June 17, 1969 J. K. P. MACKIE 3,449,901

METHOD AND APPARATUS FOR WINDING YARN

Filed Sept. 5, 1967 Sheet 1 of 4

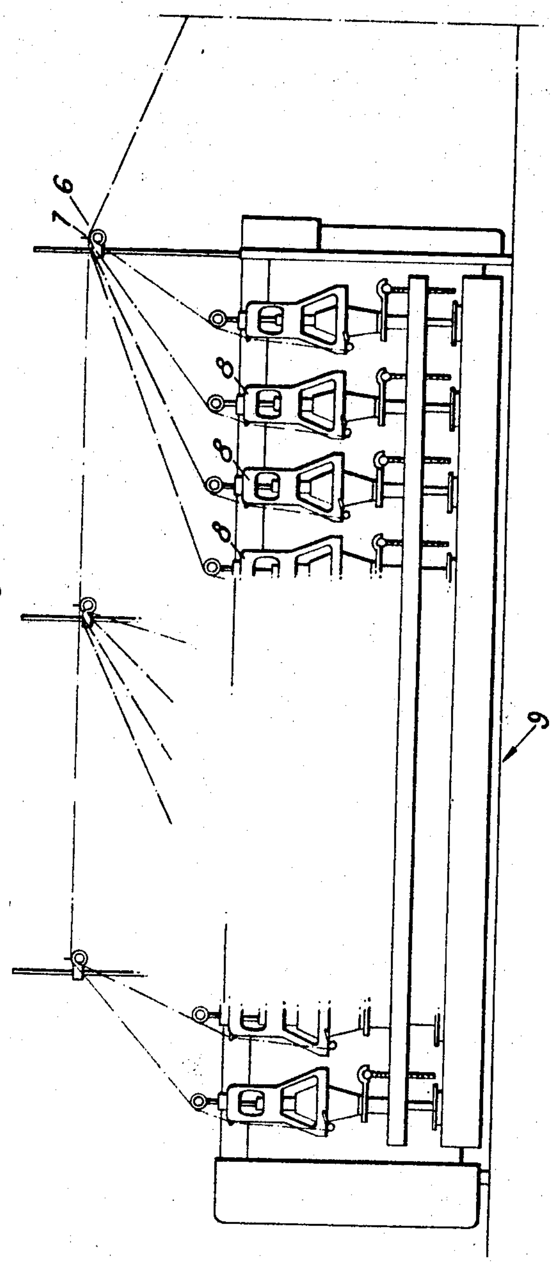


Fig. 1A.

METHOD AND APPARATUS FOR WINDING YARN

Filed Sept. 5, 1967

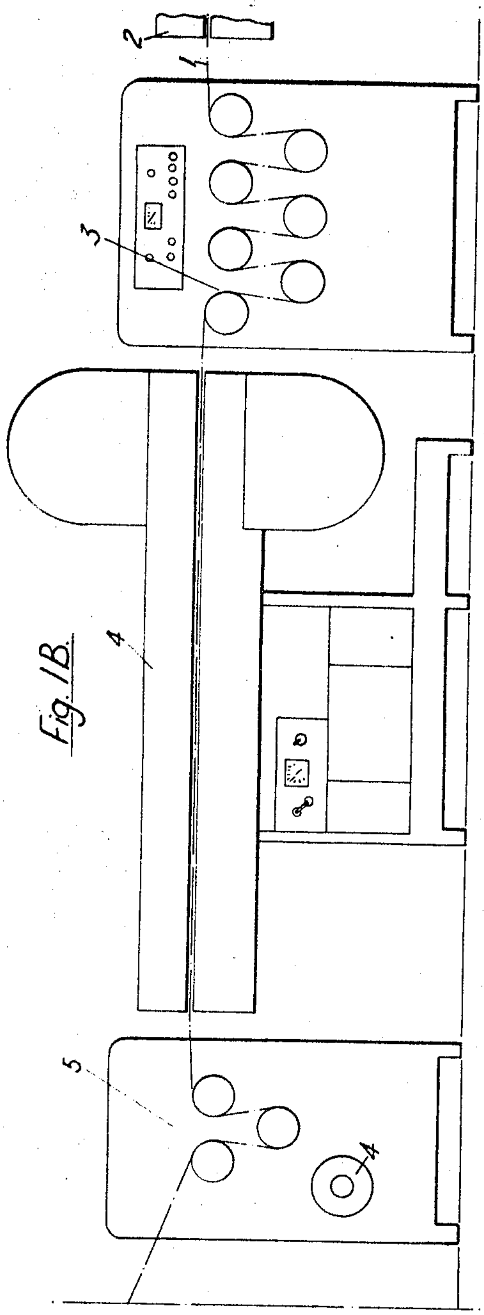


Fig. 1B.

Fig. 5.

Fig. 4.

Fig. 2.

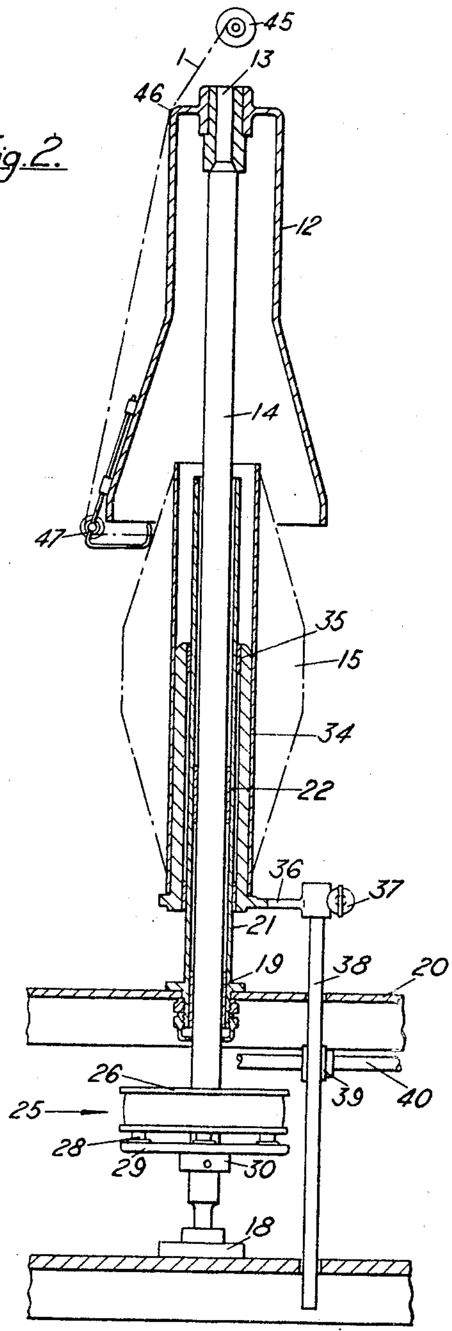
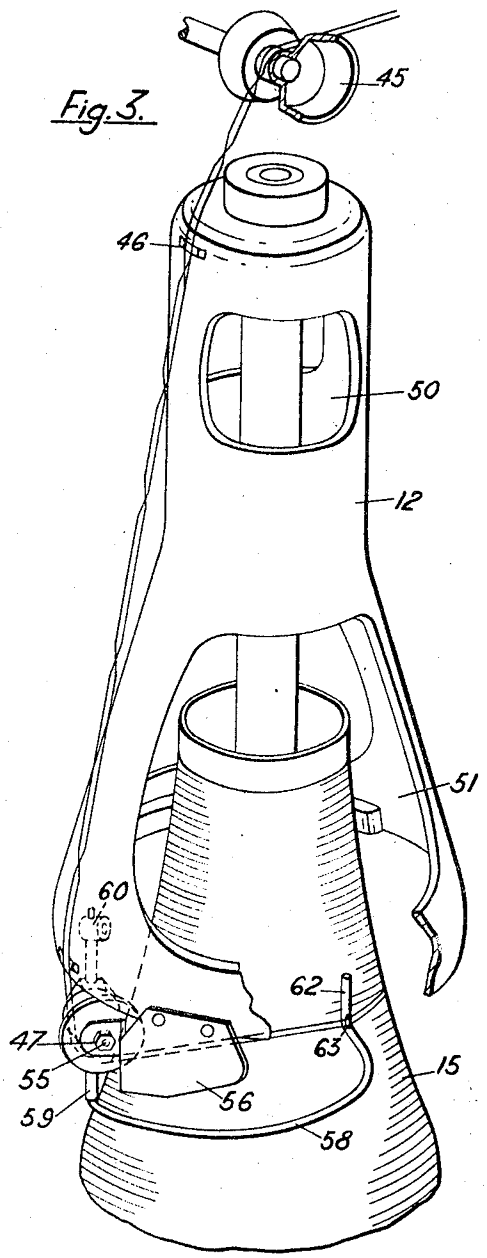


Fig. 3.



United States Patent Office **3,449,901** **Patented June 17, 1969**

3,449,901

METHOD AND APPARATUS FOR WINDING YARN

John Kay Pringle Mackie, Belfast, Northern Ireland, assignor to James Mackie & Sons Limited, Albert Foundry, Belfast, Northern Ireland, a British company

Filed Sept. 5, 1967, Ser. No. 665,615
Claims priority, application Great Britain, Sept. 8, 1966, 40,223/66
Int. Cl. D01h *1/04*
U.S. Cl. 57—71 21 Claims

ABSTRACT OF THE DISCLOSURE

Synthetic plastic tape drawn from a controlled speed supply source is wound on a non-rotary support by means of mechanism comprising a winding guide for the tape which is driven round the axis of the support, while a relative axial traversing motion takes place between the guide and the support, so as to apply one turn of twist for each revolution of the guide. The tape is fed to the winding guide in a generally axial direction from a let-off guide and at a tension such that the twist is applied in a controlled manner represented by localised folds to give a package from which the tape can be unwound over-end in a twist-free condition.

Synthetic plastics such as polypropylene and polyethylene may be produced in strip form by extruding the material as a sheet, slitting the sheet into narrow strips and then stretching the strips so as to align the molecules along the length of the strips. The stretching greatly enhances the strength of the material in a longitudinal direction to give a strip material referred to as a tape suitable for weaving on a loom. During the weaving process, however, the weft has a certain amount of twist inserted into it at irregular intervals and this has a deleterious effect on the cover of the cloth thus woven. In a normal construction of loom the weft is drawn from a cop or pirn, the diameter of which is limited to about 1¾″. There is no particular problem in winding such a cop or pirn without twist but the over-end withdrawal inserts twist at an average rate of approximately one turn for every 3″ of strip. With looms using a stationary weft supply the problem is not as marked but nevertheless still exists. With this type of loom the weft supply package is normally a 9″ by 9″ cone but again there needs to be over-end withdrawal due to the high speed intermittent weft requirement and by the time the end of the cone is reached twist is being inserted at the rate of approximately one turn in every 6″.

A similar problem of twist insertion relates to the warp supply, namely, in the beaming of the tape intended for use as the warp. For this purpose a very large number of separate tapes needs to be drawn from packages mounted in a creel. The problem can be solved by using a spool with a sideways let-off but this eliminates the possibility of tag-ending the packages which is highly desirable and which is only possible with over-end withdrawal.

This general problem applies to a wide variety of plastic tapes of which polypropylene and polyethylene, which have already been mentioned, are the most important, but also including, for example, other polyolefins, acylics, polyamides and so forth, that is to stay, any synthetic tape which can be produced by an extrusion process.

The extrusion and slitting of a sheet of plastic gives rise to a large number of tapes which may either be wound directly on to the packages required for either warp or weft supply in a continuous process directly from the extruder or alternatively may be collected on beams and then subsequently withdrawn and wound into pack-

ages in a separate operation. In either case a multi-spindle winding machine is necessary which receives the tapes at a controlled rate.

According to the present invention a synthetic plastic tape drawn from a controlled speed supply source is formed into a package by winding the tape on a non-rotary support by means of mechanism comprising a guide for the tape which is driven round the axis of the support, so that in this way one turn of twist is applied to the tape for each revolution of the guide. The tape is fed to the winding guide in a generally axial direction from the let-off guide at a tension such that the twist is applied in a controlled manner. The effect of the insertion of twist during winding is that if the tape is subsequently unwound from the package over the same end as that from which is was wound the outcome is to remove the twist applied during winding and to give a substantially untwisted strip. Thus a package wound in accordance with the present invention may be used either as a stationary weft supply for a loom or, for example, in a creel for the beaming of the warp supply and overcomes the difficulty referred to above. In other words it is possible to use over-end withdrawal with the advantages of tag-ending the packages but without the disadvantage of a twisted tape in the final product.

As mentioned above it is important to control tension in the tape during winding. If the tension is too high the tape will "rope," i.e. longitudinal creasing of the tape takes place and a product is obtained which is very difficult to restore to its original state. If, on the other hand, the tension is too low the twisting action becomes erratic, and in addition a generally unacceptable package is formed.

Since the tape speed is controlled by the supply source, satisfactory control of tension can be achieved by a slipping drive to the winding guide. An equivalent result can be achieved in other ways, however, such as by use of a constant torque electric motor for the drive. A slipping drive is preferably achieved by transmitting the drive through a slipping clutch, but the slip may occur in the source of the drive itself, e.g. an air motor. Since the linear speed of the tape remains substantially constant during winding, the rotary speed of the winding guide must be varied with changes of diameter of the package. The drive to the guide must, of course, allow for this.

After leaving the let-off guide, the tape passes to the rotary mechanism and its first point of contact with the latter may either be the winding guide or some intermediate point. It is found that if the distance between the let-off guide and the contact point is kept relatively short this assists in maintaining regularity of the twist.

A number of other factors are also involved in controlling the insertion of twist and the relative importance of these varies with the design of the apparatus used and the operating conditions. The most important factor is, of course, the tension in the tape, the effect of which has already been discussed. Other important factors are the diameter of the let-off guide and the angle of the cone generated by the tape leaving the let-off guide. It is found advantageous for this angle to be of substantial size. By correctly shaping and positioning the let-off guide, or a part associated with it, relatively to the cone angle of the tape it is found to be possible to control the nature of the folding action which results from the insertion of twist. Each winding revolution of the tape causes it to be pressed against the let-off guide and thus to be creased as a result of this pressing action in combination with the tension in the tape, thereby precreasing the tape at intervals corresponding to each revolution of winding. In this way it is possible to insert the twist in such a way that it is represented in the resultant package by localised folds spaced apart by relatively long lengths of flat or untwisted tape.

By the term "relatively long" is meant that at least 50% of the total length of the tape is untwisted, that is to say, is flat and has no twists or folds in it. In practice it may be possible for the folds to be considerably more localised than this so that a high proportion of the total length of the tape remains in an untwisted form. This is of importance for two reasons. In the first place once twist has been inserted in a tape and has been converted into a fold by the winding process there is a likelihood that the mark produced by the folding operation will remain even after the tape has been untwisted. By ensuring that a high proportion of the total length of the tape is unfolded the overall appearance of the tape is improved. A further advantage of localising the folding action is that the lines of the folds are made at a rather greater angle to the axis of the tape rather than nearly parallel to the length of the tape as would be the case if the folds were more extensive. The more nearly a fold line is parallel to the length of the tape the greater the risk of fibrillation and this is an added reason for localisation of the folding action.

Apparatus for winding a package in accordance with the method previously set out comprises a mounting for a stationary support for the package, a let-off guide mounted generally axially of the support, mechanism for driving a winding guide round the axis of the support, and for producing relative transversing movement between the guide and the support, and means for maintaining a suitable tension in the tape as the diameter of the package varies. The means for maintaining the tension may take any of the forms previously described.

The rotary mechanism for the winding guide most conveniently takes the form of a flyer having the winding guide at or close to its lower edge and a contact point for the tape close to its top, which may be constituted by a bearing point on the shoulder of the flyer. As an alternative, however, the guide may be mounted on a ring which encircles the package to be wound and which is then driven to cause the guide to move around the axis of the stationary support and thus to carry out the required winding action. Whatever the form of mechanism, however, it is advantageous for the distance between the let-off guide and the first point of contact of the tape with the mechanism, whether constituted by the winding guide or a separate contact point, to be short. A process and apparatus in accordance with the invention will now be described by way of example with reference to the accompanying drawings in which:

FIGURES 1A and 1B together show a complete production line including an extruder, stretching and stabilizing apparatus and finally winding apparatus;

FIGURE 2 is a sectional view of an individual winding head;

FIGURE 3 is a perspective view with part broken away of a flyer forming part of the winding head of FIGURE 2;

FIGURE 4 is a diagrammatic view of a length of tape unwound from a package produced on the winding head of FIGURE 2; and,

FIGURE 5 shows parts of FIGURE 4 to an enlarged scale illustrating the effect of the folding action and the subsequent removal of the fold.

The majority of the components in the production line shown in FIGURES 1A and 1B are quite standard in themselves and require no detailed description. The figures are included, however, to illustrate the facility with which tapes produced by means of standard equipment may be wound in accordance with the present invention. Turning first to FIGURE 1B the tapes shown as **1** emerge from an extruder and slitting unit **2** and then pass around a series of stretching rollers **3** which may, for example, stretch them by a factor of 7:1. After stretching, the tapes pass through the stabilisation ovens **4** and around stabilising rollers **5**. From there they pass to creel bars **6** fitted with a number of dividing pins **7** to space the individual tapes apart. Each tape then passes to its own individual winding head shown as **8** which will be described in more detail with reference to the subsequent figures. Components of the apparatus shown in FIGURE 1B are all standard while the apparatus shown in FIGURE 1A consists of a winding frame or frames indicated generally as **9** which comprises a multiplicity of winding heads **8** to wind the tapes coming from the extruder which in a typical example may be **104**. The particular winding machine shown in FIGURE 1A is double sided for convenience.

FIGURE 2 shows details of an individual winding head **8**. Each head comprises a tubular flyer **12** shown in more detail in FIGURE 3. Each flyer **12** is located on a spigot **13** on the upper end of a driving spindle **14**. This spigot provides a driving connection to the flyer **12** but allows the flyer to be lifted off for the doffing of a finished package shown as **15**.

A spindle **14** is mounted in a footstep bearing **18** and passes upwardly through bearings **19** in a reciprocating rail **20**. The bearing **19** is mounted within a tube **21** which reciprocates with the rail **20** and which carries a second bearing **22** for the spindle **14**. The spindle **14** is driven through a friction clutch arrangement indicated generally as **25**. This comprises a belt pulley **26** which is driven by a belt (not shown) from a common source of drive for the machine as a whole. The pulley **26** is free to turn on the spindle **14** and engages a ring of friction pads **28** mounted on a flange **29** secured to the spindle **14** at **30**. The friction pads **28** can be adjusted in a radial direction so as to vary the frictional drive between the pulley **26** and the flange **29** and hence the spindle **14**. This provides the required control over the tension in the tape being wound.

A non-rotary support **34** for the package **15** is removably fitted on a tube **35** having a radially extending arm **36** which is releasably attached at **37** to a vertically extending bar **38**. This bar reciprocates with the rail **20** to provide the relative traversing motion between the flyer **12** and the package **15**.

In addition the bar **38** is adjustable in relation to the rail **20** so as to provide the necessary builder motion for the shaping of the ends of the package **15**. For this purpose one face of the bar **38** is formed as a rack cooperating with a pinion **39** mounted on a shaft **40** which also reciprocates with the rail **20** and is given successive small angular movements as the rail reciprocates so as progressively to lower the bar **38** and hence the package **15** in relation to the rail **20**.

The tape shown as **1** passes from the respective creel bar **6** to a let-off point **45** on the axis of the flyer **12**. This let-off point is constituted by a small freely rotatable roller from which the tape passes to a second control point defined by a bearing surface **46** on the shoulder of the flyer **12**. From there the tape passes downwardly to a guide **47** constituted by a rotary runner and from there it is wound onto the stationary tube **34** so as to build up the package **15**.

The tapes **1** will all reach the winding machine **9** from the extruder at a substantially constant speed and to allow for this the rotary speed of each package **15** needs to be reduced correspondingly as the package builds up. This result is achieved automatically by slipping of the clutch **25**. The tension in each tape is controlled by adjustment of the clutch **25** as previously described.

The details of the flyer **12** and the path of the tape **1** will now be described in more detail with reference to FIGURE 3. As can be seen from this figure the tubular wall of the flyer **12** is interrupted by access windows **50** and **51** which also lighten the construction since as previously mentioned the flyer as a whole needs to be removed for doffing.

The guide **47** runs on a stud **55** fixed to a plate **56** carried on the bottom skirt of the flyer, part of which is broken away to show the path of the tape onto the package **15**. By mounting the guide **47** in this position the flyer is self-threading so that when the flyer is rotating it is merely necessary to hold the tape against the bottom skirt of the fly whereupon it is automatically picked up by the guide **47** and wound onto the package.

In addition to the guide **47** the flyer comprises a light arm **58** which is pivoted about a vertical axis defined by a tube **59** passing through the stud **55**. Part of the arm **58** passes up the tube **59** and is held at its upper end by a stopper **60**. The other end of the arm **58** is formed with a short extension **62** over which the tape passes immediately before being laid on the package **15**. For this purpose the extension **62** is formed with tape engaging surface, i.e. a small notch **63**, which ensures accurate location of the tape **1** in an axial direction in relation to the package **15**. The self threading operation automatically lays the tape in the notch **63**.

As shown in the drawings the arm **58** is freely pivoted and is merely held against the surface of the package **15** by the tension in the tape. In some circumstances it may be necessary to provide a biassing force so as to counteract the effect of the centrifugal force on the arm **58** and thus to assist in holding the extension **62** against the surface of the package. This may be provided, for example, by a spring or by a counterweight mounted so that the centrifugal force on it tends to swing the arm **58** inwardly towards the package **15**.

The tape passes over the roller **45** in a flat condition, being controlled laterally by the flanges of the roller, and twist is immediately inserted as shown in FIGURE 3. In the angular position of FIGURES 2 and 3 the tape continues in the same general direction after leaving the roller **45**, but by the time the flyer has turned through half a revolution a short length of tape (including the twist shown immediately following the roller **45** in FIGURE 3) has been lead around the underside of the roller **45** and pressed against it by the tension in the tape. Inspection of the apparatus during operation shows that the result of this is for the twisted tape to be creased as a result of pressure against the roller. This results from the diameter of the roller **45** which is large enough to provide sufficient bearing surface for creasing or folding the tape and the magnitude of the cone angle generated by the tape as it rotates (approximately 60° in the example shown) which causes sufficient length of tape to be led around the underside of the roller **45** as the flyer rotates. This effect is augmented by the short distance between the roller **45** and the bearing surface **46** which helps to ensure that twist is present in the length of tape which is pressed against the roller. Since the relative vertical positions of the roller **45** and the flyer **12** remain fixed during winding, the cone angle is constant and the conditions just described prevail throughout.

As an example of a construction which has been found to lead to good results on 1000 denier polypropylene tape the roller **45** had a diameter of ¾", the vertical distance between the roller **45** and the bearing surface **46** was 3³⁄₁₆", the tension in the tape was 150 grams and the cone angle was approximately 60° as mentioned above.

FIGURE 4 shows diagrammatically the effect of the localisation of the folding action. **70** and **71** represent adjacent folds and these are separated by a much greater length **72** of unfolded tape. Even if the folding is not as highly localised as shown in FIGURE 4 the provision of the control region provided by the points **45** and **46** nevertheless leads to considerable uniformity in the folding action.

This folding action is illustrated to a considerably larger scale in FIGURE 5. In the top part of FIGURE 5, **73** shows a pair of closely spaced folds representing one complete turn of twist and corresponding to either **70** or **71** in FIGURE 4. It will be seen that the fold lines are at an appreciable angle to the axis of the tape so that the folding is localized and thus leads to the relatively great unfolded length **72** of FIGURE 4. When the tape is subsequently unwound from the package **15** by withdrawing it over the same end of the package as that from which it was wound the twist is progressively taken out to leave an untwisted tape as previously described. Although the twist may have been removed the fold lines are still visible and in the lower part of FIGURE 5, **74** shows the untwisted tape exhibiting the lines resulting from the folds indicated at **73**. Owing to the fact that these lines are localized they have no marked adverse effect on the appearance of the tape and moreover their angle to the axis of the tape avoids any serious danger of fibrillation which might otherwise occur with fold lines more nearly parallel to the axis of the tape as would be the case if the folding were not localized.

I claim:

1. A method of forming a package of synthetic plastic tape drawn from a controlled speed supply source comprising feeding said tape in a generally axial direction from a let-off guide to a winding guide, driving said guide round the axis of a non-rotary support, while a relative axial traversing motion takes place between the said guide and said support, whereby to wind said tape on said support and to apply one turn of twist for each revolution of said guide, and controlling the tension in said tape such that the twist is applied in a controlled manner.

2. A method according to claim **1**, in which the twist is applied periodically in such a way that it is represented in the resultant package by localised folds spaced apart by relatively long lengths of untwisted tape.

3. A method according to claim **2** in which said tape is led around the let-off guide which is so shaped relative to the angle of the cone generated by the tape leaving the let-off guide that each winding revolution of the tape causes it to be pressed against the let-off guide and thus to be creased as a result of this pressing action in combination with the tension in the tape, thereby pre-creasing the tape at intervals corresponding to each revolution of winding, and thus leading to localised folding of the tape in the resultant package.

4. A method according to claim **1** in which the twist is inserted in a relatively short length of tape immediately following said let-off guide, prior to which said tape is untwisted.

5. A method according to claim **1**, in which the tape is fed at a substantially uniform linear speed and the rotary speed of the winding guide is varied with changes of diameter of the package.

6. A method according to claim **5**, in which the tape is drawn directly from an extruder.

7. Apparatus for winding a package of synthetic plastic tape drawn from a controlled speed supply source comprising a mounting for a stationary support for the package, a let-off guide mounted generally axially of said support, a winding guide, mechanism for driving said winding guide around the axis of the support, a contact surface on said rotary mechanism displaced from the axis of rotation, whereby to engage said tape at an angle as it passes from said let-off guide to said winding guide, the distance between said let-off guide and said contact surface being short in relation to the distance between said let-off guide and said winding guide, means for producing a relative traversing movement between said winding guide and said support, and means for maintaining a suitable tension in the tape as the diameter of the package varies.

8. Apparatus according to claim **7** in which the means for maintaining the tension comprise a slipping drive for the rotary guide.

9. Apparatus according to claim **8** including a constant speed drive and a slipping clutch.

10. Apparatus according to claim **7**, in which said rotary driving mechanism is in the form of a flyer having said winding guide at or close to its lower edge and having a contact point for engaging the tap close to its top.

11. Apparatus according to claim **10**, in which said flyer has a shoulder and said contact point is constituted by a bearing point on said shoulder which prevents the free passage of twist.

12. Apparatus according to claim **7**, in which the relative positions of said let-off guide and said contact point are such that the tape generates a substantial cone angle.

13. Apparatus according to claim **12**, in which said positions are located such that said cone angle is constant throughout the winding of the package.

14. Apparatus according to claim **7**, in which said winding guide is constituted by a rotary runner having its lower surface unobstructed so that the flyer is self-threading.

15. Apparatus according to claim **7**, and also including an arm pivoted on said rotary driving mechanism, said arm extending in a direction having a component which is tangential to the surface of the package being wound so as to engage the surface of the package, and having a tape engaging surface over which said tape passes before being wound on the package.

16. Apparatus according to claim **15**, in which said winding guide is constituted by a rotary runner having its lower surface unobstructed so that the flyer is self-threading, and said arm is so shaped and positioned relatively to said winding guide that the tape is automatically correctly located on the tape engaging surface as a result of this self-threading operation.

17. Apparatus according to claim **15**, in which the tape engaging surface of said arm is substantially straight in a direction transverse to the flow of the tape.

18. Apparatus according to claim **15**, in which said arm is so shaped as to act as a lateral guide to control the position in which said tape is laid on the package.

19. Apparatus according to claim **7**, in which said let-off guide is free to rotate.

20. Apparatus according to claim **19**, in which said guide is formed generally cylindrically with side flanges of larger diameter.

21. A method of forming, on a non-rotary support, a package of synthetic plastic tape drawn from a controlled speed supply source, comprising feeding said tape outwardly at an angle from a let-off point on the axis of said non-rotary support via an intermediate contact surface offset from said axis to a winding member and thence to a winding-on point on said support, said contact surface being spaced from said let-off point by a distance which is short in relation to the distance between said let-off point and said winding-on point, driving said winding member and said contact surface round the axis of said support while a relative axial traversing motion takes place between said member and said support, whereby said tape follows a conical path between said let-off point and said contact surface under controlled tension tending to press said tape against said contact surface and, due to the proximity of said contact surface, is creased at said let-off point during part of each revolution to produce localised folds in said tape.

References Cited

UNITED STATES PATENTS

795,766	7/1905	Kron	57—167
1,618,519	2/1927	Roysancour	57—67
2,138,857	12/1938	Harris	57—117
2,548,610	4/1951	Lambert	57—67
2,570,007	10/1951	Reynolds	57—21
2,883,822	4/1959	Dorschner	57—31
3,174,270	3/1965	Blaschke	57—67
3,383,851	5/1968	Hickman	242—159 XR

FOREIGN PATENTS

662,420	8/1929	France.

DONALD E. WATKINS, *Primary Examiner.*

U.S. Cl. X.R.

57—31, 117, 167