(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 497 451 A2

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: **92300148.1**

(22) Date of filing: **08.01.92**

(51) Int. Cl.[5]: **B24D 3/00**, B24D 11/06, B29C 65/42, //B29L29:00

(30) Priority: **30.01.91 GB 9102035**

(43) Date of publication of application: **05.08.92 Bulletin 92/32**

(84) Designated Contracting States: **DE FR GB IT**

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(54) **Abrasive belts and their manufacture.**

(57) The invention discloses a method of preparing endless abrasive belts by butt joining an elongate strip without the use of reinforcing patches or the like. The invention utilises a flexible support in conjunction with a layer of hot-melt adhesive which is caused to form a continuous layer within the region of the butt joint which possesses sufficient strength to ensure the integrity of the belt during its use.

EP 0 497 451 A2

This invention relates to abrasive belts and to their manufacture. In particular, this invention relates to a method of splicing the ends of strips of abrasive coated material to produce abrasive belts.

Abrasive belts are manufactured by joining (splicing) together the two free ends of an elongate strip of material coated with an abrasive to form an endless belt. Two types of joint are commonly used to splice together the ends of the material known as the 'lap splice' and the 'butt splice'.

A lap splice is formed by removing the abrasive layer from one end of the strip of material (skiving) or in some cases from both ends of the material (double skiving), coating one or both ends with a suitable adhesive and overlapping them to form the splice. The preparation of lap splices is disclosed in U.S. Patent Specification Nos. 1,009,709, 2,445,807, 3,037,852 and 3,643,387.

British Patent Specification No. 1340598 discloses a method of lap-slicing abrasive materials, in which the two free ends of the material are each bevelled so as to be complementary to the other, in practise necessitating the removal of the make-abrasive from one end, and then overlapped to form the splice. A slab of an adhesive composition is sandwiched between the two ends which are then heated under pressure so as to cause the adhesive to flow into contact with all the surfaces of the joint.

Lap splices are always somewhat stiffer than the rest of the belt, a condition which predisposes them to failure by delamination when the belt is in use. Moreover, such splices are slightly thicker than the rest of the belt which causes it to "bump" or "chatter" during use which is particularly aggravating for the machine operator. Furthermore, such belts are recommended to be run in one direction to minimise the chances of snagging the uppermost layer.

The "butt splice" is a joint in which the free ends of the belt are brought together without overlapping and secured, usually by means of a patch or strip of material over the ends of the belt on the non-abrasive side. Examples of such joints are disclosed in U.S. Patent Specification Nos. 766,930, 1,588,255, 1,728,673, 2,391,731, 2,733,181, 2,794,726, 3,154,897, 3,402,514 and 3,427,765.

British Patent Specification No. 1492789 discloses a method of forming a reinforced butt-splice for an abrasive belt, in which the two free ends of a strip of abrasive-coated material are brought together without overlapping and secured by means of a reinforcing patch. The patch is affixed over the two ends on the non-abrasive side of the belt. The patch comprises a laminate of a woven fabric layer and a layer of a heat-resistant plastics material which is glued across the joint. The reinforcing patch is normally prepared by gluing the fabric and plastics layer together, although the two may also be heat fused.

British Patent Publication No. 2232636 discloses another method of forming a reinforced butt-splice for endless abrasive belts, in which the two free ends of the strip of abrasive-coated material are brought together without overlapping, and secured by means of a "bonding layer". The bonding layer comprises a reinforced backing layer, typically a sheet of a plastics material with a fibrous reinforcement bonded thereto, which is coated or impregnated with a hot-melt adhesive. The bonding layer is affixed over the two ends on the non-abrasive side of the belt and heat applied to promote bonding.

Although abrasive belts incorporating butt splices can be run in either direction, they still suffer from many of the disadvantages inherent in belts incorporating lap splices. For example, the reinforcing material produces a raised area over the join which causes premature loss of abrasive in that region and also the formation of grooves in the workpiece which will tend to mar the same. Moreover, such joints tend to wear out at the end portions causing them to split and pull away from each other under the stresses and strains to which the belts are subjected to in use. This is a particular problem when sanding and polishing hard substances, such as glass, marble, granite etc. Furthermore, the raised area of a reinforced butt splice still causes the belt to "bump" and "chatter" when used on abrading machines comprising a back support platen or wheel.

U.S. Patent Specification No. 3,333,372 discloses an abrasive belt comprising:

a flexible base sheet including an inner surface and an outer surface,

a layer of finely divided abrasive particles adhesively secured to the outer surface,

the flexible base sheet having end portions abutting each other to form a closed, continuous loop,

a film of flexible adhesive material on the inner surface of the flexible base sheet, and

a reinforcing film of a tough, flexible reinforcing material bonded to the adhesive film on the inner surface of the latter, the flexible reinforcing film comprising a material selected from the group of film-forming materials consisting of poly(ethylene terephthalate) and vulcanised fibre, the flexible base sheet having a joint with abutting end portions cut at an angle of about 45° relative to the side edges of the flexible base sheet, and the reinforcing film having a fused joint spaced longitudinally from the first joint and with abutting end portions cut at acute angles relative to the side edges thereof. The integrity of the belt is derived from the presence of the fused joint formed in the reinforcing film. The base sheet and adhesive material do not contribute significantly to the mechanical strength of the belt. Moreover, the use of heat to fuse the free ends of the poly(ethylene terephthalate) or vulcanised fibre reinforcing film may produce a somewhat brittle joint which is prone to shear and split during use.

The present invention seeks to provide an alternative method for splicing the ends of a strip of abrasive coated material in the manufacture of endless abrasive belts.

According to one aspect of the present invention there is provided a method of making an endless abrasive belt comprising an abrasive layer supported on a flexible backing material, which flexible backing material comprises a flexible support and a layer of hot-melt adhesive, the method comprising the steps of:

(a) forming complementary ends on an elongate strip of said flexible backing material,
(b) placing said complementary ends in abutting engagement,
(c) applying pressure and heat over the area of the abutting ends sufficient to cause the hot-melt adhesive to flow across the abutment, and
(d) allowing said area to cool whereby the hot-melt adhesive forms a continuous layer over the abutting ends,

the layer of hot-melt adhesive having sufficient strength to maintain the integrity of the belt.

According to a further aspect of the present invention there is provided an endless abrasive belt comprising an abrasive layer supported on a flexible backing material, which flexible backing material comprises a flexible support and a layer of hot-melt adhesive and is formed from an elongate strip of said flexible support material having complementary ends in abutting engagement, the hot-melt adhesive forming a continuous layer over the abutting ends having sufficient strength to maintain the integrity of the belt.

The invention provides a simple and effective method of preparing an endless abrasive belt of substantially uniform thickness by butt joining an elongate strip without the use of reinforcing patches or the like. The invention utilises a flexible support in conjunction with a layer of hot-melt adhesive which is caused to form a continuous layer within the region of the butt joint and possesses sufficient strength to ensure the integrity of the belt during its use.

Abrasive belts formed with such a joint run equally well in either direction and are found to have a greatly extended working life when compared with abrasive belts of the prior art. The joint is easily fabricated and lends itself to the use of automated machinery. Moreover, as the joint has substantially the same thickness, density and flexibility as the remainder of the belt, abrasive belts incorporating such a joint are less prone to premature wear in the joint region, thereby avoiding the problem of marking the workpiece, and they do not "bump" or "chatter" during use.

The invention will now be described by way of example with reference to the accompanying drawings in which:

Figures 1 and 2 represent schematic illustrations of the manufacture of an abrasive belt in accordance with the invention, and

Figure 3 represents a plan view of the butt splice of an abrasive belt manufactured in accordance with the invention.

Referring to Figures 1 and 2 generally, the abrasive belt is formed from an elongate strip of an abrasive coated material (2) only the end portions (4 and 6) of which are shown. The abrasive coated material (2) comprises a flexible backing material (8) which, in the embodiment shown, comprises two flexible supports (10 and 12) sandwiching a layer (14) of a hot-melt adhesive and a layer (16) of an abrasive material. The layer (16) of abrasive material may be coated or laminated onto the flexible backing material (8) either prior to (as shown in Figure 1) or after formation of the butt splice (18) (as shown in Figure 2), the latter arrangement allowing the join (20) of the abrasive layer to be offset from the butt splice (18). In this manner, the structural integrity of the layer (16) of abrasive material may advantageously contribute to the overall strength of the butt splice (18).

In an alternative embodiment (not shown), the backing material (8) may comprise a single flexible support (12) bearing the adhesive layer (14) onto which is applied the layer (16) of abrasive material.

The flexible supports (10 and 12) of the backing material (8) may comprise any suitable material known in the art including both woven and nonwoven webs, papers, fabrics and cloths and polymeric films. The flexible supports (10 and 12) preferably comprise a web of a woven material.

The hot-melt adhesive is selected so that the melting temperature of the adhesive is above the operating temperature of the abrasive belt. For high temperature applications the hot-melt adhesive should have a melting point at or above 220°C, while for lower temperature applications, the melting point may be as low as 120°C. Polyester based adhesives are found to be particularly suitable for use in the present invention.

The backing material preferably comprises two flexible support layers sandwiching a layer of a hot melt adhesive. The backing material generally has a thickness in the range 0.5 to 2.5 mm, preferably 1.0 to 1.5 mm with a typical value of about 1.3 mm and a weight of from 0.5 to 2.5 kg/m$^2$, preferably 0.75 to 1.5 kg/m$^2$ with a typical value of about 1.15 kg/m$^2$.

A preferred backing material (8) is commercially available from Charles Walker & Co. Ltd., under the trade name BETALON TC13/NM and comprises two woven polyester/cotton sheets with a layer of a polyester hot-melt adhesive therebetween.

The layer (16) of abrasive material may comprise particles of abrasive mineral or grit embedded in one or more resin layers, but more preferably it comprises a layer of a mesh material onto which is electrodeposited a layer of a metal, e.g., nickel, into which are embedded particles of abrasive mineral. The coated mesh material is simply laminated onto the upper flexible support (10) of the backing material (8), or alternatively, in the case of a single layer backing, the adhesive layer (14).

The preparation of such electrodeposited abrasive layers is known in the art and disclosed, for example, in British Patent No. 2200920, European Patent No. 13486 and U.S. Patent Specification No. 4,256,467 amongst others. Generally, the abrasive layer is formed by laying a length of mesh material onto an electrically conducting surface and electrodepositing a metal onto the mesh material in the presence of an abrasive mineral such that the mineral becomes embedded in the metal. An insulating material is selectively applied to the mesh material before deposition of the metal layer so that the metal can only deposit onto the mesh in those areas not covered by the insulating material, thereby defining the pattern of the abrading surface.

In one method of making an electrodeposited abrasive layer, a mesh material in the form of a woven fabric of electrically insulating material such as nylon, cotton, terylene or the like is screen printed with insulating material in the form of ink. The ink is ordinarily waterproof and acid resistant and in its preferred form is colour fast at elevated working temperatures of the abrasive article, for example, up to approximately 220°C. The ink should be compatible with any hot-melt adhesive which may subsequently be applied to the abrasive layer to secure it to the backing material. The ink may be a resin based or oil based ink and coloured as desired.

The screen printing may be conducted by conventional screen printing techniques in such a manner to ensure that the ink penetrates into and is absorbed onto defined areas of the mesh material leaving discrete areas without any insulating material which defines the abrasive surface. Such discrete areas may be of any convenient shape and size, e.g., circular, diamond-shaped, rectangular etc.

The abrasive layer is adhered to the backing material by applying a layer of adhesive to either the abrasive layer or the backing material and heating the adhesive to adhere the abrasive layer to the backing.

In another method the ink may be combined with an adhesive and screen printed onto the mesh material. The metal is deposited, as described previously, and the resulting abrasive layer applied to the backing material by heating the abrasive layer to melt the adhesive content of the insulating material, thereby adhering the backing material to the abrasive layer.

In another method, instead of the insulating material being an ink or an ink and adhesive combination, adhesive only may be used as the insulating material. In this case, the adhesive may be in the form of a sheet which is applied to the mesh material before electrodeposition. Usually the adhesive sheet will be perforated and thereby formed with a plurality of openings of the desired shape and size before application to the mesh material. Preferably, this perforation will be by cutting out the openings from the sheet by any convenient means.

The adhesive sheet is then heated when in contact with the mesh material and pressure is applied to cause the adhesive to absorb and enter the spaces in the mesh material. When fully penetrated the mesh material is cooled.

The mesh material is then electrodeposited with metal and abrasive as described previously.

The resulting abrasive layer has adhesive at both sides of the mesh material and surrounding the metal areas and can be readily adhered to the backing material by applying the backing material to the rear surface and heating to cause the adhesive to adhere the mesh material to the backing material.

The adhesive is preferably a hot-melt adhesive which is acid resistant and water repellant.

Again, for high temperature applications, the adhesive should have a melting point above the working temperature, e.g., about 220°C and for lower temperature applications the melting point may be as low as 120°C. A polyester based hot-melt film adhesive has been found to be suitable for use in this method.

The abrasive mineral may be of any particle size useful for coated abrasive belts including flint, cork, vermiculite, quartz, garnet, silicon carbide, diamond, cubic boron nitride, alumina etc.

The butt splice (18) is fabricated by bringing the two ends (4 and 6) of the elongate strip of material (2) into abutting engagement and securing them in position. The two ends (4 and 6) are heated to a temperature sufficient to melt the adhesive in the region immediately adjacent to the line of abutment and sufficient pressure applied to cause the melted adhesive to flow across the joint (and between each end (4 and 6)). The ends (4 and 6) are then cooled while continuing to maintain the pressure applied thereto so that the adhesive forms a continuous film or layer (14) across the splice (18). This gives a strong join having no significant variation in its thickness or flexibility when compared with the remainder of the belt. An abrasive belt formed in this manner has an improved action and an extended working life when compared with abrasive belts of the prior art.

The complementary ends (4 and 6) of the elongate strip of abrasive coated material (2) are preferably cut in such a manner that the length of the abutting edges is greater than the width of the belt. This may be achieved by simply cutting the ends at an angle to the longitudinal axis of the elongate strip of material or more preferably by forming the ends with a plurality of complementary and interengaging tapered fingers, e.g., as shown by the sawtooth pattern (22) depicted in Figure 3 or the interlocking projections or tongues disclosed in U.S. Patent Specification Nos. 766,930 and 1,588,255. The ends are preferably cut so that the length of the abutting edges is at least three times the width of the elongate strip and more preferably at least five times the width of the elongate strip.

"BETALON" is a registered trade mark of Charles Walker & Co. Ltd.

## Claims

**1.** A method of making an endless abrasive belt comprising an abrasive layer supported on a flexible backing material, which flexible backing material comprises a flexible support and a layer of hot-melt adhesive, the method comprising the steps of:

(a) forming complementary ends on an elongate strip of said flexible backing material,

(b) placing said complementary ends in abutting engagement,

(c) applying pressure and heat over the area of the abutting ends sufficient to cause the hot-melt adhesive to flow across the abutment, and

(d) allowing said area to cool whereby the hot-melt adhesive forms a continuous layer over the abutting ends,

the layer of hot-melt adhesive having sufficient strength to maintain the integrity of the belt.

**2.** A method as claimed in Claim 1 in which the flexible backing material comprises two flexible support layers with the layer of hot-melt adhesive between said support layers.

**3.** A method as claimed in Claim 1 or Claim 2 in which the complementary ends of the strip of backing material are formed such that the length of the abutting edges is at least three times the width of the elongate strip.

**4.** A method as claimed in any one of Claims 1 to 3 in which the complementary ends comprise a plurality of tapered fingers or other interlocking portions.

**5.** A method as claimed in any preceding Claim in which the abrasive layer is applied after step (d) as a strip having complementary ends which are placed in abutting engagement.

**6.** A method as claimed in any preceding Claim in which the abrasive layer is provided with complementary ends either coterminous with the flexible backing material or spaced longitudinally round the belt from those of the flexible backing material.

**7.** A method as claimed in any preceding Claim in which the abrasive layer comprises a mesh of material bearing abrasive particles embedded in a metal.

**8.** An endless abrasive belt comprising an abrasive layer supported on a flexible backing material, which flexible backing material comprises a flexible support and a layer of hot-melt adhesive and is formed from an elongate strip of said flexible support material having complementary ends in abutting engagement, the hot-melt adhesive forming a continuous layer over the abutting ends, the layer of hot-melt adhesive having sufficient strength to maintain the integrity of the belt.

**9.** An endless abrasive belt as claimed in Claim 8 in which the flexible backing material comprises two flexible support layers with the layer of hot-melt adhesive between said layers.

**10.** An endless abrasive belt as claimed in Claim 8 or Claim 9 in which the complementary ends of the strip of backing material are formed such that the length of the abutting edges is at least three times the width of the elongate strip.

**11.** An endless abrasive belt as claimed in any one of Claims 8 to 10 in which the complementary ends comprise a plurality of tapered fingers or other interlocking portions.

**12.** An endless abrasive belt as claimed in any one of Claims 8 to 11 in which the abrasive layer is provided with complementary ends either co-terminous with the flexible backing material or spaced longitudinally from those of the flexible backing material.

**13.** An endless abrasive belt as claimed in any one of Claims 8 to 12 in which the abrasive layer comprises a mesh of material bearing abrasive particles embedded in a metal and secured to the flexible backing material by an adhesive.

FIGURE 1

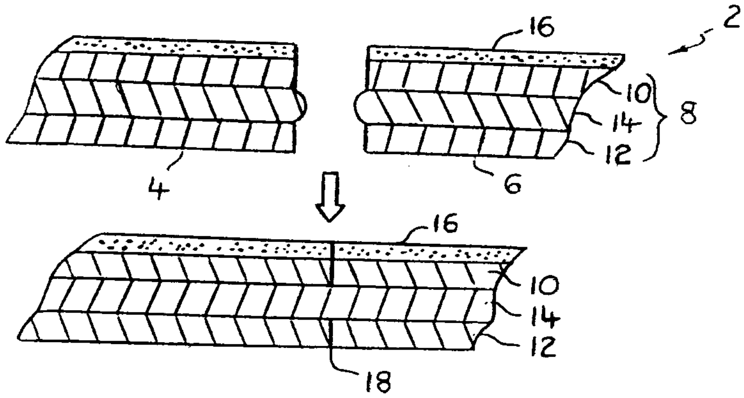


FIGURE 2

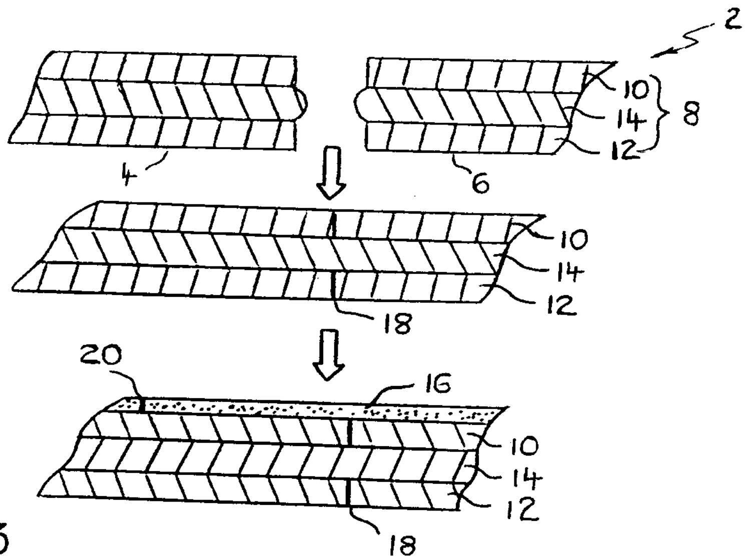


FIGURE 3