member 24 serves to radially repulse the particles of the powdered substance which tend to pass near said cylindrical portion while precipitating. This means is advantageous for reducing the amount of wasteful sprayed particles which are deposited on the external surface of the transporting tube 13 which acts as an earthing electrode, or accumulated on the die 1.

The present invention is not limited to the above mentioned embodiment but can be variously modified without departing from the spirit of the present invention.

What is claimed is:

1. An apparatus for depositing finely powdered substance on the inner surface of an inflation tube, which comprises a high tension cable electrically connected to a high voltage generator; a transporting tube for transferring said powdered substance from a feeder, said transporting tube passing through and extending uprightly above an ascensional inflation die along with said high tension cable and being earthed electrically, within said transporting tube a flexible screw being disposed for rotatable conveying said powdered substance; an annular member made of an insulating material and mounted at an end of said transporting tube; and a high voltage electrode member secured externally at the top of said annular member and applied with a high voltage of a polarity opposite to that of the charge on the inflation tube by said high tension cable.

2. An apparatus as defined in claim 1, wherein said high tension cable is coated with an insulating layer of silicon rubber and is braided with glassfiber outside thereof.

3. An apparatus as defined in claim 1, wherein said high tension cable and said transporting tube are passed through two through-holes which are formed uprightly within the ascensional inflation die, at the bottom end of each hole a plug being fixed threadedly, the portion of said transporting tube that extends within the inflation die being provided with a cooling jacket.

4. An apparatus as defined in claim 1, wherein said flexible screw disposed within the transporting tube is made a bundle of plural pieces of steel wires on which another steel wire is spirally coiled at a suitable pitch.

5. An apparatus as defined in claim 1, wherein said high voltage electrode member is made of brass and is mounted over the external upper annular portion and around the external upper circumferential portion of the annular member.

6. An apparatus as defined in claim 1, wherein said annular member forms therein a lower hole, a middle hole, an upper hole and a tapered opening, said three holes becoming larger in steps such that said upper hole
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is the largest, said tapered opening extending upwardly from the end of said upper hole, a brass-made receiving member being fitted in said middle hole and said upper hole, said receiving member being therein provided with a tapped hole which is threadedly engaged with the threaded end portion of the transporting tube inserted through the lower hole, the bottom of said annular member being pressed by a nut which is threadedly engaged with a threaded portion of the transporting tube.

6. An apparatus as defined in claim 6, wherein said receiving member forms therein a central hole in which a rotary cutter means for breaking up the masses of the powdered substance which may have been formed during transportation is received, said rotary cutter means comprising a plurality of cutter blades and a boss, said cutter blades extending radially from said boss mounted at the end of the flexible screw disposed within the transporting tube and being freely rotatable on the upper surface of the receiving member, said boss being smaller in diameter than said central hole of the receiving member in which said boss is inserted.

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