APPARATUS AND PROCESS FOR MAKING A TAPE USEFUL AS A TIRE CAP PLY

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ABSTRACT

An apparatus and process are used to make tape which can be used as cap plies, breakers and reinforcement in the carcass of tires. The tape is made by dipping a plurality of single end cords in a solvent-based cement. The cords are converged before entering the dip pan so that they are fixed in a single plane when they are dipped. The cement, which comprises solvent and an elastomeric composition, is dried so that the majority of the solvent evaporates. The elastomeric composition remains, encapsulating the cords, thereby forming the tape.
FIG. 1
(PRIOR ART)
APPARATUS AND PROCESS FOR MAKING A TAPE USEFUL AS A TIRE CAP PLY

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to an apparatus and a process for making tape which can be used as cap plies, breakers and reinforcement in the carcass of tires.

[0003] 2. Description of the Related Art

[0004] The tire industry has long had considerable interest in belted tire constructions for reinforcing tires. An example of a tire reinforcement is described in U.S. Pat. No. 3,720,569 to Kimble. This reinforcement is formed by passing a plurality of cords in the desired spaced relationship through an extruder. The cords may be coated with a rubber latex in a multiple dip operation to form a unitary strip. Such reinforcement constructions may offer the advantage of better road stability and longer tread life in both radial and bias ply constructions. However, such constructions are subject to belt-edge separation failures because the adhesion of the reinforcement to the tire rubber is inadequate.

[0005] Cap plies that envelop radial tire belts may be used to help minimize such belt-edge separation failures. Initially, cap plies were applied as a full width strip with an overlap splice. Experience has shown that the splice could pull open during curing. In addition, there is a limitation on the extension of the belt, since the cap ply is applied over the belt. Moreover, with this configuration, the same width of material must be applied across the entire belt. As a result of these limitations, a narrower cap ply tape was developed in the 1990's. This tape is spirally wound about the belt. Such a tape is made by slitting rubberized fabric. The width of the tape depends on the number of cords per inch, which varies according to the tire manufacturer. It was found that such a tape can increase winding tension, as there is no splice. Also, such a tape can be applied in extra layers at the belt edges to improve tire performance. However, this process is dependent on several processes/steps, i.e., weaving fabric, treating fabric to achieve good adhesion to the calendered rubber, compounding rubber, skimming or calendering the rubber onto the treated fabric and slitting the rubberized fabric to specific widths. These are inherently high cost/labor intensive procedures. Because of the slitting step, there may be cut cords on the edges of the tape, which may create edge fray. Consequently, such a process produces a fair amount of scrap material. Moreover, the tape so produced can be non-uniform, due to the possible varying number of single end cords in each strip. With each step the potential for error and the additive variances requires allowance for excessive tolerances in the tire building process. Finally, the addition of rubber to ensure good adhesion of the fabric to the tire rubber adds to the overall weight of the tire.

[0006] Because of the inherent drawbacks in the slit rubberized fabric process, a process for the preparation of a cap ply tape from single end cords using a cross-head extruder has been developed. Such a process is commonly known as the “Steelastic® process”, and is illustrated in FIG. 1. In the Steelastic® process, shown generally at 1, a plurality of cords 2 and rubber 3 are brought into a die head 4, where the cords are encapsulated by rubber to give a good adhesion to the tire rubber. A tape which comprises a plurality of rubberized single end cords is thus formed. The cords must be treated with a resorcinol-formaldehyde latex dip before they are brought into the die head to ensure good adhesion to the rubber introduced in the extrusion step.

[0007] The Steelastic® process provides improved uniformity as compared to the slit rubberized fabric process, since there is no possibility of uneven slitting and hence there is exact control of the number of single end cords in the tape. Moreover, this process has reduced scrap as compared to the slit rubberized fabric process, since there are no cut cords on the edges of the tape. In addition, longer lengths per roll of tape are possible with the Steelastic® process. However, the extruder and the die heads used in this process represent a major capital investment. Moreover, the tape itself is still dependent on a rubber compounding step and the addition/application of rubber as a means to ensure good adhesion to the tire rubber compounds, hence increasing weight and cost. In addition, the Steelastic® process requires above ambient pressures and temperatures. Therefore, there exists a need in the tire industry to develop a process for making a tape or strip which can be used as cap plies, breakers and reinforcement in the carcass of tires, which is less capital intensive and less labor intensive than processes of the prior art. Moreover, there needs to be a process which produces more uniform tape and which does not produce waste. In addition, it would be desirable to produce a packaged tape or strip which is ready to apply to a tire as a cap ply or which can be used as breakers and reinforcement in the carcass of tires.

BRIEF SUMMARY OF THE INVENTION

[0008] Applicants have recognized that cement flows much better than rubber, and that the use of cement for encapsulating single end cords is superior to the rubber used in the Steelastic® process. In addition, Applicants have recognized that cement can be applied at ambient temperature and ambient pressure, as opposed to rubber in the Steelastic® process, which must be applied in a heated extruder. Thus, the present invention overcomes the problems associated with the prior art by providing a process which is does not require the use of extruder dies as in the Steelastic® process.

[0009] In addition, the process of the present invention is not as labor intensive as the slit rubberized fabric process of the prior art, as it does not involve slitting of fabric. In addition, it is not as capital intensive as the slit rubberized fabric process, as it does not require a calender roll. Moreover, the process of the present invention avoids the potential for error in that it does not have a slitting step, and hence the possibility of non-uniformity due to the possible varying number of single end cords in each strip is virtually eliminated. Also, since there is no slitting step in the process of the present invention, no edge fray is created and there are no cut cords on the edges of the tape. Thus, the process of the present invention produces less scrap than the slit rubberized fabric process. Finally, the overall weight of the tire could be reduced, since there is no need to add rubber to ensure good adhesion of the fabric to the tire rubber.

[0010] Therefore, in accordance with the present invention, there is provided an apparatus and a process for making a tape from a plurality of single end cords. The apparatus comprises a dip pan for applying a solvent-based cement
comprising an elastomeric composition dissolved in a solvent to the single end cords. The apparatus also comprises means for converging the cords before they travel to the dip pan, so that the cords are converged into a single plane. In the dip pan, the cords are fixed in a single plane as the dip is applied. In addition, the apparatus comprises an oven for curing the cement so that the majority of the solvent is driven off and the cords are encapsulated in the elastomeric composition to form a tape.

[0011] Further in accordance with the present invention, there is provided a process for making a tape. The process comprises dipping a plurality of single end cords in a dip comprising a cement and an elastomeric composition; and curing the cement so that the majority of the solvent evaporates, thereby forming a tape comprising single end cords encapsulated in the elastomeric composition.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 is a perspective view of a portion of the Steelastic® process of the prior art for making a tire reinforcing tape from single end cord.

[0013] FIG. 2 is a partial elevational view of a portion of the process of the present invention for making a tire reinforcing tape from single end cord.

[0014] FIG. 3 is a plan or elevational view, taken across directional lines 3-3 in FIG. 2, of a pair of combs which are disposed ahead of the dip pan of the present invention.

[0015] FIG. 4 is a perspective view of the press roll of the present invention.

[0016] FIG. 5 is a cut-away, perspective view of a guide roll for guiding the tape in the apparatus of the present invention.

[0017] FIG. 6 is a perspective view of the final drive unit of the apparatus of FIG. 2.

[0018] FIG. 7 is a perspective view of a comb for guiding the tape of the present invention to a winder.

[0019] FIG. 8 is an elevational view of the winder of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0020] In accordance with the present invention, there is provided an apparatus and a process for making strip, or tape which can be used as cap plies, breakers and reinforcement in the carcass of tires. The process of the present invention will be described in the context of the operation of the apparatus of the present invention with respect to FIGS. 2-8. The tape is made from a plurality of single ends cords. By “single end cord” is meant treated cords which are packaged on a spool as single ends, as opposed to a fabric packaged on a roll. Single end cord is commercially available from a number of suppliers, such as Mehler Textile Industries of Fulda, Germany, Dan River, Inc. of Atlanta, Ga. and Southern Weaving Company of Greenville, S.C. In the preferred embodiment, the number of single end cords is either a multiple of ten or a multiple of twelve, depending on the application. The number of ends per inch for cap plies or carcass applications varies depending on the cord construction, and for a particular construction, depending on the tire type and the tire manufacturer.

[0021] Typical synthetic yarns useful for the cords of the present invention are made from polyamides, such as 6,6 nylon, 6 nylon, or any copolymers thereof. Alternatively, the yarns may comprise polyesters, aramid fibers, rayon, glass or carbon, etc. A particularly suitable yarn for use with the present invention is T-728, which is a heat stabilized 66 nylon, commercially available from DUSA International of Wilmington, Del. To meet the strength and durability requirements for tire applications, the yarns are normally prepared from high viscosity polymers containing stabilizers and are drawn at high draw ratios to yield high tenacity yarns, as disclosed in U.S. Pat. No. 3,311,691.

[0022] The single end cord, shown generally at 10 in FIG. 2, enters the apparatus of the present invention. For simplicity of illustration, only a single cord is illustrated at 10. The apparatus of the present invention includes a frame having a plurality of vertical beams 12, a pair of horizontal beams 14, and a set of braces 16. The cords are sent to a type-one guide roll 18, which may be optional, depending on the distance the cords must travel. The apparatus of the present invention includes a dip station, shown generally at 20 in FIG. 2. Dip station 20 includes a take-out 22, a dip pan 24 and a mechanism 26 for lifting and lowering the dip pan.

[0023] The apparatus of the present invention also includes means for converting the cords before they travel to the dip pan. The means for converting the cords comprises a first comb 28 and a second comb, 30 as shown in FIGS. 2 and 3. The first comb converges the cords before they travel to the dip pan. The second comb is disposed between the first comb and the dip pan for further converging the cords after they leave the first comb and before they travel to the dip pan. These combs are shown in greater detail in FIG. 3, which is a plan or elevational view of the combs. The first comb has a plurality of first grooves, 28a as shown in FIG. 3. Each first groove has a plurality of first teeth 28b. A first space 28c is formed between consecutive teeth. The cords travel through the first spaces to the second comb. The second comb has a plurality of second grooves 30a as shown in FIG. 3. Each second groove of the second comb has a plurality of second teeth 30b. A second space 30c is formed between consecutive second teeth. The cords travel through the second spaces to the dip pan. The width of each of the second grooves is less than the width of each of the first grooves, so that the cords are converged and are positioned in a single plane as they travel to the dip pan.

[0024] It should be apparent that modifications may be made to the apparatus as described without departing from the spirit of the invention. For instance, instead of using a plurality of combs to converge the cords, the means for converging the cords before they travel to the dip pan could comprise a guide roll. Such a guide roll would not have equally spaced grooves across the width of the roll. Instead, the grooves would be clustered so that as the cords travel across the guide roll, they are converged in the clustered grooves. In either case, whether combs or a guide roll are used, the converging means of the present invention is designed to converge the cords and position them into a single plane, as well as to ensure the integrity of a pre-dip, should one be applied. A converged set of cords is shown leaving the second comb at 31 in FIG. 3.
As can be seen from FIG. 2 in particular, dip pan 22 includes a plurality of receiving rolls 32. The rolls keep the single end cords advancing through the dip pan and ensure that the cords are submerged in the dip pan. Rolls 32 include a plurality of crests 32a as shown in FIG. 4 and a plurality of grooves, or valleys 32b as shown in FIGS. 3 and 4. The converged cords rest in the grooves 32b of the receiving roll. A press roll 34 is disposed above the middle dip pan roll 32. Press roll 34 includes a plurality of crests 34a and valleys 34b. As can be seen from FIG. 4, crests 34a mesh with the valleys 34b of receiving roll 32. The cords stay on the crests of the press roll and in the valleys of the dip pan roll to press the cement into the spaces between the cords as they travel through the dip pan. The converged cords are fixed in a single plane as the dip is applied. A solvated, or wet tape, is shown coming out of the grooves of the dip pan roll at 33 in FIG. 4.

Again, variations of the specific equipment used may be made without departing from the scope of the present invention. For instance, if there is enough tension in the cords as they travel through the dip pan, the use of the press roll may not be necessary. In this case, there just must be enough tension in the cords to keep them in the valleys of the receiving roll of the dip pan. In this case, an appropriate support, such as a guide roll or a glass bar, can be used for the cords.

The dip that is used in the dip pan is a solvent-based cement. This solvent-based cement includes an elastomeric composition, which is dissolved in a solvent, such as toluene. This elastomeric composition may comprise, for example, but is not limited to, a natural rubber, or a natural rubber with styrene butadiene or styrene butadiene with polybutadiene. These constituent materials in the elastomeric composition may be mixed with reinforcing agents, activators and/or plasticizers, depending on the needs of the end user. The percentage of solvents in the cement depends on the speed at which the cords are run through the apparatus. This percentage is typically in the range of 10-30%.

The solvated, or wet tape, is then sent to a type-two guide roll 36 and to another type-two guide roll 38 as shown in FIG. 2, and more particularly in FIG. 5. FIG. 5 is a cut-away view showing a portion of an exemplary type-two guide roll of the present invention. As can be seen from FIG. 5, there are grooves 40 formed in the tape guide roll. These grooves 40 are wider than the grooves which accommodate single end cord, such as the grooves in type-one guide roll 18, in order to accommodate the solvated tape. It should be noted that rather than using guide rolls for guiding the tape after it leaves the dip pan, sleeves may be used around the guide rolls after the dip pan. The purpose of either the guide rolls or the sleeves is to keep the tape aligned and to prevent it from rolling as it passes out of the apparatus as shown in FIG. 2.

The solvated, or wet tape, is then sent to an oven 42, where it goes through one pass, to another type-two guide roll 44, and then another pass through the oven. In the oven, the cords must remain fixed in a single plane. This is done by maintaining the tension in the cords, and is necessary to maintain the integrity of the tape. The cement, including the solvent and the elastomeric composition, is dried in the oven. This drying typically occurs at about 110° C. for some period of time, which is dependent on the speed at which the cords, or the tape at this point, are being driven through the apparatus. The drying drives off, or evaporates, the majority of the solvent, such as toluene. What remains are the cords, fixed in the single plane and encapsulated in the elastomeric composition to form a tape, shown at 46 in FIG. 6. In the final end product, some small residual amount of solvent remains as a component of the tape. The solvent may comprise 0.0009-5% of the weight of the tape.

From the oven, the tape is sent back through guide roll 38, to a series of guide rolls, 46, 48 and 50, and to a drive unit, shown generally at 52 in FIGS. 2 and 6. Another drive unit 54, including shaft 54a and rolls 54b and 54c, is optional, and is used only when drive unit 52 is not operational. As can be seen from FIG. 2, drive unit 52 includes a shaft 52a and geared rolls 52b and 52c, for driving the tape through the apparatus. As shown in FIG. 6, the drive unit is supported in a frame 56, which includes a support bar 58 for presenting the tape as it moves through the apparatus. The support roll is held between a pair of supports 60.

The tape, which is shown at 62 in FIG. 6, is then sent to a pair of type-two guide rolls, 62 and 64 and to a mechanism 66 for presenting the tape to an optional comb 68 as shown in FIG. 7. Mechanism 66 includes vertical supports 66a, a horizontal bar 66b as well as a roller 66c. The bar and the roller are held together by an end cap 66d. The tape rolls over roller 66c and is advanced to comb 68. The comb of FIG. 7 is similar to a comb used in a known single end cord process to keep the cords separated, except that in the comb of FIG. 7 has less teeth, and the teeth are more widely spaced, than a comb used in a known single end cord process, in order to accommodate the tape. The tape is then sent to a winder 70 as shown in FIG. 8, which is supported by a framework 72 as shown in FIG. 7. After the winder, the tape is sent to a bobbin 74, where it is wound and stored. A pair of bobbins is shown in FIG. 7.

After the comb, the tape is sent to a guide wheel 76 as shown in FIG. 8. The guide wheel is held onto the framework 72 of the winder by a fastener 78. From guide wheel 76 the tape is sent to another guide wheel 80. Similar guide wheels can be found in a known apparatus for making single end cord; however, such guide wheels have crests and valleys for accommodating the single end cords. In contrast, in the apparatus of the present invention, the surfaces of both guide wheels 76 and 80 do not have crests and valleys, but rather are smoothed out to accommodate the tape. The use of such a guide wheel is optional in the present invention, and is used to ensure that the tape stays in place. As the tape moves from guide wheel 76 to guide wheel 80 and to the final package (i.e., the winder 70 with tape wound on it), the tension in the tape is maintained by a dancer arm 82. The end of the dancer arm pivots about an upper pivot point 84, and about a lower pivot point 86. The movement of the dancer arm is limited by a lower limit device 88, which keeps the dancer arm from hitting against the bobbin. Upper pivot point 84 and lower limit device 88 are held against the framework by a plate 90, which fastens to the framework of the winder. A guide roll 92 guides the tape to a guide 94, through which the tape travels to be presented to the final package.

With the present invention, because the individual cords are dipped in a cement, the cords have better access to the cement than to rubber in the prior art, because rubber
does not flow as well as cement. Thus more complete coverage of the cords, either individually, or in the fabric, can be achieved as compared to processes of the prior art. Consequently, with the present invention it is possible to produce a superior tape as compared to the slit fabric or Steelastic® process. While it might be possible to achieve the desired encapsulation characteristics for elastomeric compositions such as rubber at high heat and high pressures, the present invention is able to achieve these desired encapsulation characteristics at ambient temperature and ambient pressure while the cement is being applied.

[0034] The tape of the present invention is ready to use as a cap ply for a tire. When used in this application, the tape is wound directly onto the tire. The single end cord in the tape then adheres to the rubber in the tire curing process. Alternatively, as noted above, the tape may be used as a breaker and reinforcement in the carcass of tires. The tape of the present invention is generally about ½" to 3/8" wide.

[0035] The invention will be described in greater detail with reference to the following examples which are intended to illustrate the invention without restricting the scope thereof.

EXAMPLE

[0036] A tape may be made using the apparatus of FIG. 2 from a plurality of single end cords, such as T-728, commercially available from DUSA, International. The cords may then be sent to a dip pan, where an rf dip, may be applied. This dip may be made by adding water, sodium hydroxide (NaOH), or caustic pellets, resorcinol flake and formaldehyde to a tank, to form a solution with a solids content of about 6%. The solution should be mixed for approximately 30 minutes. This solution may then aged for a minimum of about 3 hours (minimum of 2 hours, maximum of 4 hours). In another tank, a latex may be added. Then water may be mixed with ammonium hydroxide, NH₄OH, and added to the latex slowly.

[0037] Then an anti-foaming agent may be added to form a solution, which should be mixed slowly. This solution may have a solids content of about 35%. This solution may then combined with the solution from the first tank. The combined solutions should be mixed together for about 30 minutes prior to use. The cords should be dipped in this combined solution for about 3 seconds. The dip should then be dried in an oven at a temperature of about 225°C, for a dwell time in the range of 100 and 200 seconds. The cords should then be sent to another oven, where the dip may be dried at a temperature of 165°C. The cords may then be dipped in a cement dip pan. The cement in the cement dip pan may be a mixture of a solvent, such as toluene, (85 kg) and a rubber-based elastomeric composition (15 kg), such as natural rubber, natural rubber and styrene butadiene, or styrene butadiene and polybutadiene. Any of these may be mixed with reinforcing agents, activators and/or plasticizers. The cement should be dried in an oven at a temperature of 110°C, so that the toluene is driven off. A tape which is about ½ inch wide may thus be formed.

What is claimed is:

1. An apparatus for producing a tape suitable for use as a cap ply from a plurality of single end cords, comprising:
   a) a dip pan for applying a cement to the single end cords; and
   b) means for converging the cords before they travel to the dip pan, so that the cords converge and are fixed in a single plane as they are dipped in the dip pan.

2. The apparatus of claim 1, wherein the converging means includes:
   i) a first comb for converging the cords before they travel to the dip pan; and
   ii) a second comb disposed between the first comb and the dip pan for further converging the cords after they leave the first comb and before they travel to the dip pan.

3. The apparatus of claim 2, wherein the first comb has a plurality of first grooves, each first groove having a plurality of teeth with first spaces therebetween, wherein the cords travel through the first spaces to the second comb, and the second comb has a plurality of second grooves, each second groove having a plurality of teeth with second spaces therebetween, wherein the cords travel through the second spaces to the dip pan, wherein the width of each of the second grooves is less than the width of each of the first grooves, so that the cords converge as they travel from the first grooves to the second grooves.

4. The apparatus of claim 1, further including an oven for drying the cement.

5. The apparatus of claim 1, further including a dip pan roll disposed in the dip pan and having a plurality of teeth and valleys, and a press roll disposed above the dip pan roll, having a plurality of teeth and valleys, wherein the teeth of the press roll mesh with the valleys of the dip pan roll to compress the cement into the spaces between the single end cords.

6. The apparatus of claim 1, further including at least one guide roll adapted to guide the tape after it exits the dip pan, wherein the first guide roll has a plurality of grooves formed in the outer periphery thereof, and the second guide roll has a plurality of grooves formed in the outer periphery thereof, and wherein the grooves in the second guide roll are spaced apart by a greater distance than the grooves in the first guide roll.

7. The apparatus of claim 1, further including a winder for winding the tape after it exits the oven, wherein the winder comprises a shaft having a valley of a width sufficient for accommodating the tape after it exits the dip pan.

8. The apparatus of claim 2, further including a third comb disposed between the dip pan and the winder, the third comb having a plurality of teeth, wherein the teeth are spaced apart by a distance sufficient for accommodating the tape as it is presented to the winder.

9. A process for producing a tape suitable for use as a cap ply from a plurality of single end cords, comprising:
   a) converging the plurality of single end cords so that the cords are fixed in a single plane as they travel through the dip pan;
   b) applying a dip in the dip pan to the cords so that the cords are encapsulated in the dip; and
   c) drying the dip to form a tape.

10. The process of claim 9, further including pressing the dip into the spaces between the cords.
11. The process of claim 9, wherein the dip is a cement comprising an elastomeric composition dissolved in a solvent, and further including the step of drying the cement so that the majority of the solvent evaporates, and the elastomeric composition remains, thereby forming the tape.

12. A process for making a tape suitable for use as a cap ply, comprising:
   a) dipping a plurality of single end cords in a solvent-based cement comprising a solvent and an elastomeric composition; and
   b) drying the cement so that the majority of the solvent evaporates, and the elastomeric composition remains, encapsulating the cords, thereby forming the tape.

13. A tape made by the process of claim 12.

14. The tape of claim 13, wherein the solvent comprises 0.0009-5% by weight of the tape.

15. A tape suitable for use as a cap ply, comprising a plurality of single end cords encapsulated in an elastomeric composition, and trace amounts of a solvent.

16. The tape of claim 15, wherein the solvent comprises 0.0009-5% of the weight of the tape.

17. The tape of claim 15, wherein the solvent is toluene.

18. The tape of claim 15, wherein the elastomeric composition is selected from the group consisting of a natural rubber, a natural rubber with styrene butadiene or styrene butadiene with polybutadiene.

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