

Description

Helical cutting of a flexible tubular film of polymeric material is disclosed in generic document GB-A-816,607. The object in that patent was to manufacture bands having a strong molecular, oblique, orientation. The bands are mainly used for manufacture of high strength cross laminates of uniaxially oriented plies. In order to achieve the desired properties, the tubular film is strongly oriented in its original longitudinal direction prior to the helical cutting, which is generally conducted over a mandrel. The tube is forwarded either with a screw movement before cutting with a fixed knife, or with a linear movement before cutting with a rotating knife, in which event the winder for taking up the helically cut film must rotate with the knife in a planetary type of movement. The cut strip is drawn away from the tubular film.

Helical cutting of flexible tubular film is also used in GB-A-1,526,722. The tube that is to be cut generally has a uniaxial polymer grain, this being produced during the extrusion. However the extrusion need not, prior to the helical cutting, provide any significant orientation of the film below its melting point. The object again is the manufacture of high strength cross laminates but in this case the plies are biaxially oriented by stretching after or during the lamination, the transverse and longitudinal stretching processes being mutually independent steps and each step generally being uniaxial.

These patents do not disclose means for synchronising the different movements that control the helical cutting, i.e., the advancement of the film, the rotation of the film or the cutter, and the withdrawing of the cut film. However, some degree of such synchronisation can be developed using conventional engineering techniques.

Nevertheless certain problems do remain.

One problem is that the take-off of the cut strip is at an angle to the original direction of advance of the film and therefore tends to produce torque forces in the tubular sheet. This tends to result in distortion of the tube at the time of cutting, and thus distorts the cut and the resultant cut strip. It is very difficult to balance the forces so as to avoid this distortion.

Another problem is that it can be difficult to achieve a regular and accurate supply of film towards the cutting station, particularly when the film is provided in flat form wound on a very heavy reel.

As is well known, there are many instances when it is desirable to provide films of sheet material which is oriented under an angle to the longitudinal direction and, as indicated above, the known processes of helical cutting can be used to this end. However it is desirable to provide a more technically feasible and reliable process, that is also suitable for heavy or wide reels and for high production speeds.

Objects of the invention are to overcome these various problems and to provide methods and apparatus for improved helical cutting of films, and to provide improved films.

In US-A-2644522 apparatus is described for bias cutting tubular fabric supplied from a large reel on which the tube is wound in flat form. The tubular fabric as it is removed from the reel must pass over a reel mounted above the supply reel, from which it passes down again towards a mandrel over which the tube passes. The tube of fabric is provided with a helical movement by driven rollers bearing against the fabric on the mandrel. A blower is provided to supply an air blast through a nozzle provided in the upstream end of the mandrel which opens the fabric tube and, by being given a whirling movement, facilitates the helical travel of the tube over the mandrel. The supply reel for the flat tube is mounted on a horizontal axle, which in turn is fixed to a turntable on a vertical axis mounted via a bearing ring small relative to the length of the supply reel. The tubular material is drawn from the supply reel in a direction tangential to the reel surface.

According to a first aspect of the invention, a flexible tubular film of polymeric material is supplied to a first position in a flat form from which it is drawn, opened to tubular form, drawn over a mandrel and helically cut while passing over the mandrel to form a cut strip that is drawn away from tubular film, the method of the invention being characterised in that the tubular film is inflated by air that is continuously supplied through the mandrel towards the first position to form a stiff tube that makes a sliding fit with the mandrel and that resists deformation during the cutting and in which the opening of the flat form to the tubular form by inflation is controlled by driven support means which support the tube against the force of the air emerging from the mandrel.

Apparatus for carrying out the process is also part of the present invention.

Thus, in the invention air is forced from the mandrel into the tubular film as it travels from its flat state to the mandrel and thereby inflates the film to a tube. The mandrel must have a diameter only very slightly smaller than the tube, in order to allow an adequate pressure to exist within the tube to render it sufficiently stiff. However some air inevitably escapes between the tube and the mandrel and this escaping air can provide lubrication between the tube and the mandrel.

As a result of the tube being stiff as it slides over the mandrel towards the position at which it is helically cut, distortion of the tube by the cutting and the drawing of the cut strip can be greatly reduced. The degree of stiffness that is required for any particular film will depend upon the material being used and the process conditions. However it is easy to choose the air pressure within the tube, and thus the stiffness of the tube, to obtain whatever degree of resistance to deformation that is optimum for the particular process. Thus, in the invention, it is possible to apply much higher forces during the pull-off of the helical cut strip from the mandrel and the winding of this cut strip.

The pressure within the tube, and the supply of air through the mandrel, will be selected according to the materials being used. For instance relatively low pres-

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sures should be used when the film is liable to split, for instance when the film is of low gauge, high degree of uniaxial orientation, and/or high stiffness. However if the pressure is too low relative to the oblique pulling forces, then the tubular sheet will lose its stiffness and will become twisted and the process will become less accurate or may terminate. Provided the film permits it, it is generally desirable for the air pressure to be sufficient to allow a tension of at least 200g per metre width in the strip at the pull-off from the mandrel and, provided the strip permits it, preferably the tension is at least 2kg per metre.

The advantages of the invention are achieved mainly when the flat tube has a width of at least 20cm. The width can be up to 200cm or even higher.

The cutting angle is generally at least 20°. Values of up to 70° can be achieved relatively easily with good accuracy, but it is also possible to achieve values approaching 90°.

Preferably the diameter of the mandrel is variable. For instance it can be made from a tubular rubber sheet held by a circular array of ribs which are supported by extendable means (for instance in the same manner as the support ribs of an umbrella). Adjustment of these extendable means will thus result in adjustment of the effective diameter of the mandrel and so the same mandrel can be used for different widths of tube. The diameter can also be varied to control the air pressure. This is of particular value when cutting fragile films, such as thin, rigid and/or highly oriented films, when minimisation of the air pressure and air flow is important. In this situation the variable diameter of the mandrel can be feedback controlled by registration of the air flow or the overpressure inside the tube.

The surface of the mandrel can be corrugated to minimise the friction between the film and the mandrel. These corrugations can conveniently consist of generally longitudinally ribs. The corrugations promote the flow of air over the entire circumference of the mandrel and therefore improve the lubrication effect of the annular air flow between the film and the mandrel.

The helical cutting can be arranged in line with the initial extrusion of the flexible tubular film, but the machinery for this combination will tend to be rather complicated and will generally only operate at relatively low rates of production. It is therefore preferred first to extrude the tubular film and then to wind this in flat form on a reel. This reel is then mounted in an unwind device and this simultaneously causes the tubular film to unwind in flat form and to rotate around its centre axis. The location of cutting should then be fixed in relation to the room and the film moves linearly after the cutting. This is more convenient than providing for the film to move linearly and for the knife to rotate around the mandrel, together with the winding machinery.

In a simple form of apparatus for providing that the flat film at the first position is rotating, the axis of the reel is mounted perpendicular to the axis of rotation of the tube with the middle point of the reel on or near to the

last mentioned axis. Such an arrangement is illustrated in Figure 1 of the accompanying drawings. This method is very satisfactory for spiral cutting of reels that are not too heavy (e.g., up to about 400kg) provided the reel is of proper shape and tightness and has its centre of gravity properly on the axis of rotation and provided the velocity of rotation is not too high. However the method is less satisfactory if the reel is very heavy, is rotated very fast, or has imperfect shape or tightness. These problems exist also even when there is no air flow through the mandrel. A new system of supplying the flat film is provided that overcomes these problems.

Thus according to another aspect of the invention (that need not be combined with the inflation of the tubular sheet by air through the mandrel) the location of cutting is fixed (i.e., it is fixed relative to the room in which the process is conducted).

In this aspect there is provided a method in which a flexible tubular film of polymeric material is supplied to a first position from a reel, being discharged from the reel at a discharge zone, in a flat form from which first position it is drawn, opened to tubular form, drawn with a screw movement over a mandrel and helically cut while passing over the mandrel to form a cut strip at a location which is fixed, the cut strip being then drawn away from the tubular film, characterised in that the tubular film is drawn from the reel substantially along the axial direction of the reel while the discharge zone spins around the reel to produce rotation of the tube.

The present invention includes apparatus for carrying out the method.

Preferably the reel has substantially the same axis as the axis of rotation of the tube and the tubular film is guided and maintained in flat form from unwind to the discharge zone and transformation to the tubular form begins at that zone, whereby the middle line of the flat film is guided to become substantially coincident with the axis of the reel.

This technique minimises the problem of mechanical forces on the rotating unwind, and reduces the need for exact adjustment of the position of the reel in the unwinder. It also minimises the risk of telescoping during the unwind of film that is wound too loosely on the reel. Thus it permits the use of much heavier reels and much higher velocities.

The bearing or bearings around which the unwind unit rotates can be located at one end only of the unit, namely at the end opposite to the cutting as shown in Figure 1. However when heavy weights are involved this system is vulnerable to fatigue breakage unless the shaft, bearings and support for the latter are of particularly heavy construction.

Another aspect of the invention (that can again be operated in combination with or without the air inflation and with or without the defined mounting of the reel) provides a solution to this problem.

In this aspect of the invention there is provided a method in which a flexible tubular film of polymeric material is supplied to a first position from a reel, being dis-

charged from the reel at a discharge zone, in a flat form from which first position it is drawn, opened to tubular form, drawn with a screw movement over a mandrel and helically cut while passing over the mandrel to form a cut strip at a location which is fixed, the cut strip being then drawn away from the tubular film, characterised in that the reel is mounted in an unwind unit and is drawn to the mandrel with a screw movement that is provided by rotation of the unwind unit, and the unwind unit is mounted on a bearing that comprises a bearing ring that surrounds the tubular film.

The present invention includes apparatus for carrying out this method.

The processes of the invention are normally intended to manufacture cross laminates having high strength, and for this purpose two or more helically cut films are subsequently laminated with one another with the original longitudinal directions of the tubular film criss-crossing each other. Preferably therefore the tubular film is given a uniaxial melt orientation. Alternatively or in combination therewith the tubular film may be longitudinally oriented below the melting range of the polymer material.

As geometrical conditions show, the following equation relates the width (h) of the flat tube, the cutting angle (v) measured between the longitudinal direction of the flat tube and the direction of cutting and the final width (w) namely

$$w = 2h \cos v$$

As examples, with a cutting angle of 60° the final width would equal the flat width, at 45° the flat width will be increased by $\sqrt{2}$ (=1.41) and with cutting angle 30° by $\sqrt{3}$ (=1.73). With cutting angles higher than 60°, the obtainable width for a given spiral cutting machine will rapidly decrease.

Another aspect of the invention has the purpose of increasing the obtainable final width for a given final angle of melt orientation and for a given spiral cutting machine, especially in the case of angles about 60° or closer to 90°. Although this aspect is preferably used in combination with the air inflation and optionally one or more of the other aspects of the invention, it can again be used independently of those.

In this aspect of the invention, there is provided a method in which a flexible tubular film of polymeric material is supplied to a first position in a flat form from which position it is drawn, opened to tubular form, drawn over a mandrel and helically cut while passing over the mandrel to form a cut strip that is drawn away from the tubular film, characterised in that the film was initially manufactured by extrusion through an extrusion die with spiral melt orientation by draw-down in molten to semi-molten state and simultaneous relative rotation between the take-off means from the die and the exit of the die, and in which the spiral cutting is carried out in such a direction that the angle of orientation is increased.

In theory it could be assumed that the spiral cutting could be omitted (except when an angle of 90° is desired) if the relative rotation was fast enough. In practice however difficulties in carrying out such extrusion increase with the increased angle of orientation and it has been found that an increased angle inherently leads to an increased component of biaxially melt oriented material, and this is generally not desirable at least in the production of cross laminates. For instance it is not usually feasible to produce angles higher than about 30° by such relative rotations in connection with the take-off from the extrusion die.

Thus this aspect of the invention permits, in an easy practical manner, a substantial increase in the angle relative to the length direction of the cut strip. e.g., the 30° angle from the extrusion can be made a 60° angle by cutting under 30° or it can be made perpendicular by cutting under 60°. In the first mentioned case the flat width is increased by a ratio of 1.73:1 and in the second case it is the same before and after the spiral cutting.

The strip that is obtained in all the aspects of the invention can be relatively wide, typically 50cm or higher, and so for the first time the invention provides the provision of a strip of 50cm or greater width and which has an angle of melt orientation of 70° up to perpendicular. Preferably, but not essentially, it is made using the air inflation technique described above. This material gives important advantages and yet its production is, as a result of the invention, relatively easy without use of a tenter frame or similar apparatus. In particular, it is now relatively easy to produce substantially perpendicularly oriented sheet material of, for instance, 3m width even on reels of several tons (especially when the second aspect of the invention is used, preferably in combination with the third aspect).

Extruded sheet material will normally exhibit a grain showing the direction of take-off from the extrusion die and the strip formed in the process according to this aspect of the invention is characterised in that the width is at least 50cm, the angle between the grain which shows the direction of take-off from the extrusion die and the longitudinal direction of the sheet, is from 70° up to perpendicular.

This sheet material can be used for, for example, the production of a novel type of biaxially oriented film in which at least the major proportion of the transverse orientation is produced at take-off from the extrusion die and the longitudinal orientation is produced at a much lower temperature. The longitudinal orientation and optional additional transverse orientation of relatively low temperature can with advantage be carried out by the method described in WO88/05378.

The various aspects of the invention are of particular value for the manufacture of a cross laminate of plies which have a generally uniaxial grain from the extrusion and in which the grain from different plies is in cross laminated relationship, but which subsequently has been biaxially oriented. Such cross laminates are described in GB 1,526,722. When making such cross laminates, it

may be desirable to produce one or more plies having a grain from the extrusion forming an angle of from 70 to 90° to the longitudinal direction, especially in combination with one or more plies having a grain of 0° or close to this.

It has been found that cross laminates of this type and with these angles (especially about 90° combined with about 0°) show maximum tear strength in the 45° direction and it has been found that the need for high tear strength in a sewn seam is highest at the angle 45° to the direction of tear. Therefore such cross laminates are, for instance, very suited for sewn sacks and for sewn raincoats and other sewn products.

A particularly preferred composition in cross laminates, or for the main layer in an individual ply of the laminate (or in the main layer of the ply if the ply consists of several coextruded sublayers) is formed of a blend of high molecular weight high density polyethylene with significantly lower molecular weight low density polyethylene. The latter preferably is selected from copolymers and/or branched polyethylenes which have the same or higher elongation of break (tested at room temperature under slow stretching) as the high molecular weight polyethylene and which are capable of distinctly segregating, while forming a distinct microphase, from the high molecular weight polyethylene on cooling of a molten homogeneous blend of the components. The blending ratio of the polyethylenes is preferably 25:75 to 75:25. The inclusion of polypropylene having significantly lower molecular weight than high molecular weight polyethylene can also be advantageous, in amounts of from 0 to 70% based on the combined weight of polypropylene and both polyethylenes. The high molecular weight high density polyethylene preferably has a melt flow index of 0.2 or lower by ASTM D1238 condition E and the low density polyethylene is preferably linear low density polyethylene.

The invention will now be explained in more detail with reference to the schematic drawings in which:

Figure 1 is a horizontal view from above of apparatus for spiral cutting with a rotating unwind unit, in which the axis of the reel which is being unwound is perpendicular to the axis of the inflated tube. The rotating unwind unit is supported with bearings at one end only.

Figure 2 is a similar view showing a different unwind unit in which the axis of the reel which is unwound is essentially coinciding with the axis of the inflated tube, and the flat tube is guided over one end of this reel. The drawings also show a particularly suitable giant roller bearing surrounding the tubular sheet. The guide system for taking the sheet off the reel is not shown.

Figure 3 is a perspective view of the guide system that is omitted from Figure 2. Rollers are shown only as dotted lines indicating their axes.

The apparatus of Figure 1 includes an unwind unit 1 which has a shaft 2 at one end and rotates around the axis of the shaft supported by a column 3 through heavy roller bearings 4. The column 3 is mounted on the floor of the room. For simplicity the unwind unit 1 is shown as having a housing consisting of an end plate 5 and two side plates 6. The drawing shows the unit at the time of rotation when these side plates are in a horizontal position and only the upper plate, indicated by dotted lines, can be seen. In practice a framework mainly of profile steel may be preferable to plates since it will be lighter and more convenient.

The support column 3 carries a fixed gear wheel 7 which is engaged with another gear wheel 8 mounted on the end plate 5 and therefore carries a planetary movement. The wheel 8 supplies the drive to the various rollers and wheels in the unit 1, but for simplicity the transmission for these movements is not shown.

A reel 9 of flat tubular sheet 10 is mounted through bearings in the side plate and is supplied with a brake, the bearings and brake not being shown. The flat sheet 10 is taken off the reel 9 by means of a set of nip rollers 11 that define the first position in the process. The transmissions between the gear 8 and the rollers 11 determines the cutting angle. Preferably the gear ratios are made variable, for instance by providing the possibility of changing gear wheel.

There is a cylindrical cutting mandrel 14 and an air jet to inflate the sheet 10 is blown by a fan 13, such as a centrifugal fan, through the mandrel towards the first position. The mandrel is mounted on the floor through a column 15 and makes a relatively tight fit with the tubular sheet 10 which slides over it. The air will escape through the narrow space between the mandrel and the sheet and will produce some lubrication effect. The tip 16 of the mandrel may be rounded to avoid hang-up of the sheet.

The lubrication effect can be improved by corrugating the surface of the mandrel. The corrugations are preferably a circular array of ribs. They may be arranged only on one side of the mandrel, namely the one which is opposite to the direction of pull, or may be deepest on this side, since this is where the tensions are highest.

It will be seen that the axis of the inflated tube (23) coincides at least substantially with the axis of rotation of the unwind unit 1.

In order to achieve a smooth screw movement of the inflated tubular sheet, it is very advantageous (and may even be necessary if the sheet is wide) to provide a driven support from the first position to a position at which the tube is inflated. Appropriate support for the inflating tube may be a pair of belts, and as shown in Figure 1 there are two pairs of driven belts 17 which support the tube against the backwardly directed force of the air emerging from the mandrel 14 towards the first position, and promotes a smooth change in shape of the tube from the flat shape to the cylindrical shape. The belts are driven at generally the same velocity as that of the sheet, or at a higher velocity. Instead of using two arrays of belts,

a pair of single belts, or two arrays of rollers having a relatively small diameter (only the last roller needing to be driven) could be used. For a relatively narrow flat sheet, one pair of driven barrel-like rollers of a large diameter may be sufficient.

The tubular sheet is cut by a simple knife or blade on a support 18 which conveniently can be fixed to the mandrel at an adjustable angle. The edge 19 that is shown on the drawing left of the knife, which becomes the right edge of the final sheet, moves first downwards and underneath the cutting mandrel.

The cut sheet is pulled by a driven winding unit 20 that is shown diagrammatically. The angle of cut, as mentioned, is determined by the ratio between the speeds of rotation of the unit 1 and the rolls 11, but the direction of the knife or blade and of the pull exerted by the unit 20 must also be adjusted so that they approximately fit with the rotation-determined cutting angle. The winding unit 20 includes a dancer roller 21 and two auxiliary idle rollers 22 to control the speed of the winder 20 and thereby set up a convenient tension.

By appropriate adjustment of the air pressure inside the tube (relative to the ambient air pressure around the tube) high tensions can be applied by the unit 20 (except in the case of very fragile sheets, when lower tensions must be used). Thus, when cutting a flat sheet of about 100 micron gauge and 1m wide, tensions of from 5 to 20kg/m final width are normally applicable.

It should be understood that the support for the rotating unwind unit, i.e., shaft 2 in bearing 4 in column 3, is only an example of support systems. For carrying heavier weights, this support can conveniently be supplemented or substituted by one or more big steel rings, which surround and form part of the rotating unwind unit, and which stand and roll on a number of support rollers or support wheels and so serve as bearing rings. Alternatively, the support fixed to the floor may form part of one or more bearing rings, on which stand and roll one or more circular arrays of rollers or wheels, which surround and are mounted on the rotating unwind unit.

As a further modification of the machinery shown, the gear wheel 7, instead of being fixed to column 3, may be rotatable and driven by a separate motor which is electronically regulated in relation to the motor for rotation of the entire unwind unit so as to provide for an easy adjustment of cutting angles.

While the drawing shows the unwind unit being rotated and the knife as well as the rewind unit being stationary, the opposite is also possible, namely a stationary unwind unit, while the knife together with the rewind unit rotating around the axis of the inflated tubular sheet. Although this last mentioned system is practical for relatively narrow sheets, it is less satisfactory for wide sheets.

In Figures 2 and 3, reel 9 has its axis substantially coinciding with the axis of the inflated tube and thus also with the axis of rotation of the unwind unit 1. The shaft of the reel is supported by a bearing 24 which is fixed to the end plate 5 and bearing 25 which is fixed to a beam

26, shown in cross section. This beam connects the two side plates 6. The bearings 24 and 25 can be opened for exchange of reels by means not shown. An adjustable brake 27 for the unwind is shown schematically.

In order to facilitate the understanding of Figure 3, the edges of the flat tube are marked a and b, respectively, at different stations of their path.

The unwound flat sheet is guided by idle roller 28, sheet-turner bar 29 which can be a fixed roller, idle roller 30 and the set of driven nip rollers 11 which are similar to item 11 in Figure 1. The above-mentioned rollers and bar or their bearings are fixed directly or through beams (not shown) to the side or end plates 6 and 5 of the unwind unit 1. The flat sheet is pulled off the reel at discharge zone 31 and the entire sheet guide system and the discharge zone 31 will spin around the axis 23.

The rest of the spiral cutting machine can be constructed similarly to Figure 1 except that in Figure 2 a large roller bearing 34 is shown. This is shown as the cross section of a big ring fixed to the side plates 6 (the connection is indicated by dotted lines) and two support reels or rollers 32 which are fixed to a support (not shown) through bearings. The two rollers as shown can only support the rotating unwind unit in respect of sideways movements and there must of course also be one or preferably several such wheels to hold the weight of the unit. Preferably there is a circular array of such wheels or rollers.

The direction of rotation of reel 9 relative to the housing or frame of the unwind unit 1 should preferably, but not necessarily, be opposite to the direction of rotation of the housing. This will make the absolute rotation of reel 9 as small as possible.

Dependent on the cutting angle v and the flat width of the tube h there will be a momentary radius of the reel ($r = \frac{h}{\pi \cdot 18 v}$) for which the absolute velocity of rotation of reel 9 is zero even though the housing of the unwind unit (and with this the discharge zone 31) may spin around the axis 23 at high velocity. The weight of rotating machine parts is therefore an essential limiting factor for the capacity of the spiral cutter even more in this embodiment than it is in the embodiment of Figure 1. Instead of the unwind unit based on end wall 5 and side wall 6, it is therefore particularly desirable to use a lightweight framework of which the ring 31 and possibly a similar ring at the other end are integral parts.

In order to guide and turn the flat tube in the desired manner, the bar or fixed roller 29 must form an angle close to 45° to the axis 23. This angle is preferably made automatically adjustable over a narrow range of angles and adjusted by the input of a sensor which senses the position of one of the edges. In this manner the middle of the sheet 10 is controlled to reach the axis of rotation 23 even when the reel 9 is not cleanly wound or has been put in a slightly wrong position on the shaft.

When the rotation of the unwind unit is very fast, as is normally intended, the guiding of the sheet shown in Figure 3 may be brought out of order by air turbulence. In order to overcome this, a wind shield or hood (prefer-

ably transparent) may be provided around the entire rotating unwind unit 1, fixed to and rotating with the latter.

When the knife is at a constant location and the tubular sheet is carried away from the reel along the axial direction of the latter, while the zone 31 is spinning around the reel, a guide system similar to Figure 3 is preferable but not essential. Especially when the cutting angle is relatively small, e.g., about 30°, the sheet may be allowed to wrinkle and even to compact to tow-form, since subsequent inflation by air can bring it back to tube-form. However support belts 17 will normally not be sufficient in such cases and should preferably be substituted by a circular array of many narrow belts. At the exit of the support system, the diameter of this array should be close to that of the tubular sheet. The optimum diameter of the array at the inlet to the support zone, and the necessary length of the zone, can be established by simple experiments.

Provided the array of support belts rotates around the axis of the array with exactly the same rotational velocity as the velocity by which the discharge zone 31 spins around the reel, it is not absolutely necessary for nip rollers 11 to follow this rotation. If they do not, the tubular sheet may become compacted and twisted in front of rollers 11 but will untwist and open when it moves away from the rollers.

As shown, the reel 9 is held from the inside and the tube is drawn off the outside but the reel 9 may alternatively be held from the outside with the unwind taking place from the inside.

Although the apparatus shown in Figures 2 and 3 does incorporate a supply of air through the mandrel 14, the features of these systems are also valuable even when the air supply is omitted. Thus the rotating unwinding system shown in Figures 2 and 3, and similar unwind systems in which tubular sheet is carried away over one end of the reel while the zone of discharge spins, is of general value for spiral cutting of materials from heavy reels and can be practiced independent of the use of the mandrel and air supply shown in Figure 1. Likewise the achievement of spiral formed orientation by relative rotations between extrusion die and take-off means, combined with spiral cutting which makes the angle of orientation bigger, also can be utilised independent of air inflation from the cutting mandrel.

Apparatus constructed for use in the defined processes is new and forms a further aspect of the invention.

Example

Helical cutting under about 30° of a 100 micron tubular low density polyethylene sheet of lay-flat width 2080mm, taking from a 200kg reel.

In principle the apparatus is constructed as shown in Figure 1. However, the housing for the unwind unit is substituted by a more lightweight frame construction, and the main bearing to support this unit is a big steel ring surrounding the unit forming part of the frame, and the bearing is nested in a circular array of rollers.

The control of cutting angle is electronical as explained at the end of the description of Figure 1. The external diameter of the mandrel, including an array of thin ribs on the surface, is 1300mm, while the flat width 2080mm corresponds to a diameter of 1324mm, i.e., the different between the radii of the tubular sheet and the mandrel is 12mm. The final width of the sheet is 3600mm, the take-up velocity 60m per minute.

The air jet is established by a centrifugal fan, full yield of which is 2000m³ per hour, which is judged to have worked at about half of about full yield, that is about 1000m³ per hour. According to the data for the fan this corresponds to 600mmH₂O overpressure. (This is a reliable although rough indication since the pressure does not very significantly depend on air flow.)

The machinery works very reliably and the helical cut is straight.

Claims

1. A method in which a flexible tubular film (10) of polymeric material is supplied to a first position (11) in a flat form from which it is drawn, opened to tubular form, drawn over a mandrel (14) and helically cut while passing over the mandrel to form a cut strip that is drawn away from the tubular film, characterised in that the tubular film is inflated by air that is continuously supplied (13) through the mandrel towards the first position to form a stiff tube that makes a sliding fit with the mandrel and that resists deformation during the cutting and in which the opening of the flat form to the tubular form by inflation is controlled by driven support means (17) which support the tube against the force of the air emerging from the mandrel.
2. A method according to claim 1 in which the air pressure within the tube is sufficient to allow a tension of at least 0.2 kg/m width of the helically cut strip at the pull-off from the mandrel.
3. A method according to claim 1 or claim 2 in which the diameter of the mandrel is variable.
4. A method according to claim 3 in which the diameter is feed-back controlled by registration of the air flow through the mandrel or the overpressure in the tube.
5. A method according to any preceding claim in which the driven support means comprise belts (17).
6. A method according to any preceding claim in which the surface of the mandrel (14) is corrugated, preferably by longitudinal ribs, to minimise friction between the film and mandrel.
7. A method according to any preceding claim in which the location of cutting (18) is fixed, the film (10) is provided at the first position on a reel (9) and is dis-

ably transparent) may be provided around the entire rotating unwind unit 1, fixed to and rotating with the latter.

When the knife is at a constant location and the tubular sheet is carried away from the reel along the axial direction of the latter, while the zone 31 is spinning around the reel, a guide system similar to Figure 3 is preferable but not essential. Especially when the cutting angle is relatively small, e.g., about 30°, the sheet may be allowed to wrinkle and even to compact to tow-form, since subsequent inflation by air can bring it back to tube-form. However support belts 17 will normally not be sufficient in such cases and should preferably be substituted by a circular array of many narrow belts. At the exit of the support system, the diameter of this array should be close to that of the tubular sheet. The optimum diameter of the array at the inlet to the support zone, and the necessary length of the zone, can be established by simple experiments.

Provided the array of support belts rotates around the axis of the array with exactly the same rotational velocity as the velocity by which the discharge zone 31 spins around the reel, it is not absolutely necessary for nip rollers 11 to follow this rotation. If they do not, the tubular sheet may become compacted and twisted in front of rollers 11 but will untwist and open when it moves away from the rollers.

As shown, the reel 9 is held from the inside and the tube is drawn off the outside but the reel 9 may alternatively be held from the outside with the unwind taking place from the inside.

Although the apparatus shown in Figures 2 and 3 does incorporate a supply of air through the mandrel 14, the features of these systems are also valuable even when the air supply is omitted. Thus the rotating unwind system shown in Figures 2 and 3, and similar unwind systems in which tubular sheet is carried away over one end of the reel while the zone of discharge spins, is of general value for spiral cutting of materials from heavy reels and can be practiced independent of the use of the mandrel and air supply shown in Figure 1. Likewise the achievement of spiral formed orientation by relative rotations between extrusion die and take-off means, combined with spiral cutting which makes the angle of orientation bigger, also can be utilised independent of air inflation from the cutting mandrel.

Apparatus constructed for use in the defined processes is new and forms a further aspect of the invention.

Example

Helical cutting under about 30° of a 100 micron tubular low density polyethylene sheet of lay-flat width 2080mm, taking from a 200kg reel.

In principle the apparatus is constructed as shown in Figure 1. However, the housing for the unwind unit is substituted by a more lightweight frame construction, and the main bearing to support this unit is a big steel ring surrounding the unit forming part of the frame, and the bearing is nested in a circular array of rollers.

The control of cutting angle is electrical as explained at the end of the description of Figure 1. The external diameter of the mandrel, including an array of thin ribs on the surface, is 1300mm, while the flat width 2080mm corresponds to a diameter of 1324mm, i.e., the difference between the radii of the tubular sheet and the mandrel is 12mm. The final width of the sheet is 3600mm, the take-up velocity 60m per minute.

The air jet is established by a centrifugal fan, full yield of which is 2000m³ per hour, which is judged to have worked at about half of about full yield, that is about 1000m³ per hour. According to the data for the fan this corresponds to 600mmH₂O overpressure. (This is a reliable although rough indication since the pressure does not very significantly depend on air flow.)

The machinery works very reliably and the helical cut is straight.

Claims

1. A method in which a flexible tubular film (10) of polymeric material is supplied to a first position (11) in a flat form from which it is drawn, opened to tubular form, drawn over a mandrel (14) and helically cut while passing over the mandrel to form a cut strip that is drawn away from the tubular film, characterised in that the tubular film is inflated by air that is continuously supplied (13) through the mandrel towards the first position to form a stiff tube that makes a sliding fit with the mandrel and that resists deformation during the cutting and in which the opening of the flat form to the tubular form by inflation is controlled by driven support means (17) which support the tube against the force of the air emerging from the mandrel.
2. A method according to claim 1 in which the air pressure within the tube is sufficient to allow a tension of at least 0.2 kg/m width of the helically cut strip at the pull-off from the mandrel.
3. A method according to claim 1 or claim 2 in which the diameter of the mandrel is variable.
4. A method according to claim 3 in which the diameter is feed-back controlled by registration of the air flow through the mandrel or the overpressure in the tube.
5. A method according to any preceding claim in which the driven support means comprise belts (17).
6. A method according to any preceding claim in which the surface of the mandrel (14) is corrugated, preferably by longitudinal ribs, to minimise friction between the film and mandrel.
7. A method according to any preceding claim in which the location of cutting (18) is fixed, the film (10) is provided at the first position on a reel (9) and is dis-



- charged from the reel at a discharge zone (31) and is drawn to the mandrel with a screw movement, and in which the tubular film is drawn from the reel substantially along the axial direction (23) of the reel while the discharge zone (31) spins around the reel to produce rotation of the tube. 5
8. A method according to claim 7 in which the reel has substantially the same axis of rotation (23) as the tube and the tubular film is guided and maintained in flat form from the unwind zone to the first position (11) at which inflation starts, whereby the middle line of the lay-flat sheet is guided to become substantially coinciding with the axis (23) of the reel. 10
9. A method according to any preceding claim in which the location of cutting (18) is fixed, the film (10) is provided on a reel (9) mounted in an unwind unit (1) and is drawn to the mandrel (14) with a screw movement that is provided by rotation of the unwind unit, and the unwind unit is mounted on a bearing (32, 34) that comprises a bearing ring (34) that surrounds the tubular film (10). 15
10. A method according to any preceding claim in which the tubular sheet has been longitudinally oriented below the melt range of the polymer material. 20
11. A method according to any of the claims 1 to 9 in which the tubular film was manufactured by extrusion through an extrusion die with spiral melt orientation by draw-down in molten to semi-molten state and simultaneous relative rotation between take-off means from the die and the exit of the die, and in which the spiral cutting is carried out in such a direction that the angle of orientation is increased. 25
12. A method according to claim 11 in which the resultant angle is from 70° to perpendicular. 30
13. A method according to any preceding claim in which two or more helically cut films are subsequently laminated to one another with the original longitudinal directions of the films criss-crossing one another. 35
14. A method in which a flexible tubular film (10) of polymeric material is supplied to a first position (11) from a reel (9), being discharged from the reel at a discharge zone (31), in a flat form from which first position it is drawn, opened to tubular form, drawn with a screw movement over a mandrel (14) and helically cut while passing over the mandrel to form a cut strip at a location (18) which is fixed, the cut strip being then drawn away from the tubular film, characterised in that the tubular film is drawn from the reel substantially along the axial direction (23) of the reel while the discharge zone (31) spins around the reel to produce rotation of the tube. 40
15. A method in which a flexible tubular film (10) of polymeric material is supplied to a first position (11) from a reel (9), being discharged from the reel at a discharge zone (31), in a flat form from which first position it is drawn, opened to tubular form, drawn with a screw movement over a mandrel (14) and helically cut while passing over the mandrel to form a cut strip at a location (18) which is fixed, the cut strip being then drawn away from the tubular film, characterised in that the reel is mounted in an unwind unit (1) and is drawn to the mandrel with a screw movement that is provided by rotation of the unwind unit, and the unwind unit is mounted on a bearing (32, 34) that comprises a bearing ring (34) that surrounds the tubular film (10). 45
16. A method in which a flexible tubular film (10) of polymeric material is supplied to a first position (11) in a flat form from which position it is drawn, opened to tubular form, drawn over a mandrel (14) and helically cut while passing over the mandrel to form a cut strip that is drawn away from the tubular film, characterised in that the film was initially manufactured by extrusion through an extrusion die with spiral melt orientation by draw-down in molten to semi-molten state and simultaneous relative rotation between the take-off means from the die and the exit of the die, and in which the spiral cutting is carried out in such a direction that the angle of orientation is increased. 50
17. Apparatus constructed for carrying out the process of any one of claims 1 to 16 and comprising means (24, 5, 25, 26) for mounting a reel (9) of tubular film material (10) in flat form, a mandrel (14), means (11) for drawing the film material off the reel, means for opening (13, 17) the drawn-off film material into tubular form and for drawing it over the mandrel, and means for cutting (18) the film material helically while passing over the mandrel and means for withdrawing (20, 21, 22) cut strip from the tubular film, characterised in that there are air supply means (13) through the mandrel (14) for inflating the tubular film to a stiff tube and driven support means (17) for controlling the opening of the flat form to the tubular form by supporting the tube against the force of the air emerging from the mandrel. 55
18. Apparatus constructed for carrying out the process of claim 14 and comprising means (25, 5, 25, 26) for mounting a reel (9) of tubular film (10) of polymeric material in flat form, a mandrel (14), a discharge zone (31) at which the film material is drawn off the reel, means for drawing (11) the material off the reel, means for opening (13, 17) the drawn-off material into tubular form and for drawing it over the mandrel with a screw movement, fixed means for cutting (18) the material helically while passing over the mandrel and means for withdrawing (20, 21, 22) cut strip from the mandrel, characterised by comprising guide



means (28, 29, 30, 11) for drawing the material in flat form from the reel at the discharge zone and into an axial path zone (between 11 and 16) in which it is directed substantially along the axial direction (23) of the reel and by comprising means for spinning (7, 8) the discharge zone and the guide means around the axis of the reel.

19. An apparatus according to claim 18 in which the reel (9) has substantially the same axis (23) as the axis of rotation of the screw movement of the tubular form material.
20. Apparatus according to claim 18 or 19 in which means are provided for rotating the reel in one direction about its axis and the means for spinning (7, 8) the discharge zone and guide means spin those components in the opposite direction about the axis (23) of the reel.
21. Apparatus according to any of claims 18 to 20, in which the means for mounting (24, 5, 25, 26) the reel are mounted in an unwind unit (1), and the unwind unit is mounted for rotation on a bearing (32, 34) which comprises a bearing ring (34) that surrounds the drawn off film material (10).
22. Apparatus constructed for carrying out the process of claim 15 and comprising means for mounting (24, 5, 25, 26) a reel of tubular film material (10) in flat form, a mandrel (14), means for drawing (10) the film material off the reel, means for opening (13, 17) the drawn-off material into tubular form and for drawing it over the mandrel with a screw movement, and fixed means for cutting (18) the sheet material helically while passing over the mandrel, the means for mounting the reel are mounted in an unwind unit (1), and the unwind unit is mounted for rotation on a bearing (32, 34) characterised in that the bearing comprises a bearing ring (34) that surrounds the drawn off film material (10).

Patentansprüche

1. Verfahren, bei dem ein aus einem polymerischen Material bestehender biegsamer, rohrförmiger Film (10) einer ersten Position (11) von seinem Abzug aus in flacher Form zugeführt, zur Rohrform geöffnet, über einen Dorn (14) gezogen und während des Ueberfahrens des Dornes (14) spiralförmig zur Bildung eines vom rohrförmigen Film (10) weggezogenen, geschnittenen Streifens geschnitten wird, dadurch gekennzeichnet, dass der rohrförmige Film (10) durch kontinuierlich durch den Dorn (14) zugeführte, in Richtung auf die erste Position (11) strömende Luft zur Bildung eines steifen, den Dorn (14) gleitend überfahrenden und während des Schneidvorganges Verformungen widerstehenden Rohres aufgeblasen und die durch Aufblasen erfolgende

Oeffnung von der flachen Form in die rohrförmige Form durch angetriebene Stützeinrichtungen (17), die das Rohr gegen die aus dem Dorn abströmende Luft abstützen, kontrolliert wird.

2. Verfahren nach Anspruch 1, bei dem der Luftdruck ausreichend zur Einstellung einer Spannung von wenigstens 0,2 kg/Meter Breite spiralförmig geschnittenen Streifens am Abzug vom Dorn eingestellt wird.
3. Verfahren nach Anspruch 1 oder 2, bei dem der Durchmesser des Dornes veränderbar ist.
4. Verfahren nach Anspruch 3, bei dem der Durchmesser durch Aufnahme des Luftdurchflusses durch den Dorn oder durch den Ueberdruck im Rohr rückgekoppelt kontrolliert wird.
5. Verfahren nach irgend einem vorangehenden Anspruch, bei dem die angetriebenen Stützeinrichtungen Riemen (17) umfassen.
6. Verfahren nach irgend einem vorangehenden Anspruch, bei dem die Oberfläche des Dornes (14) zur Minimierung der Reibung zwischen Film und Dorn mit Riefen, vorzugsweise durch in Längsrichtung verlaufende Rippen versehen ist.
7. Verfahren nach irgendeinem vorangehenden Anspruch, bei dem der Ort des Schnittes (18) feststehend ist, der Film (10) an der ersten Position auf einer Spule (9) vorrätig gehalten und von der Spule (9) in einer Abnahme-Zone (31) abgenommen und mit einer Schraubenbewegung zum Dorn gezogen wird und bei dem der rohrförmige Film von der Spule im wesentlichen in axialer Richtung (23) der Spule abgezogen wird, während die Abnahme-Zone (31) um die Spule (9) zur Erzeugung einer Drehung des Rohres dreht.
8. Verfahren nach Anspruch 7, bei dem die Spule im wesentlichen die gleiche Drehachse (23) wie das Rohr und bei dem der rohrförmige Film in flacher Form von der Abwickelzone zur ersten Position (11) geführt und gehalten wird, an der das Aufblasen beginnt, wobei die Mittellinie des Flachlage-Bogens zum im wesentlichen Zusammenfall mit der Achse (23) der Spule geführt wird.
9. Verfahren nach irgend einem vorangehenden Anspruch, bei dem der Ort des Schnittes (18) feststeht, der Film (10) auf einer an einer Abwickleinrichtung (1) angeordneten Spule (9) verfügbar ist und in Richtung auf den Dorn (14) mit einer Schraubenbewegung gezogen wird, die durch Drehung der Abwickleinrichtung ausgelöst wird und bei dem die Abwickleinrichtung in einem Lager (32,34) aufgenommen ist, wobei das Lager (32,34) einen Lager-



ring (34) umfasst, der den rohrförmigen Film (10) umgibt.

10. Verfahren nach irgend einem vorangehenden Anspruch, bei dem der rohrförmige Bogen unterhalb des Schmelzbereiches des polymerischen Materiales in Längsrichtung orientiert worden ist. 5
11. Verfahren nach einem der Ansprüche 1 bis 9, bei dem der rohrförmige Film hergestellt wurde durch Extrusion durch ein Extrusionswerkzeug mit spiralförmiger Schmelzorientierung durch Absenkung vom geschmolzenen zum halbgeschmolzenen Zustand und gleichzeitiger relativer Drehung zwischen den Abnahmeeinrichtungen von dem Werkzeug und dem Ausgang aus dem Werkzeug und bei dem der spiralenförmige Schnitt in solcher Richtung erfolgt, dass der Winkel der Orientierung vergrößert wird. 10 15
12. Verfahren nach Anspruch 11, bei dem der resultierende Winkel zwischen 70 Grad und perpendicular ist. 20
13. Verfahren nach irgend einem vorangehenden Anspruch, bei dem zwei oder mehr spiralenförmig geschnittene Filme nachträglich mit den ursprünglichen Längsrichtungen der Filme einander überkreuzend miteinander laminiert werden. 25 30
14. Verfahren, bei dem ein biegsamer, aus einem polymerischen Material bestehender rohrförmiger Film (10) einer ersten Position (11), ausgehend von einer Spule (9) und entladen von der Spule in einer Entladezone (31) in flacher Form zugeleitet wird, von welcher ersten Position (11) er abgezogen, zu einer rohrförmigen Gestalt geöffnet, mit einer schraubenförmigen Bewegung über einen Dorn (14) gezogen, spiralenförmig während seines Ueberfahrens des Dornes (14) zur Bildung eines Streifens an einer feststehenden Stelle (18) geschnitten und der geschnittene Streifen dann vom rohrförmigen Film weggezogen wird, dadurch gekennzeichnet, dass der rohrförmige Film im wesentlichen in axialer Richtung (23) der Spule von der Spule abgezogen wird, wobei die Entladezone (31) um die Spule zur Erzeugung einer Drehung des Rohres dreht. 35 40 45
15. Verfahren, bei dem ein biegsamer, aus einem polymerischen Material bestehender rohrförmiger Film (10) einer ersten Position (11), ausgehend von einer Spule (9) und entladen von der Spule in einer Entladezone (31) in flacher Form zugeleitet wird, von welcher ersten Position (11) er abgezogen, zu einer rohrförmigen Gestalt geöffnet, mit einer schraubenförmigen Bewegung über einen Dorn (14) gezogen, spiralenförmig während seines Ueberfahrens des Dornes (14) zur Bildung eines 50 55

Streifens an einer feststehenden Stelle (18) geschnitten und der geschnittene Streifen dann vom rohrförmigen Film weggezogen wird, dadurch gekennzeichnet, dass die Spule in einer Abwickel-Einrichtung (1) angeordnet, mit einer schraubenförmigen Bewegung zum Dorn gezogen wird, wobei die schraubenförmige Bewegung durch Drehung der Abwickel-Einrichtung (1) zur Bildung gelangt und dass die Abwickel-Einrichtung (1) an einer Lagerung (32,34) angeordnet ist, die einen Lagerring (34) umfasst, der den rohrförmigen Film (10) umgibt.

16. Verfahren, bei dem ein biegsamer rohrförmiger Film (10) aus einem polymerischen Material einer ersten Position (11) in flacher Form zugeleitet, von dieser ersten Position (11) abgezogen und zu rohrförmiger Form geöffnet, über einen Dorn (14) gezogen und während des Ueberlaufes über den Dorn (14) spiralenförmig zur Bildung eines geschnittenen Streifens geschnitten, der von dem rohrförmigen Film weggezogen wird, dadurch gekennzeichnet, dass der Film eingangs durch Extrusion durch ein Extrusionswerkzeug mit spiralförmiger Schmelzeorientierung durch Absenkung vom geschmolzenen zu halbgeschmolzenem Zustand und gleichzeitiger relativer Drehung zwischen Abnahme-Einrichtungen vom Werkzeug und dem Ausgang des Werkzeuges gebildet wird, und dass der spiralenförmige Schnitt in eine Richtung vorgenommen wird, so dass der Orientierungs-Winkel vergrößert wird.
17. Vorrichtung zur Durchführung des Verfahren nach einem der Ansprüche 1 bis 16, umfassend Mittel (24,5,25,26) zur Lagerung einer Spule (9) aus rohrförmigem Filmmaterial (10) in flacher Form, einen Dorn (14), Mittel (11) zum Abzug des Filmmateriales von der Spule, Mittel (13,17) zur Öffnung des abgezogenen Filmmateriales in Rohrform und zum Ziehen über einen Dorn (14), Mittel zum Schneiden (18) das Filmmaterial spiralenförmig während Ueberlaufes über den Dorn (14) und Mittel zum Abzug (20,21,22) des geschnittenen Streifens von dem rohrförmigen Film, dadurch gekennzeichnet, dass zum Aufblasen des rohrförmigen Streifens zu einem steifen Rohrkörper Luftzufuhreinrichtungen (13) durch den Dorn (14) und angetriebene Stützeinrichtungen (17) zur Kontrolle der Öffnung der flachen Form zur Rohrform durch Stützung des Rohres gegen die Kraft der aus dem Dorn (14) austretenden Luft vorgesehen sind.
18. Vorrichtung zur Durchführung des Verfahrens nach Anspruch 14, umfassend Mittel (25,5,25,26) zur Halterung einer Spule (9) aus rohrförmigem Film (10) polymerischen Materiales in flacher Form, einen Dorn (14), eine Entladezone (31), in der der Film von der Spule abgezogen wird, Mittel zum



Abzug des Materiales (11) von der Spule, Mittel zur Oeffnung des abgezogenen Materiales in Rohrform und zum Ueberzug mit einer schraubenförmigen Bewegung über einen Dorn (14), feststehende Mittel zum Schneiden (18) des Materiales spiralförmig während des Ueberlaufes über den Dorn und Mittel zum Abzug (20,21,22) geschnittenen Materiales von dem Dorn,

dadurch gekennzeichnet, dass Führungsmittel (28,29,30,11) zum Abzug des Materiales in flacher Form von der Spule an der Entlade-Zone und in die axiale Weg-Zone (zwischen 11 und 16) vorgesehen sind, in welcher es im wesentlichen entlang der axialen Richtung (23) der Spule geführt wird und dass Mittel zur Drehung (7,8) der Entlade-Zone und der Führungsmittel um die Achse der Spule vorgesehen sind.

19. Vorrichtung nach Anspruch 18, bei der die Spule (9) im wesentlichen die gleiche Achse (23) wie die Drehachse der schraubenförmigen Bewegung des Materiales in Tübenform aufweist.

20. Vorrichtung nach Anspruch 18 oder 19, bei der Mittel zur Drehung der Spule (9) um ihre Achse in eine Richtung und Mittel zur Drehung (7,8) die Entlade-Zone und Führungsmittel in entgegengesetzte Richtung um die Achse (23) der Spule vorgesehen sind.

21. Vorrichtung nach einem der Ansprüche 18 bis 20, bei der die Haltermittel (24,5,25,26) für die Spule in einer Abwickel-Einrichtung (1) aufgenommen sind und dass die Abwickleinrichtung (1) zur Drehbewegung an einer Lagerung (32,34) angeordnet ist, die einen Lagerring (34) umfasst, der das abgezogene Filmmaterial (10) umläuft.

22. Vorrichtung zur Durchführung des Verfahrens nach Anspruch 15, umfassend Mittel zur Lagerung (24,5,25,26) einer Spule rohrförmigen Materiales (10) in flacher Form, einen Dorn (14), Mittel zum Abziehen (10) des Filmmateriales von der Spule, Mittel zur Oeffnung (13,17) des abgezogenen Materiales zu rohrförmiger Form und zum Ueberzug über den Dorn in schraubenförmiger Bewegung, feststehende Mittel (18) zum spiralförmigen Schneiden des bogenförmigen (sheet) Materiales während seines Ueberlaufes über den Dorn, wobei die Mittel zur Halterung der Spule in einer Abwickel-Einrichtung (1) angeordnet und die Abwickel-Einrichtung (1) mittels einer Lagerung (32,34) drehbar gelagert ist

dadurch gekennzeichnet, dass die Lagerung einen Lagerring (34) umfasst, der das abgezogene Filmmaterial (10) umgibt.

Revendications

1. Méthode dans laquelle un film tubulaire flexible (10) en un matériau polymérique est fourni à une première position (11) sous une forme plate d'où il est étiré, ouvert en une forme tubulaire, tiré sur un mandrin (14) et découpé hélicoïdalement tout en passant sur le mandrin pour former une bande coupée qui est tirée au loin du film tubulaire, caractérisée en ce que le film tubulaire est gonflé par de l'air qui est continuellement fourni (13) à travers le mandrin vers la première position pour former un tube raide qui s'ajuste en couissant avec le mandrin et qui résiste à une déformation pendant qu'on le coupe et où l'ouverture de la forme plate à la forme tubulaire par gonflage est contrôlée par des moyens menés de support (17) qui supportent le tube contre la force de l'air émergeant du mandrin.

2. Méthode selon la revendication 1, où la pression de l'air dans le tube est suffisante pour permettre une tension d'au moins 0,2 kg/m de largeur de la bande coupée hélicoïdalement à l'extraction du mandrin.

3. Méthode selon la revendication 1 ou la revendication 2, où le diamètre du mandrin est variable.

4. Méthode selon la revendication 3, où le diamètre est contrôlé par contre-réaction par l'enregistrement de l'écoulement d'air à travers le mandrin ou de la surpression dans le tube.

5. Méthode selon toute revendication précédente, où les moyens menés de support comprennent des courroies (17).

6. Méthode selon toute revendication précédente, où la surface du mandrin (14) est ondulée, de préférence par des nervures longitudinales, pour minimiser le frottement entre le film et le mandrin.

7. Méthode selon toute revendication précédente, où l'emplacement de la coupe (18) est fixe, le film (10) est prévu à sa première position sur un rouleau (9) et il est déchargé du rouleau à une zone de décharge (31) et il est attiré vers le mandrin via un mouvement hélicoïdal et où le film tubulaire est attiré sensiblement du rouleau le long de la direction axiale (23) du rouleau alors que la zone de décharge (31) tourne autour du rouleau pour produire la rotation du tube.

8. Méthode selon la revendication 7, où le rouleau a sensiblement le même axe de rotation (23) que le tube et le film tubulaire est guidé et maintenu sous forme plate à partir de la zone de déroulement jusqu'à la première position (11) à laquelle commence le gonflage, la ligne médiane de la feuille à



* C L M S *

plat étant guidée pour venir sensiblement coïncider avec l'axe (23) du rouleau.

9. Méthode selon toute revendication précédente, où l'emplacement de la coupe (18) est fixe, le film (10) est prévu sur un rouleau (9) qui est monté dans une unité de déroulement (1) et il est attiré vers le mandrin (14) avec un mouvement hélicoïdal qui est produit par la rotation de l'unité de déroulement et l'unité de déroulement est montée sur un palier (32, 34) qui comprend une bague d'appui (34) qui entoure le film tubulaire (10). 5
10. Méthode selon toute revendication précédente, où la feuille tubulaire a été longitudinalement orientée en dessous de la plage de fusion du matériau du polymère. 10
11. Méthode selon l'une des revendications 1 à 9, où le film tubulaire a été fabriqué par extrusion à travers une filière d'extrusion avec orientation en phase fondue en spirale par étirage à un état fondu à semi-fondu et rotation relative simultanée entre le moyen d'extraction de la filière et la sortie de la filière, et où la coupe en spirale est effectuée dans une direction telle que l'angle d'orientation soit augmenté. 15
12. Méthode selon la revendication 11, où l'angle résultant est compris entre 70° et la perpendiculaire. 20
13. Méthode selon toute revendication précédente, où deux films coupés hélicoïdalement ou plus sont sub-séquentiellement laminés l'un à l'autre avec les directions longitudinales d'origine des films se croisant. 25
14. Méthode où un film tubulaire flexible (10) en un matériau polymérique est fourni à une première position (11) d'un rouleau (9), étant déchargé du rouleau à une zone de décharge (31), sous une forme plate, première position de laquelle il est tiré, ouvert en une forme tubulaire, tiré avec un mouvement hélicoïdal sur un mandrin (14) et est découpé hélicoïdalement tout en passant sur le mandrin pour former une bande coupée en un emplacement (18) qui est fixe, la bande coupée étant alors tirée au loin du film tubulaire, caractérisée en ce que le film tubulaire est tiré du rouleau sensiblement le long de la direction axiale (23) du rouleau alors que la zone de décharge (31) tourne autour du rouleau pour produire la rotation du tube. 30
15. Méthode dans laquelle un film tubulaire flexible (10) en un matériau polymérique est fourni à une première position (11) à partir d'un rouleau (9), étant déchargé du rouleau à une zone de décharge (31), sous une forme plate, première position de laquelle il est tiré, ouvert en une forme tubulaire, tiré avec un mouvement hélicoïdal sur un mandrin (14), et coupé hélicoïdalement tout en passant au-dessus de man- 35

drin pour former une bande coupée en un emplacement (18) qui est fixe, la bande coupée étant alors tirée au loin du film tubulaire, caractérisée en ce que le rouleau est monté dans une unité de déroulement (1) et est tiré vers le mandrin avec un mouvement hélicoïdal qui est produit par la rotation de l'unité de déroulement, et l'unité de déroulement est montée sur un palier (32, 34) qui comprend une bague d'appui (34) qui entoure le film tubulaire (10). 40

16. Méthode dans laquelle un film tubulaire flexible (10) en un matériau polymérique est fourni à une première position (11) sous une forme plate, position de laquelle il est tiré, ouvert en une forme tubulaire, tiré sur un mandrin (14) et coupé hélicoïdalement tout en passant sur le mandrin pour former une bande coupée qui est tirée au loin du film tubulaire, caractérisée en ce que le film a initialement été fabriqué par extrusion à travers une filière d'extrusion avec orientation en phase fondue en spirale par étirage à l'état fondu à semi-fondu et rotation relative simultanée entre le moyen d'extraction de la filière et la sortie de la filière, et où la coupe en spirale est effectuée dans une direction telle que l'angle de rotation augmente. 45
17. Appareil construit pour effectuer la mise en oeuvre du procédé selon l'une quelconque des revendications 1 à 16 et comprenant des moyens (24, 5, 25 et 26) pour monter un rouleau (9) d'un matériau en film tubulaire (10) sous forme plate, un mandrin (14), un moyen (11) pour tirer le matériau en film au loin du rouleau, un moyen (13, 17) pour ouvrir le matériau en film tiré en forme tubulaire et pour le tirer sur le mandrin et un moyen (18) pour couper le matériau du film hélicoïdalement tout en le faisant passer sur le mandrin et un moyen pour retirer (20, 21, 22) la bande coupée du film tubulaire, caractérisé en ce qu'il y a des moyens de fourniture d'air (13) à travers le mandrin (14) pour faire gonfler le film tubulaire en un tube raide et des moyens menés de support (17) pour contrôler l'ouverture de la forme plate à la forme tubulaire en supportant le tube contre la force de l'air émergeant du mandrin. 50
18. Appareil construit pour la mise en oeuvre du procédé de la revendication 14 et comprenant des moyens (25, 5, 25, 26) pour monter un rouleau (9) d'un film tubulaire (10) en un matériau polymérique sous forme plate, un mandrin (14), une zone de décharge (31) à laquelle le matériau en film est tiré du rouleau, un moyen (11) pour tirer le matériau au loin du rouleau, un moyen (13, 17) pour ouvrir le matériau tiré en une forme tubulaire et pour le tirer sur le mandrin avec un mouvement hélicoïdal, un moyen fixe pour couper (18) le matériau hélicoïdalement tandis qu'il passe sur le mandrin et un moyen (21, 22) pour retirer la bande coupée du mandrin, caractérisé en ce qu'il comprend des moyens de 55



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guidage (28, 29, 30, 11) pour tirer le matériau sous forme plate du rouleau à la zone de décharge et dans une zone du trajet axial (entre 11 et 16) où il est dirigé sensiblement le long de la direction axiale (23) du rouleau et en ce qu'il comprend des moyens pour faire tourner (7, 8) la zone de décharge et le moyen de guidage autour de l'axe du rouleau. 5

19. Appareil selon la revendication 18, où le rouleau (9) a sensiblement le même axe (23) que l'axe de rotation du mouvement hélicoïdal du matériau en forme tubulaire. 10

20. Appareil selon la revendication 18 ou 19, où des moyens sont prévus pour faire tourner le rouleau dans une direction autour de son axe et les moyens (7, 8) pour faire tourner la zone de décharge et les moyens de guidage font tourner ces composants en direction opposée autour de l'axe (23) du rouleau. 15 20

21. Appareil selon l'une des revendications 18 à 20, où les moyens (24, 5, 25, 26) pour le montage du rouleau sont montés dans une unité de déroulement (1), l'unité de déroulement est montée pour une rotation sur un palier (32,34)- qui comprend une bague (34) qui entoure le matériau du film (10) retiré. 25

22. Appareil construit pour la mise en oeuvre du procédé de la revendication 15 et comprenant des moyens pour monter (24, 5, 25, 26) un rouleau d'un matériau en film tubulaire (10) sous forme plate, un mandrin (14), un moyen pour tirer (10) le matériau film au loin du rouleau, un moyen (13,17) pour ouvrir le matériau tiré en forme tubulaire et pour le tirer sur le mandrin avec un mouvement hélicoïdal et un moyen fixe pour couper (18) le matériau en feuille hélicoïdalement tandis qu'il passe sur le mandrin, les moyens pour monter le rouleau sont montés dans une unité de déroulement (1) et l'unité de déroulement est montée pour une rotation sur un palier (32, 34), caractérisé en ce que le palier comprend une bague (34) qui entoure le matériau du film retiré (10). 30 35 40

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