Method for splicing of elastomeric belts.

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Description

The present invention relates to a method for rapid splicing of open-end, reinforced elastomeric belting into an endless belt, and to belts thus produced.

There are known various types of open-end belting which can be spliced, utilizing different means, requiring tooling of varying degrees of sophistication and complexity, and yielding a range of properties of the finished belt.

Thus, elastic belts have been utilized, comprised of various sections made of thermoplastic elastomers and spliced by butt-welding the two open ends together. Such belts are seriously restricted in their pull-force capabilities and exhibit undesirable creep and stretch. Also, similar belts were gripped, or with a hollow construction allowing the use of mechanical fasteners and inserts for belt splicing. Thus German Patent P2152215.6 (Woodward) describes a metallic shank to be inserted into both ends of a hollow belt for production of an emergency belt. Such joining means are highly unreliable, as the elastomeric material cannot adequately resist shank pull-out. Also, the hollow construction of the elastomeric belt further reduces its resistance to creep and stretch. Additionally, the shank introduces a very stiff section to the belt. In order to alleviate these drawbacks, belts have been proposed where tensile members are embedded within the body element of the belt. Such tensile members could be woven tape of synthetic fibers as in US Patent 4,366,014 (Pollard), or metallic cables as in US Patent 4,283,184 (Berg). In both cases, the body element comprises a thermoplastic elastomer such as polyurethane.

Major attempts were made to provide continuity in the pull capability of the belt in the splice area. Thus in the Berg patent a metallic bushing crimped on both ends of the steel cables is used for splicing. Durability of this type is very limited, however, due to concentration of stresses at the bushing end.

The Pollard patent suggests welding of both belting ends in such a way that the reinforcing tape of both belt ends overlap. This results in a stiff section that shortens belt life and also requires quite elaborate preparation and tooling, a tool being described which includes two clamping jaws adapted to firmly grip the end portions of the belt to be joined and movable relative to each other to bring the gripped portion of the belt into engagement, and at least one handle for causing said clamping jaws to move.

U.S. Patent 3,558,390 discloses another example of a method of splicing a reinforced plastic belt by means of a lap joint. In this case the ends of the belt are cut at an acute angle to the lengthwise direction of the belt before being overlapped and fused or bonded together. The ends of the reinforcement may be flush with the lapped ends of the belt or may be cut back therefrom.

However, while the method of butt-welding plastic belts appears to be most desirable due to simplicity, quickness and appearance of splice, it has so far not been possible to extend the method to longitudinally reinforced belting. Such belting, when butt-welded, breaks at the weld upon flexing due to concentration of stresses at the weld area, as the sections on either side of the weld are stiffer than the weld section. A method circumventing this drawback could provide belts for both power transmission and conveying applications for longer life ratings not possible with non-reinforced plastic belts.

It is thus an object of this invention to provide a method of splicing reinforced plastic belting in a quick and simple manner using a butt-joint and by which flexural stress concentrations in the splice region of the resulting endless belt are avoided.

To this end, the present invention provides a method of splicing an elastomeric belt having one or more reinforcing members extending in the lengthwise direction of the belt, wherein the or each reinforcing member is recessed at least one open end of the belt before the two end faces of the belt are joined to form an endless belt, characterized in that the end faces of the belt are substantially perpendicular to the lengthwise direction of the belt for producing a butt-joint, and the recessing of the or each reinforcing member is effected either by means of a pin which is substantially aligned with the reinforcing member and pushed into the end of the belt in the lengthwise direction of the reinforcing member or by means of a drill which is substantially aligned with the reinforcing member and which is advanced, relative to the reinforcing member, in the lengthwise direction thereof.

This method of splicing belting into endless belts is applicable to a wide variety of belting constructions, geometries and end uses. Thus belting intended for conveying as well as power transmission applications can be obtained utilizing this method.

The invention also provides a tool for use in splicing the ends of a length of elastomeric belt having one or more reinforcing members extending in the lengthwise direction thereof to produce an endless belt, comprising two clamping jaws adapted to firmly grip the end portions of the belt to be joined and movable relative to each other to bring the gripped portions of the belt into engagement, and at least one handle for causing said clamping jaws to move.
belt in the lengthwise direction of the reinforcing member to recess said member when said jaws are moved towards each other.

The invention will now be described further in connection with certain preferred embodiments with reference to the accompanying drawings so that it may be more fully understood.

With specific reference now to the figures in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice.

In the drawings:

Fig. 1 is a perspective view of a typical plastic V-belt, single-cord reinforced, that can be spliced by the method of this invention;

Fig. 2 is a perspective view of a typical plastic V-belt, reinforced by two cords and spliceable by the method of this invention;

Fig. 3 is a perspective view of a round belt axially reinforced;

Figs. 4a, b, c show examples of cross sections of cord-reinforced plastic belting that can be spliced by the method of this invention;

Fig. 5 is a perspective view of a flat belt with parallel longitudinal multi-cord reinforcements;

Fig. 6 is a perspective view of cogged, plastic V-belt with double-cord reinforcement;

Fig. 7 is a partial sectional of a cord reinforced plastic belt butt-joined at 90° without cord recessing;

Fig. 8 is similar to Fig. 7, but with a lapped joint;

Fig. 9 is a partial section of a belt spliced at 90° by the cord recess method of this invention;

Fig. 10 is a partial section of a belt spliced by the method of cord recessing with the addition of an insert;

Fig. 11 is a perspective view of a single-cord reinforced insert;

Fig. 12 is a perspective view of a chopped-fiber reinforced insert;

Fig. 13 is a perspective view of a braid-reinforced insert;

Fig. 14 is a perspective view of a welding iron for butt welding with an arrangement for an insert, and

Fig. 15 is a plan view of a pair of welding pliers with a detachable pin for reinforcement recessing.

Referring now to the drawings, there are seen in Figs. 1 and 6 some of the belts used in industry for both power transmission and conveying applications that can be spliced by the method according to the invention.

The body element 10 may consist of any elastomeric compound, of which typical ones are copolymers such as polyurethane, copolymers, polyblends such as mechanical blends of EPDM and polypropylene and many known rubbers. The matrix properties need to meet the demands on the belt as to hardness, stiffness, coefficient of friction, and chemical and environmental resistance. For example, a soft polyurethane of hardness of 75 to 100 Shore-A may be used in round belts in tile conveying lines, while harder grades ranging from 80 Shore-A to 72 Shore-D may be needed for power transmission in a V-belt.

Reinforcing members 11 are fully embedded in the belt body longitudinally and usually consist of twisted or braided cords of synthetic fibers such as polyester, aramids or others. Configurations may vary from a single to multiple cord arrangement located in various positions within the belt section.

The reinforcing member 11 is intended for carrying the tension loads of the belt in operation at low elongations. The body matrix forms the external contour to fit the pulleys and sheaves, provides the desired contact with conveyed products, and protects the cord from abrasion and environmental exposure. It also transmits the power from the drive pulley to the belt reinforcement and from the reinforcement to the driven pulleys or conveyed products. An additional important function of the belt body is to transmit forces through the splice zone. Attempts at simply butt and lap welding the belt ends are shown in Figs. 7 and 8. As can be seen in the drawings, the cord ends 21 and 22, pushed against each other, flare out and tend to reduce the effective joint area 23 and 24, thus reducing the pull force capability of the belt in the splice zone. A further detriment of such a splicing method is that the belt sections on both sides of the splice are stiffer than the splice section and therefore stresses are concentrated in tension and under flexing in the splice itself and dramatically shorten its life. The process of producing an endless belt according to the present invention starts with first cutting the welding to the required length. The reinforcing cords are then recessed at one or preferably both ends of the belt as shown in Fig. 9 to the appropriate depths a and b. This can be effected by pushing the cords into the belt with the aid of a tool shown in Fig. 15 and explained further below or, with non-metallic reinforcing members, using heated pins to push in and crumble the cord ends so as to better anchor them in the belt. Alternatively, recessing may be effected by drilling out the cord ends to the required depth. In whatever way this is done, new positions of ends 31 and 33 are formed, thus defining the length of the splice zone c as the distance between opposing ends of cords along the splice, that is c = a + b. After butt welding, distance c obviously shrinks to some extent.

The belt ends are then butt-joined together to form an endless belt. The method of butt joining may be selected to best suit the body material
properties and availability of tooling. Thus for thermoplastic materials fusion may be produced by such means as having both ends contact a hot plate, or with the aid of a jet of hot air, the use of ultrasonic welding, spin welding or any welding technology known to the art. It is also possible to fuse into the splice area a meltable electrode as is common in connecting ends of flat belting of thermoplastic body.

Another alternative for butt-joining is the use of adhesives, a method that is not restricted to thermoplastic materials and can include vulcanized rubber, cross-linked polyurethane and others.

An endless belt is thus formed, in which longitudinal reinforcements are present throughout its length with the exception of the splice area. The splice zone thus formed introduces a flexible section whose length can be predetermined, separating two sides of a stiffener construction. The resultant stresses developed upon flexing and tensioning will be much better distributed and reduces as compared to butt weld without recessed cords. Additionally, with cords recessed on both sides of the joint face 38, the peak values of stress obtained at the cord ends 31 and 33 will not be concentrated at the joint face 38, but rather at points along the homogeneous belt body matrix 39 and 40. Also, due to the cords being recessed, a substantially uninterrupted cross section is obtained at the welding area for maximum strength. Obviously attention must be paid not to unnecessarily increase the length of the splice zone c, as this contributes to an undesirable increase in belt stretch under tension. The parameters determining the adequate length of the splice zone will be explained hereunder.

The desirable length of the splice zone is determined by the relative flexural stiffness of the reinforced section and the non-reinforced splice zone. Further factors determining the stiffness to be expected in the belt are its eventual operating conditions such as flexing radii and tension loads.

The following specific examples will offer an understanding of the wide applicability of the method to diverse operating conditions of belts and intended end uses, and should not be construed as an exhaustive or limiting list of possibilities covered by this invention.

To first demonstrate a case of very moderate conditions, a conveyor belt is chosen of a round cross section of 8 mm in diameter. A thermoplastic polyurethane of Shore-A hardness 80 and reinforced with a twisted polyester cord of 15,000 denier along its center axis and intended for light use on pulleys of over 100 mm in diameter. As the stresses exerted in this case are rather low and the extremely elastic nature of the belt body material can easily tolerate the flexing extensions, only very shallow recesses will be required. A recess on either end of only 2 mm will suffice in this case, and has the main function of ensuring a full cross section at the joint. The belt ends are welded with the aid of a hot iron such as that shown in Fig. 14 and explained further below.

This belt is obviously quite limited in its capability to withstand tension loads due to the weak consistency of the belt body in the splice zone. Yet a belt thus spliced can transmit substantially higher loads than a similar belt without reinforcement, as the total stretch and creep are significantly reduced.

When higher tension loads have to be handled, such as in the case of a power-transmission V-belt, the obvious approach is to incorporate a higher modulus and strength in both the reinforcing members and the body material. Thus for a V-belt of classical size B intended for use over pulleys of 110 mm and operating at 25 m/sec while transmitting 2.2 KW, a caged V-section may be chosen, made of 67 Shore-D hardness polyester elastomer and two polyester cords of 55,000 denier each, longitudinally located in a horizontal plane as shown in Fig. 6. In such a case, a regular butt-welded joint without cord recessing would result in the joint snapping upon flexing. It was found that such a design and operating conditions demand a minimum cord recess of 4 mm on either side. A belt with 10 mm recess on each side was found to perform satisfactorily both with respect to power transmission capability and belt life.

In a different embodiment of this invention, inserts 51 may be introduced into the cavities formed by the cord recess, as schematically illustrated in Fig. 10, prior to butt joining the two belt ends. Different forms of such inserts are shown in Figs. 11 to 13. In general, the insert 51 is of a construction that exhibits higher stiffness than the belt body material of equivalent diameter. The insert reduces stress concentration at the joint and shifts the points of peak stress towards the cord ends. Stress distribution is affected by selection of the insert according to its stiffness and length.

Stiffer inserts may be provided by use of stiffer elastomers or other material, by reinforcing an elastomeric shank with longitudinal cords as in Fig. 11 or with cored fibers as in Fig. 12, or using a braided elastomer as in Fig. 13. The external surface of the insert can be either smooth or it may be fluted or ribbed for better mechanical grip in the belt body. In another configuration, the inserts may be made of a semi-rigid or even rigid material, having a number of circumferential ridges of a sawtooth-like cross section oriented in such a way as to facilitate introduction into the recessed belt ends, while offering considerable resistance to extraction therefrom.

Fig. 14 shows a simple butt-welding tool, consisting of a thermally insulated handle 60 and a heatable plate 61 in which there is provided a slot 62 for the insert to pass through. When the belt ends, pressed from both sides against the hot plate 61, begin to fuse, the tool is rapidly withdrawn and the ends are pushed one against the other, producing the joint.

Another tool for carrying out the method according to the invention is illustrated in Fig. 15. This is a pair of pliers comprising handles 70,
clamping jaws 71 to rigidly hold the belt ends,  
and a recessing pin 72 which can be gripped in  
one of the jaws 71 and is used to push back the  
reinforcing member 11 first in one belt end, then  
in the other. This having been accomplished, the  
pin 72 is removed, and the second belt end  
mounted in its place. The insert 51 (if an insert is  
used) is introduced into both belt ends, and a  
welding tool (e.g. such as shown in Fig. 14 is  
applied). At the proper moment the butt-welding  
tool is withdrawn and, by operating the handles  
70, the jaws 71 and, thereby, the fixedly held belt  
ends, are forced one against the other, producing  
the joint. Guide bars 73 keep the jaws 71 and,  
thus, the clamped belt ends, in alignment, even  
in the absence of an insert 51 which has a certain  
aligining effect, at least for round belts.  
It would also be possible to make the heatable  
butt-welding plate an integral part of the pilers.  
It will be evident to those skilled in the art that  
the invention is not limited to the details of the  
foregoing illustrative embodiments and that the  
present invention may be embodied in other  
specific forms without departing from the spirit  
or essential attributes thereof. The present  
embodiments are therefore to be considered in  
all respects as illustrative and not restrictive,  
the scope of the invention being indicated by the  
appended claims rather than by the foregoing  
description, and all changes which come within  
the meaning and range of equivalency of the  
claims are therefore intended to be embraced  
therein.

Claims

1. A method of splicing an elastomeric belt (10)  
having one or more reinforcing members (11)  
extending in the lengthwise direction of the belt  
(10), wherein the or each reinforcing member  
(11) is recessed (31, 33) at least one open end  
of the belt (10) before the two end faces of the  
belt are joined (38) to form an endless belt,  
characterized in that the end faces of the belt are  
substantially perpendicular to the lengthwise  
direction of the belt for producing a butt-joint,  
and the recessing of the or each reinforcing  
member (11) is effected by means of a drill which  
is substantially aligned with the reinforcing  
member and which is advanced, relative to the  
reinforcing member, in the lengthwise direction  
thereof.

4. A method as claimed in claim 1 or claim 3, in  
which the or each reinforcing member (11) is a  
cord or woven tape of relatively high tensile  
strength.

5. A method as claimed in claim 1 or claim 3, in  
which an insert (51) is introduced into the  
recesses produced in the ends of the belt by the  
recessing of the reinforcing members (11), prior  
to the butt-joining of the belt ends.

6. A method as claimed in any one of claims 1  
to 5, in which the butt-joining is performed by  
heat-fusion of the abutting belt ends.

7. A method as claimed in any one of claims 1  
to 5, in which the butt-joining is performed by  
application of adhesives.

8. A tool for use in splicing the ends of a length  
of elastomeric belt (10) having one or more  
reinforcing members (11) extending in the  
lengthwise direction thereof to produce an end-
less belt by a method according to claim 1,  
comprising two clamping jaws (71) adapted to  
firmly grip the end portions of the belt to be  
joined and movable relative to each other to  
bring the gripped portions of the belt into  
engagement, and at least one handle (70) for  
causing said clamping jaws to move, charac-
terised in that the clamping jaws (71) are  
arranged to hold the end portions of the belt in  
alignment with each other for butt-joining the  
end faces thereof, and in that the tool includes  
guide means (73) which act on at least one of  
said clamping jaws (71) to ensure continuous  
alignment of said belt portions during movement  
of said clamping jaws with the belt portions  
gripped therein, and a recessing pin (72) attach-
able to one of said jaws instead of one end  
portion of the belt, said pin being attached in  
alignment with a reinforcing member in the end  
portion of the belt gripped in the other jaw  
whereby said pin is pushed into the end of the  
belt in the lengthwise direction of the reinforcing  
member to recess said member when said jaws  
are moved towards each other.

Patentansprüche

1. Verfahren zum Verbinden eines elastomeren  
Riemens (10), der ein oder mehrere Armierungs-
elemente (11) aufweist, die sich in Längsrichtung  
des Riemens (10) erstrecken, wobei das oder  
jedes Armierungsselement (11) an wenigstens  
einem offenen Ende des Riemens (10) vor dem  
Verbinden (38) der beiden Stirnseiten des Rie-
mens zur Bildung eines endlessen Riemens  
zugrükgesetzt wird (31, 33) dadurch gekennzeichnet,  
dafs die Stirnseiten des Riemens im wesent-
lichen senkrecht zur Längsrichtung des Riemens  
verlaufen, um eine stumpfe Verbindung zu bil-
den, und daafs die Zurücksetzung des oder jedes  
Armierungsselements (11) mittels eines Stiftes
1. Procédé pour la mise sans fin d’une courroie (10) en élastomère possédant un ou plusieurs éléments d’armature (11) s’étendant dans le sens de la longueur de la courroie (10), selon lequel on enlève (31, 33) l’élément ou chaque élément d’armature (11) à au moins une extrémité de la longueur de courroie (10), avant d’assembler (38) les deux faces d’extrémité de cette longueur en la transformant ainsi en une courroie sans fin, caractérisé en ce que les faces d’extrémité de la courroie sont sensiblement perpendiculaires à la direction longitudinale de la courroie, en vue de la réalisation d’un joint droit, et où on enlève l’élément ou chaque élément d’armature (11) sur une certaine longueur au moyen d’une tige (72) qui est sensiblement alignée avec l’élément d’armature (11) et est enfoncée dans l’extrémité de la courroie dans le sens de la longueur de l’élément d’armature.

2. Procédé selon la revendication 1, dans lequel on chauffe la tige (72).

3. Procédé pour la mise sans fin d’une courroie (10) en élastomère possédant un ou plusieurs éléments d’armature (11) s’étendant dans le sens de la longueur de la courroie (10), selon lequel on enlève (31, 33) l’élément ou chaque élément d’armature (11) à au moins une extrémité de la longueur de courroie (10), avant d’assembler (38) les deux faces d’extrémité de cette longueur en la transformant ainsi en une courroie sans fin, caractérisé en ce que les faces d’extrémité de la courroie sont sensiblement perpendiculaires à la direction longitudinale de la courroie, en vue de la réalisation d’un joint droit, et où on enlève l’élément ou chaque élément d’armature (11) sur une certaine longueur au moyen d’un foret qui est sensiblement aligné avec l’élément d’armature et est avancé, par rapport à l’élément d’armature, dans le sens de la longueur de cet élément.

4. Procédé selon la revendication 1 ou 3, dans lequel l’élément ou chaque élément d’armature (11) est une corde, un câble ou un ruban tissé ayant une résistance à la traction relativement élevée.

5. Procédé selon la revendication 1 ou 3, dans lequel une pièce (51) est insérée, prêlablement à la jonction bout à bout des extrémités de la longueur de courroie, dans les cavités formées dans ces extrémités par l’enlèvement de l’élément ou de chaque élément d’armature (11) sur une certaine longueur.

6. Procédé selon l’une quelconque des revendications 1 à 5, dans lequel on produit la jonction
bout à bout en faisant fondre, sous l’effet de la chaleur, les extrémités de courroie à assembler.

7. Procédé selon l’une quelconque des revendications 1 à 5, dans lequel on produit la jonction bout à bout par l’application d’adhésifs.

8. Outil pour assembler les extrémités d’une longueur de courroie (10) en élastomère possédant un ou plusieurs éléments d’armature (11) s’étendant dans le sens de sa longueur, afin de produire une courroie sans fin selon le procédé de la revendication 1, outil qui comprend deux mâchoires de serrage (71) conçues pour saisir fermement les extrémités de courroie à assembler, les mâchoires étant déplaçables l’une par rapport à l’autre pour amener les extrémités de courroie en contact l’une avec l’autre, ainsi qu’au moins un manche (70) pour déplacer les mâchoires, caractérisé en ce que les mâchoires (71) sont agencées pour maintenir les extrémités de courroie mutuellement alignées en vue de la réalisation d’un joint droit entre leurs faces d’extrémité, et que l’outil comporte des moyens de guidage (73) qui agissent sur au moins l’une des mâchoires (71) pour assurer que les extrémités de la courroie restent alignées pendant que les mâchoires tenant ces extrémités sont déplacées, et une tige d’enlèvement (72) susceptible d’être attachée à l’une des mâchoires à la place d’une extrémité de courroie, la tige étant attachée en alignement avec un élément d’armature contenu dans l’extrémité de courroie tenue par l’autre mâchoire, de sorte que la tige est enfoncée dans cette extrémité de courroie, dans le sens de la longueur de l’élément d’armature, pour enlever cet élément sur une certaine longueur lorsque les mâchoires sont approchées l’une de l’autre.