United States Patent [19]

Hnatek

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[54] VEE BELT MANUFACTURE

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[21] Appl. No.: **151,099**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 783,076, Oct. 14, 1968, abandoned.

[52] **U.S. Cl.**........... **264/231,** 264/DIG. 59, 264/290, 264/347

[51] **Int. Cl.**.. **B29h 7/22**

[58] **Field of Search**.................... 264/231, 290, 347, 264/DIG. 59

[56] **References Cited**

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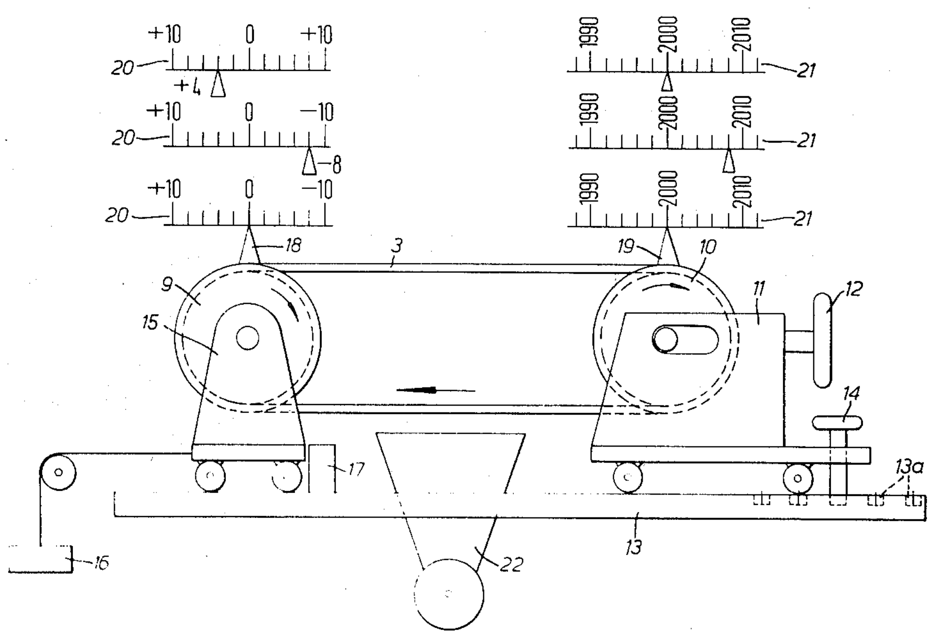
[57] **ABSTRACT**

A method of treating a conventional vee-belt (having a polyester reinforcement) to stabilize the belt at a required nominal length includes the steps of pre-vulcanizing the otherwise completed belt on a heating drum around which the vee-belt is passed without tension being applied. The belt is prepared for vulcanization under tension so as to eliminate shrinkage caused by the pre-vulcanization step and bring the belt back to its original length. Subsequently the belt is stretched over two rollers under a standard load and when the required length is achieved, is given a permanent set by immediate cooling.

5 Claims, 5 Drawing Figures



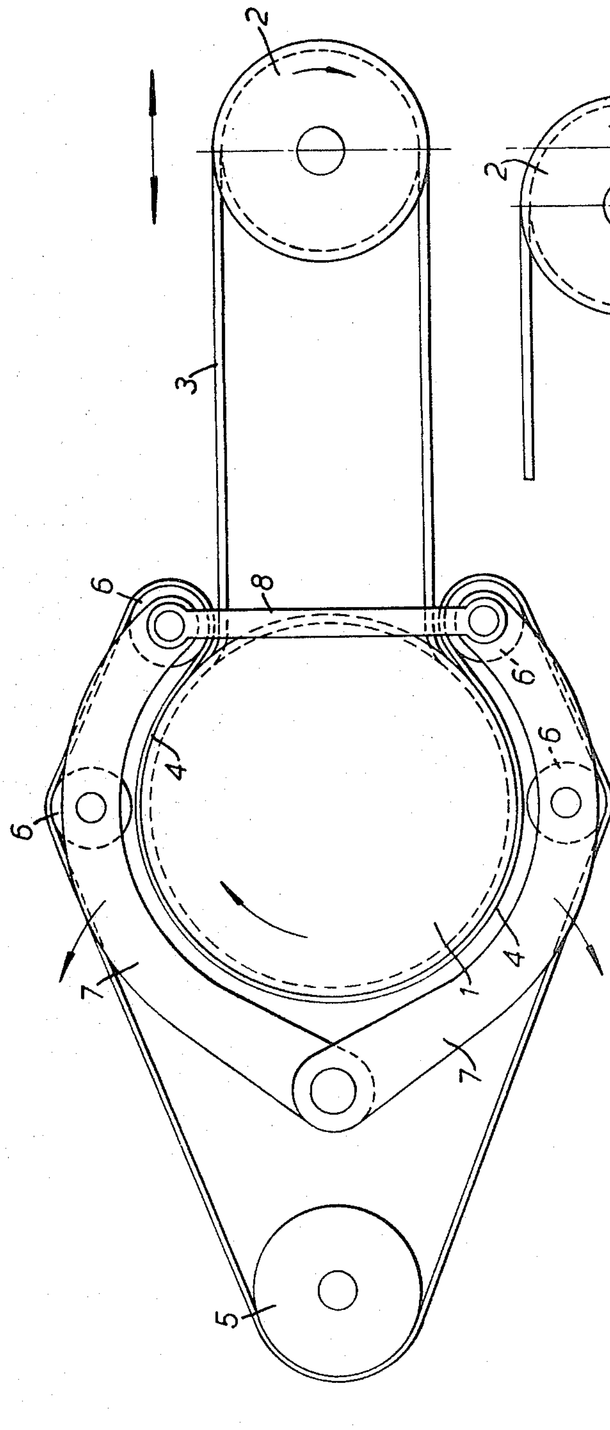


FIG. 1.

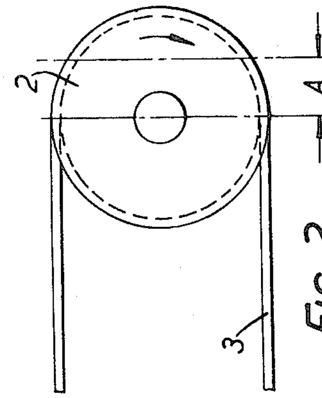


FIG. 2.

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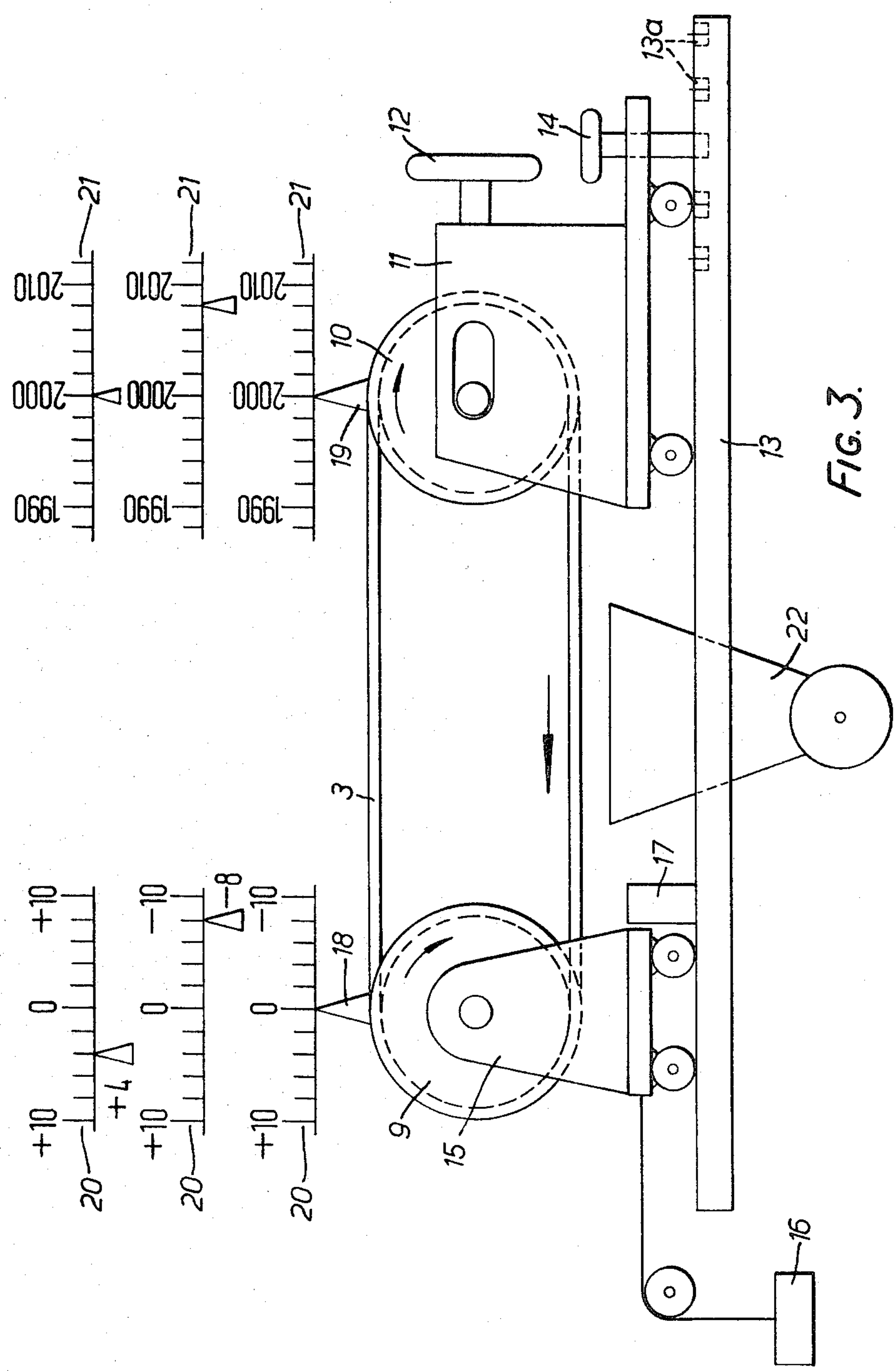

FIG. 3.

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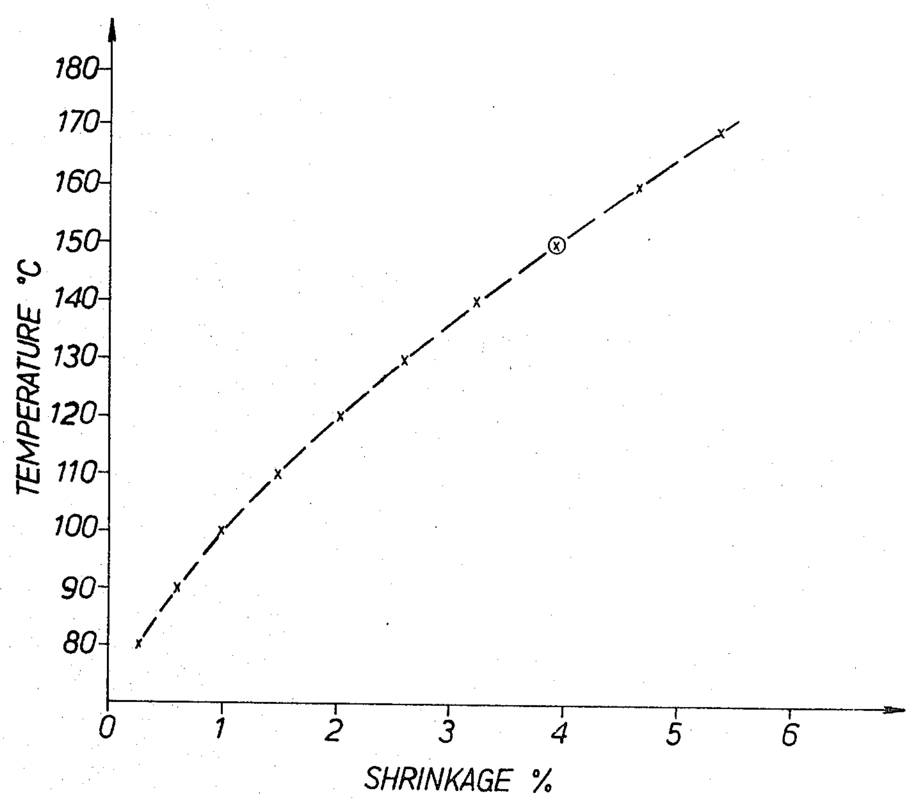

FIG. 4.

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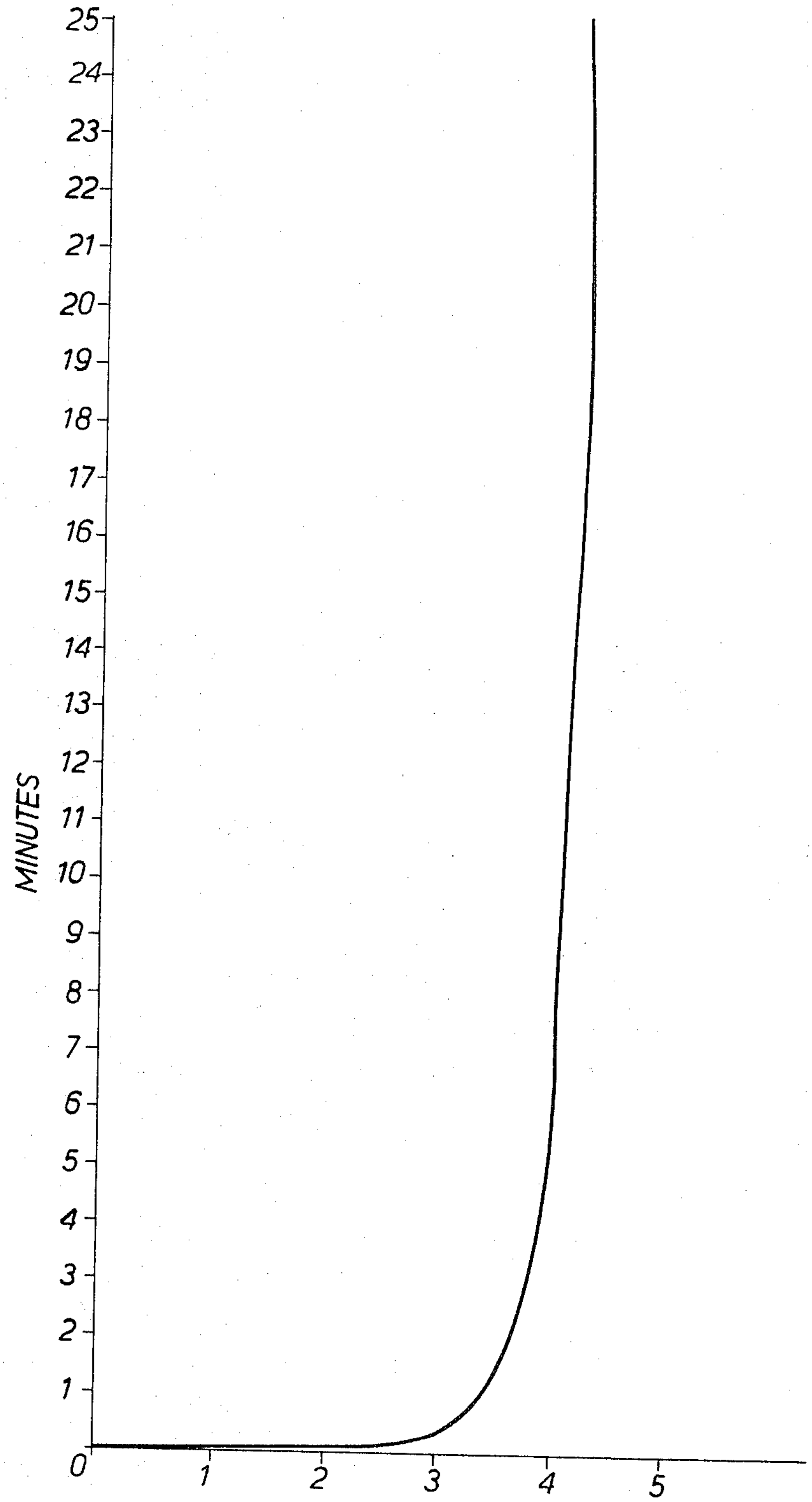

FIG. 5.

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VEE BELT MANUFACTURE

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part application to application Ser. No. 783,076 filed Oct. 14, 1968 for "Vee-belt manufacture, method and (now abandoned)".

BACKGROUND OF THE INVENTION

The invention relates to a method of producing stabilized Vee-belts having a rubber body and internal reinforcements of polyester fiber cord.

The tensile member subject to elastic contraction is a polyester material — yarn, thread or tape — having the following characteristics: When a tensile member made of one of these materials is subjected to heating to between 100° and 180° C. and is not securely gripped, it contracts lengthwise to some extent (1 to 7 percent, according to the nature of the tensile member concerned). When cold, the polyester material exhibits only its property of elastic elongation.

The invention turns this effect to account for length stabilization, the belt being secured in the hot condition at the desired length, which lies between the contraction percentages.

After cooling, contraction is no longer possible, for polyester is unaffected by moisture.

A Vee-belt incorporating a tensile component made of a material that is affected by moisture, such as rayon, for example, undergoes longitudinal shrinkage by the absorption of moisture during storage and is accordingly unsuitable for the proposed method.

It is general knowledge that conventional Vee-belt drives are composed of several such belts combined to form a set and hence that their length measurements must be accurate in order to avoid excess loading of the shorter belt or belts. The total tolerance acceptable in such drives is 0.25 percent of the nominal length of the belts; and in many instances only half that figure is permissible.

It has already been proposed in the U.S. Pat. No. 2,325,204 to Kilborn to vulcanize rubber Vee-belts in a side-by-side arrangement on a pair of appropriately grooved drums. Heating of the belts to effect vulcanization is produced by the passage of a hot medium through passages within the grooved drums and, during vulcanization a stretching tension is applied to the belts by means of a hydraulic motor which forces the two drums apart. At the same time those parts of the belts which are at any given time in engagement with the grooves of the drums are also subjected to a pressure acting radially inwardly by clamp arms which engage the outer surfaces of the belts over approximately 180° of arc at each drum.

The belts which are to be treated by the process described in this prior specification have an unspecified reinforcement and there is no indication that any problem arises with regard to shrinkage of the belts or the need to stabilize the belts at a predetermined dimension.

The prior specification also discloses a method of vulcanizing an endless rubber Vee-belt comprising supporting the belt at spaced points on its inner periphery, moving the supporting points apart to stretch the material, limiting the movement apart of the support points by flexibly and inextensibly confining the outer periphery of the belt when the movement apart of the support points has brought the material length to exactly that desired, subjecting the inner and outer peripheries of the belt to the action of vulcanizing heat, and moving the belt along an endless path during the application of the vulcanizing heat.

The previously proposed apparatus and method were developed prior to the discovery of polyester fibers and hence neither apparatus nor method are capable of taking into account the shrinkage property of a rubber Vee-belt having a reinforcing or tensile member of polyester fiber.

An object of the present invention is to provide a method of producing a Vee-belt of exact dimensions and which is dimensionally stable in use apart from normal elastic stretching under load.

SUMMARY OF THE INVENTION

According to the present invention, there is provided in a method for forming a plurality of Vee-belts of uniform length, each belt including a tensile member of elastically-contractile polyester material which contracts on heating, the improvement comprising the steps of subjecting each said Vee-belt, after passage through vulcanizing apparatus in unstressed condition in which initial vulcanization is effected, to a vulcanizing step whilst tensioned by an amount which offsets the contraction of the tensile member resulting from the initial vulcanizing step, immediately thereafter placing the belt under a standard load, stretching the belt by an amount to bring it to the nominal length, and cooling the belt to stabilize it at the nominal length.

By this method, the behavior of the tensile member or other reinforcement of the Vee-belt as regards elastic contraction is so controlled that belts of equal, and stable length are produced.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows part of the vulcanizing unit in equipment for putting the method into practice;

FIG. 2 shows a portion of the unit illustrated in FIG. 1;

FIG. 3 shows part of a stretching device forming part of the apparatus;

FIG. 4 is a graph in which temperature is plotted against shrinkage in percent for a particular polyester fiber; and

FIG. 5 is a graph of time in minutes plotted against shrinkage in percent for the same polyester as that of FIG. 4, at a temperature of 150° C. and a load of 250 grams.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, a grooved heating drum **1** of the vulcanizing unit, co-operates with a roller **2** that can be adjusted and locked in the direction in which a conventional Vee-belt **3** with a polyester reinforcing member to be treated is tensioned. One or more Vee-belts **3** pass around the heating drum **1** operating for example at 150° C. and the roller **2**. The tensile member of the Vee-belt is in polyester of known type and has a conventional fabric cover and an example thereof will be described hereinafter, in detail.

Also slowly passing around the heating drum **1** is a belt **4**, which can be tensioned by means of an adjustable roller **5**. This belt **4** is also led around guide rollers **6**, mounted on pivotally connected arms **7**, which are held together by a pair of straps **8**. The drum rotates at a rate of one revolution for every ten to eighteen minutes. The vulcanization time is dependent upon the width and height of the belt and of the rubber mix.

While the Vee-belt, or belts for example fifteen if the drum has a corresponding number of peripheral grooves, arranged side-by-side, is passing round for the first time, pre-vulcanization takes place with the belt or belts substantially unstressed to enable the thermal contraction of the tensile member to take full effect. Thus, the tensile member within the Vee-belt is shortened by the distance A (FIG. **2**) in consequence of the vulcanizing process.

Next, a small amount of tension having been applied by movement of the tensioning roller **2**, the belt **3** is subjected to a second stage of vulcanization while under tension, until the contraction of the belt has been offset as a result of this stretching process. The second vulcanizaton is therefore ended upon the original starting length having been reached.

The hot Vee-belt **3** is thereupon removed from the apparatus and at once passed on a convenient holder to a stretching device (FIG. **3**), which has two rollers **9** and **10**, to take the belt **3**. One of these rollers **10**, can be adjusted and locked in the direction in which the belt **3** is tensioned. This roller **10** is mounted with freedom to rotate in a tensioning carriage **11**, which can be moved and locked in position by means of a tensioning wheel **12**.

For coarse adjustment, a running rail **13** below the carriage **11** contains recesses **13***a*, in which a screw **14** can be selectively engaged.

The roller **9** is mounted with freedom to rotate in a carriage also mounted on the rail **13**, to which a tensile standard load **16** can be connected. This standard loading is laid down precisely, for any given belt cross-section, in German DIN Standards 2215, 7753 sheet **1** and 7753 sheet **3**.

For ease of reference the following extract is given from these Standards:

Measurement of the belt length

The effective length L_w or the length L_a are derived as follows: The belt is fitted according to FIG. **6** over two equal sized measuring Vee-belt pulleys, the groove form and the values of which are respectively set out in FIG. **7** and Table **2**. The movable measuring pulley is so loaded that the measuring force Q acts on the belt. In order to ensure proper seating of the belt in the grooves, the pulleys are rotated under load so that before the measurement of the axis spacing e at least three rotations have been completed. The effective length L_w is derived from twice the axis spacing e plus the effective periphery U_w of the measuring Vee-belt pulley, or from the equation. The outer length L_a is given

For belt section SPZ: $L_a = L_w + 13$

$$SPA: L_a = L_w + 18$$

$$SPB: L_a = L_w + 22$$

$$SPC: L_a = L_w + 30$$

$$19: L_a = L_w + 25$$

TABLE 2.

Measurements of Vee-belt pulleys and measuring force

Explanations

Belt Section	Dimensions of Vee-belt pulleys effective circumference U_N[5]	Effective diameter d_w ±0.05	Outer diameter d_a ±0.05	Effective width b_N	Groove Depth f minimum	Measuring force Q[5] kilograms
SPZ	300	95.49	100	8.5	11	36
SPA	450	143.24	149	11.0	14	56
SPB	600	190.99	198	14.0	17	90
SPC	1000	318.31	328	19.0	24	150
19	800	254.65	263	16.0	20	120

5. The value is recommended by ISO.

The sections SPZ, SPA and SPB correspond to ISO-recommendations.

R 459 Grooved pulleys for narrow Vee-belts;

R 460 Lengths of narrow Vee-belts.

Other details of the dimensions and characteristics of standard Vee-belts are also given in these DIN Standards.

The movement of the carriage **15** is limited in one direction by a stop **17** secured to the rail **13**.

Connected to the rollers **9** and **10** are gauge marks **18** and **19** respectively, which operate in conjunction with the corresponding measurement scales **20** and **21**.

Between the two rollers **9** and **10** is a cooling device **22**, which stabilizes the Vee-belt or belts **3**.

The vee-belt set made up of the individual belts **3** is fitted while hot over the rollers **9** and **10** of the stretching device (FIG. **3**), which can be set in such a way as to bring the gauge mark **18** opposite zero, while the gauge mark **19** indicates the nominal length of for example 2,000 mm., on the scale **21**. Next, a drive is applied to one or both of the rollers **9** and **10**, so that the belt **3** moves in the sense of the arrow. Then the belt is briefly subjected while hot to the tensile standard load **16** and then relieved of the loading. When, upon removal of the load, the gauge mark **18** reaches the measurement mark "zero" on the scale **20**, the length of the belt is at its predetermined nominal value, so that the cooling device **22** can be brought into action to stabilize it at that value. Alternatively, the cooling device **22** lies within the boundary of the Vee-belts and is arranged to direct cooling air outwardly through a number of jet nozzles. The air flow is approximately 10 cubic meters per minute at a pressure of 185 millimeters water gauge. The cooling air is preferably at a temperature of from 8° to 15° C. and cools the belts to approximately 50° C. in a time of from 6 to 8 minutes. Further cooling is unnecessary since substantially no further shrinkage occurs at lower temperatures.

Should the gauge mark **18** reach only the scale reading −8, the roller **10** in FIG. **3** is moved to the right until the gauge mark **19** indicates the value +2,008 (millimeters) on the length scale.

On the other hand, if the gauge mark **18** should move out as far as the measurement value +4 (millimeters), the roller **10** should not be moved, so that the gauge mark **19** stays at the reading 2,000 (millimeters) on the scale **21**. Then, when this is followed by the cooling action, the belt **3** will contract precisely to the set measurement.

After cooling, the standard loading **16** is again applied by way of check, to verify that the length of the belt **3** is correct. The gauge mark **18** will then be seen to move the zero reading on the scale **20**.

The invention is applicable to all conventional Vee-belts having a polyester tensile member or other reinforcement which contracts on heating. Such belts are generally based on a standard vehicle tire rubber mix such as natural rubber, Buna and Neoprene (Registered Trade Mark) containing fillers such as carbon black, chalk and kaolin, ageing and fatigue retarders and a vulcanization accelerator such as sulfur.

The reinforcement takes the form of a polyester fiber cord. A polyester fiber may be defined as a long-chain synthetic polymer generally produced as a condensation product from the reaction of ethylene glycol and terephthalic acid or its derivatives and which has been formed into a textile fiber or filament.

To form the yarn a melted mass of the condensation product is spun at 275° to 290° C. and is then stretched slightly. The yarn made in this manner is twisted as a multi-filament and then transformed into a cord, which has for example the dimensions 1,000 Denier/ 3 × 3 or Nm p.3 × 4. This yarn is marketed under the Registered Trade Mark "Diolen" 1625 and has the following properties: Breaking load 88.5 kg; stretch at 30 kg. 3.4 percent; stretch at 50 kg. 6.5 percent; extension at rupture 10.4 percent; weight per 100 meters 145.2 grams. This cord is then dipped in rubber. The dipping compound used is a mixture of vinyl pyridine latex (Gentax) and resorcin formaldehyde. Other examples of suitable fibers are "Trevira" GPA produced by Farbewerke Hoechst, Germany, "Terlenka 760" produced by Algemeene Kunst. Unie. Holland, and "Dacron" by Du Pont in the United States of America. Shrinkage tests have been carried out on certain of these polyester fibers and it has been shown that as in the specific example given hereinafter the percentage shrinkage at 150° C. is from 3 to 4 percent. Clearly, this degree of thermal shrinkage is not permissible in vee-belts and the method in accordance with the invention overcomes this disadvantage by reducing, in the finished vee-belts, the thermal shrinkage substantially to zero. Examples of suitable materials are disclosed in U.S. Pat. No. 3,216,187.

The cord is then subjected to the second heat treatment, which is carried out at 200° C.

Every Vee-belt consists of three rubber mixes, namely a carcass mixture such as is used in the construction of motor vehicle tires and which encases the dipped fibers and a rubberized textile covering. The carcass mixture has for example the following composition:

Elastomer (natural rubber, Buna, Neoprene)	100 parts
Fillers, carbon black of SRF type	45 parts
Zinc Oxide	5 parts
Softener oils	3–5 parts
Anti-ageing and fatigue agents	2–3 parts
Sulfur and accelerators, according to the type of elastomer	1–4 parts

Such a mixture has a hardness depending on the required rate of vulcanization of the operating apparatus for example 65 Shore A.

The rubber cushion on which the cord rests when in use and passing over pulleys has for example a hardness of 80 Shore A, and the formula for the rubber mixture is as follows:

Elastomer (natural rubber, Buna, Neoprene)	100 parts
Fillers, oil carbon black, chalk, kaolin	90-100 parts
Zinc oxide	5 parts
Softener oils	10 parts
Anti-ageing and fatigue agents	2-3 parts
Sulfur and accelerators, according to the type of elastomer	1-4 parts

There are of course other rubber cushion materials, for example rubber mixtures with 5–25 percent fiber admixtures consisting of fibers 5–7 mm long of nylon, polyester and the like.

Most Vee-belts are provided with a rubberized textile covering, which may consist of natural or artificial fibers. The rubber layer on both sides of the textile material, which can be applied to the rubber roller by means of a rubber solution or friction (solid mixture) has the following composition:

Elastomer (natural rubber, Buna,Neoprene)	100 parts
Fillers, gas carbon black of type HAF, also electrically-conducting carbon black	45 parts
Zinc oxide	5–10 parts
Magnesium oxide	5–10 parts
Softener oils (according to processing as solution or solid mixture)	5–25 parts
Anti-ageing and anti-fatigue agents	1–3 parts
Accelerators (according to elastomer and vulcanizing time required)	1–4 parts

Such a mixture has a 70 Shore A hardness.

The temperature ranges for the pre-vulcanization are adapted to the rubber mix to be vulcanized, and have to be matched to the peripheral speed of the rotating drum. The preferred temperatures of the surface of the vulcanizing drum, that is at the vee grooves for the belts between 145° and 158° C. and are coupled with the time of rotation and the accelerators of the rubber mix; the temperatures therefore depend on the rate of vulcanizing of the elastomer mix. A pre-set temperature is kept constant throughout the vulcanizing process (i.e., pre- and secondary vulcanizing or 1st and 2nd vulcanization). The cords of the Vee-belts are heated in dependence upon thermal conductivity of the encasing rubber mix, and through the degree of cord shrinkage it is possible to determine according to shrinkage diagram of FIG. 4 the percentage of the shrinkage path.

A shrinkage force in kilogrammes corresponds to this shrinkage percentage. If it is desired to restore the Vee-belt to its original length with the same heat action, it is only possible with the action of heat, the shrinkage force has to be calculated for each Vee-belt on retightening. It is found in practice that about twice the shrinkage force has to be used to stretch the Vee-belt in the second vulcanizing cycle, in order to obtain the same extension of the cord throughout the length of the Vee-belt.

If the temperature remains constant during the second vulcanization, the rotational speed can be the same as that of the first cycle, but can also be up to five times faster, depending upon the height of the Vee-belt section.

An example of the process in accordance with the invention will now be described as applied to Vee-belts of particular size.

A set of Vee-belts consisting of, for example, 15 Vee-belts of section, outer width 17 millimeters by height 11 millimeters, 3,000 millimeters internal length is mounted on the rotary vulcanizing apparatus and the tension drum 9 is tightened by means of a predetermined weight 16 which can be calculated from the following values: In a Vee-belt of the above section 17 × 11 there are nine cords of the structure Nm 9/3 × 3. This produces for the 15 Vee-belts 135 cords and there will thus be 270 cords for upper and lower runs. The fundamental load in the shrinkage tests of the cord used is given as 200 grams/cord. Thus for all the belts a pre-stress of 270 × 200 = 54 kg. was chosen which, in practice means 60 kilograms owing to frictional losses.

The first vulcanization is now carried out substantially without stress since the load of 60 kilograms for the 15 Vee-belts produces substantially no elongation.

The vulcanizing drum rotates very slowly, namely at a peripheral speed of 0.1 meter per minute. This speed is matched to the vulcanizing curve of the rubber mix at a temperature of 158° C. The temperature of the grooves of the vulcanizing drum is regulated accurately by thermostats with electrical heating.

The Vee-belt set enters the vulcanizing drum at the bottom and at the top the hot vee-belts emerge. The hot prevulcanized Vee-belt that emerges shrinks according to the temperature attained by the cord (see FIG. 4). In this example the tension drum 2 will move by an axial distance of 36 millimeters in relation to the vulcanizing drum; this results in a belt length of 2,928 millimeters and a shrinkage value of 36 × 2 × 100/3,000 = 2.4 percent of the length, = 72 millimeters.

When the first revolution without tension is completed (this revolution can only be carried out free from tension, for in fixing the Vee-belts, the cord threads would contract in the softened sub-structure of the Vee-belts, and thus yield only faulty products), a cord position is attained which lies perfectly in the Vee-belt, considered in cross-section.

In the second vulcanizing cycle a load of 1,000 kilograms is applied; this can be done without risk of damage, because the sub-structure of the Vee-belt is vulcanized with the upper structure (i.e., is elastically solid). This 1,000 kilogram tensile force is calculated from the shrinkage force per cord thread with 2.4 percent shrinkage. This force is calculated at 3.7 kg per cord thread.

270 cord threads × 3.7 kilograms = 1,000 kilogrammes.

At the end of the second revolution, which is carried out at a speed of the vulcanizing drum between 0.10 and 0.50 meter per minute (in this case 0.30 meter per minute at the same vulcanizing drum temperature of 158° C.), the initial length of 3,000 millimeters is again attained.

If the Vee-belt set were to be taken hot from the apparatus, i.e., without further treatment, the hot part of the Vee-belt set which is about 3,000 millimeters long, i.e., in this case about 1,400 millimeters long after the residual temperature would shrink 1,400 × 2.4 percent = 33 millimeters. The Vee-belt set would therefore attain a dimension of 2,967 millimeters after cooling. The partly hot vee-belt set is then rapidly removed by means of a convenient device from the vulcanizing apparatus and placed in the second apparatus (FIG. 3) which consists of two grooved drums. One grooved drum can be adjusted along a millimeter scale to the desired length of vee-belt (3,000 millimeters) and fixed. The other grooved drum only moves 4–5 millimeters in the axial distance according to the expansion diagram of the cord, during the measuring process. In this case, with the standard load of 36 kilograms determined by German Standard DIN 2215, with the load on the set of 15 × 36 kilograms = 540 kilograms there is an axial distance of barely 3 millimeters.

If the vee-belts, under this standard load, attain the zero mark, after 3 millimeters expansion of the whole set, because they are, in part, still hot, they become cooled in the regularly recurring measuring rhythm. After cooling, the vee-belts are removed from the apparatus; they are now capable of being stored with a constant length. When measured individually they display in relation to one another no greater tolerance than ± 2 mm in length.

Length of belt in this example is therefore 2,998 – 3,002 millimeters.

German Standard DIN 2215 permits a batch tolerance of ± 4 millimeters, i.e., 2,996–3,004 mm.

Accordingly, with the method of manufacture which used the heat of vulcanizing for stabilizing the length by means of standard load, the vee-belts are much more accurate than is prescribed in the German Standard DIN sheet 2215. Even with a belt length of for example 17 × 5,000 millimeters, Vee-belts in accordance with the invention can keep to a tolerance of ± 2 millimeters, which compared with DIN 2215 at 5,000 millimeters is much more accurate, by ± 6.25 mm. Hence it is possible to deliver sets from stock without checking the measurements.

I claim:

1. In a method for forming a plurality of vee-belts of uniform length, each belt including a tensile member of elastically-contractile polyester material which contracts on heating, the improvement comprising the steps of subjecting each said Vee-belt, after passage through thermal vulcanizing apparatus in an unstressed condition in which initial vulcanization is effected, to a thermal vulcanizing step while tensioned by an amount which offsets the contraction of the tensile member resulting from the initial vulcanizing step, immediately thereafter placing the belt under a load which is sufficient to prevent its contraction due to cooling and cause a slow expansion of the belt while still hot, stretching the belt by an amount to bring it to its desired length, and cooling the belt to stabilize it at the said desired length.

2. In a method for bringing an initially partially, thermally-vulcanized vee-belt to its desired length, said vee-belt including a tensile member of polyester material which contracts elastically with increasing temperature, the steps of further thermally-vulcanizing the partially-vulcanized belt while tensioned for a time sufficient to compensate for the contraction caused by the initial partial thermal-vulcanization, and immediately placing the hot belt under a tension caused by a load sufficient to prevent its contraction due to cooling and cause a slow expansion of the belt while still hot in order to stretch the belt to bring it to its desired, length, and cooling the belt to give a permanent set.

3. A method according to claim 1, wherein the vulcanization in the unstretched conditon takes place at 150° C.

4. In a method for producing a plurality of Vee-belts of uniform length, each belt including a tensile member of elastically-contractile polyester produced as a condensation product from the reaction of ethylene glycol and a substance selected from terephthalic acid and derivatives thereof and which has been formed into a textile filament, each filament being liable to contract on heating, embedded in a vehicle tire rubber mix, the improvement comprising the steps of subjecting each said Vee-belt to an initial thermal vulcanization while the

belts are in motion around spaced pulleys and substantially free of tension, subjecting each said Vee-belt to further thermal vulcanization while the belts are in motion around spaced pullys and under a tension such that on completion of the further vulcanization the contraction produced by the initial vulcanization has been offset, immediately thereafter placing each hot belt under a load for its dimensions which is sufficient to prevent contraction from the effects of cooling and allow a slow expansion of each belt while still hot, stretching each belt by an amount to bring it to the precise length which is desired, and immediately cooling the belts to room temperature to stabilize them at the said desired length.

5. A method of forming a plurality of vee-belts of uniform length, each belt composed of rubber material which encases a tensile member of elastically-contractile polyester material having the physical characteristic of contracting on heating, the method comprising the steps of:

Subjecting said belts to a first thermal vulcanizing cycle in an unstressed conditon whereby said rubber material of each belt is vulcanized with its tensile member located therein in its desired position and each said belt shrinks to less than its original length from the contraction of its tensile member;

Subjecting said belts to a second thermal vulcanizing cycle while applying sufficient tensile force thereto whereby said belts attain their original length in this second cycle;

While said belts are still hot, rotating same under a tension sufficient to prevent their contraction while cooling and cause slow expansion of the belts while still hot, and at the same time continually measuring the length of said belts; and

When said belts attain their original length, cooling said belts while continuing to rotate same; whereby each said belt has a permanent length within a tolerance of not greater than 0.067 percent variance of its original length.

* * * * *