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[54] **COATED ABRASIVE BELT JOINT**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. Nos. 822,934, May 8, 1969, abandoned, and Ser. No. 103,148, Dec. 31, 1970, abandoned.

[52] **U.S. Cl.** **51/399**, 51/293

[51] **Int. Cl.** **B24d 11/06**

[58] **Field of Search** 51/293, 399

[56] **References Cited**

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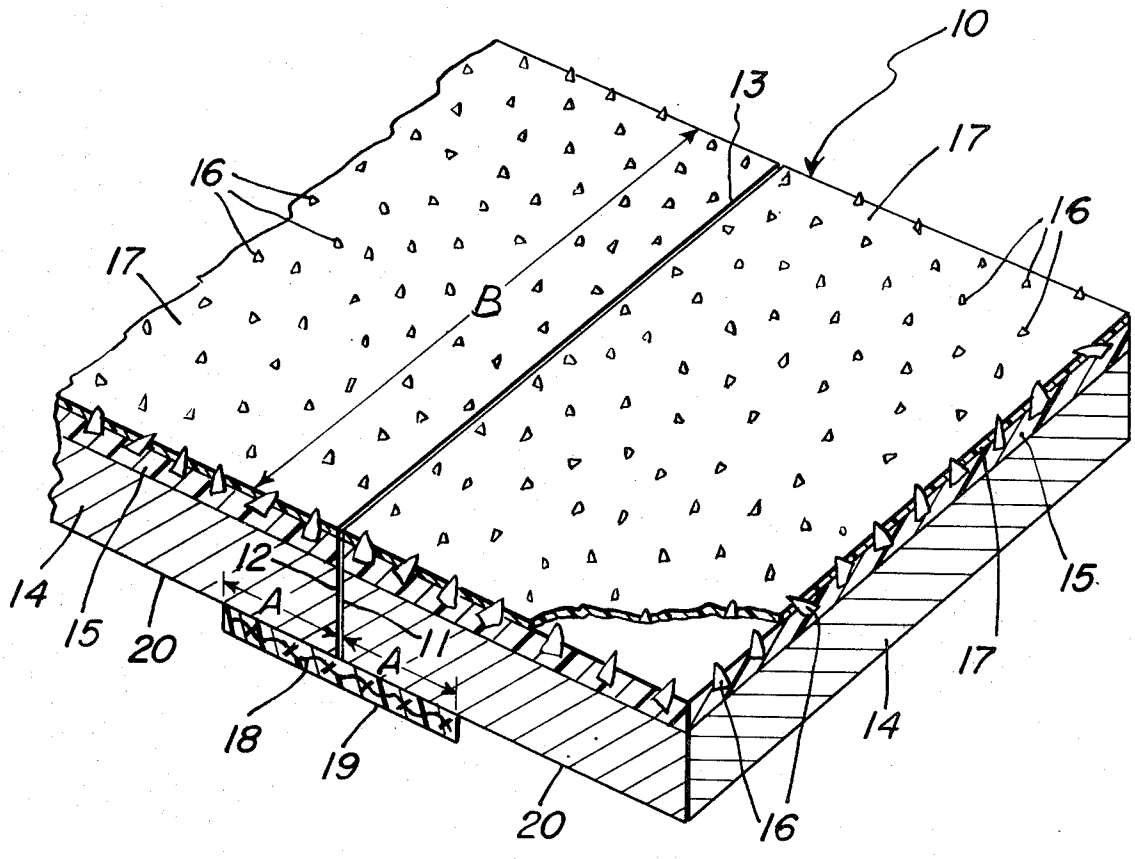
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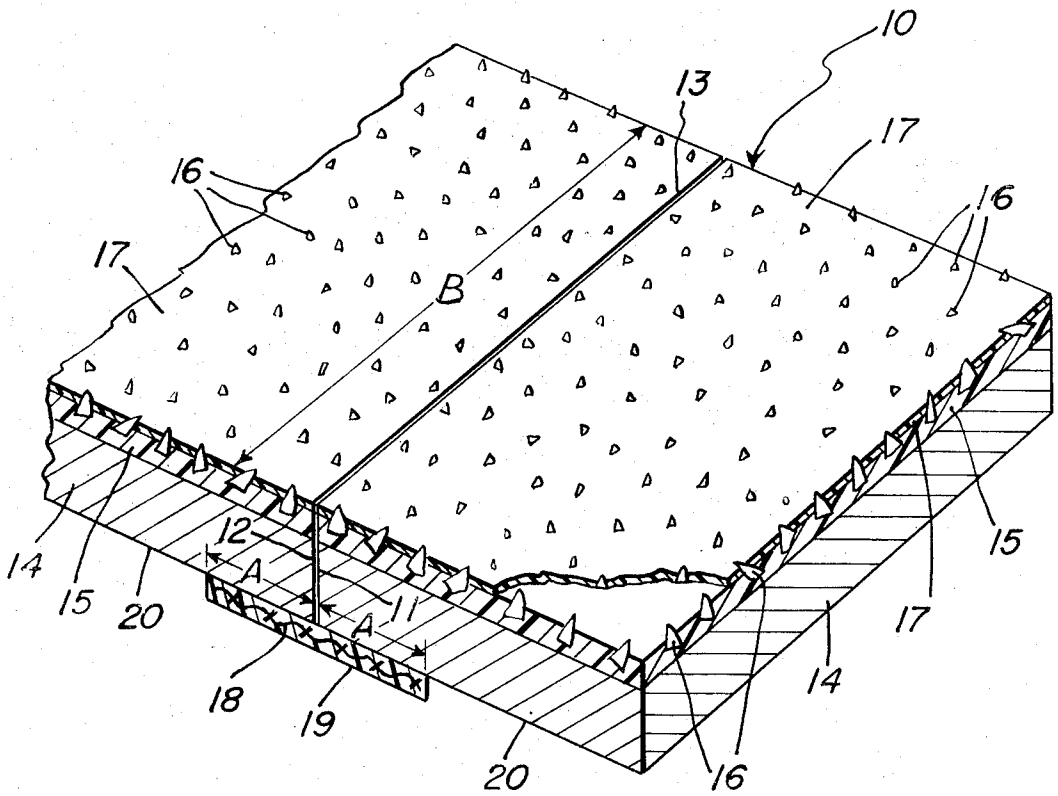
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[57] **ABSTRACT**

A butt joint is provided in coated abrasive material in which the abutting ends are joined together by means of an adhesive layer reinforced with a patch woven from man-made fibers of high tensil strength, the preferred butt joint being not only of higher tensile strength initially than the coated abrasive material but retaining this high tensile strength in usage to a high degree.

40 Claims, 1 Drawing Figure




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COATED ABRASIVE BELT JOINT

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of application Ser. No. 822,934 filed May 8, 1969, now abandoned, and application Ser. No. 103,148 filed Dec. 31, 1970 now abandoned.

BACKGROUND OF THE INVENTION

1. Field of Invention

The present invention relates to the art of joining and, in particular, to the joining together of two free ends of flexible coated abrasive material. Even more particularly, it relates to endless coated abrasive belts and their manner of manufacture.

2. Description of the Prior Art

Although coated abrasive belts having butt joints therein have been used for some time in the coated abrasive industry and these belts have been used relatively extensively in certain applications, particularly where fine finishes are required, abrasive belts having such a joint have found substantially minor usage compared with coated abrasive belts formed with a lap joint.

In a lap joint, contrasted to a butt joint, the ends of a segment of coated abrasive material forming the belt overlie, or lap, one another. These overlying ends, or at least one of them, is usually tapered so as to provide a joint approximating the thickness of the coated abrasive material. Moreover, in most cases the abrasive ends are backrubbed thereby to provide for better adhesion. Traditionally, a lap joint in a coated abrasive belt has been considered stronger than a butt joint and, as indicated, has been much more widely used in belt formation despite the tendency of such a belt during use to bump and cause marking of the work piece due to the somewhat necessarily thicker area of the joint relative to the rest of the coated abrasive material.

Butt joints, on the other hand, are formed by butting together two free ends or the like of coated abrasive material and thereafter securing these ends together in some fashion, usually by means of an adhesive. Over the years, various attempts have been made to improve on these joints and, for the most part, these attempts have involved basically some sort of reinforcing material in combination with an adhesive. Exemplary of the prior art involving butt joints are U.S. Pat. Nos. 1,588,255; 1,728,673; 2,391,731; 2,733,181; 2,794,726; 3,154,897; 3,427,765; and 3,402,514. Although some of the coated abrasive belt joints disclosed in the prior art may be found satisfactory in certain applications, none of them, to my knowledge, has been found totally satisfactory. In particular, they have not, it is believed, resulted in coated abrasive belts having the desirable physical characteristics, for example, resistance to flex fatigue and joint tensile strength, found in the butt joint of my invention.

SUMMARY OF THE INVENTION

In its basic aspects, the present invention involves a butt joint in coated abrasive material, e.g., an endless belt, wherein, in the preferred joint, the joint tensile strength initially exceeds that of the coated abrasive material joined, and during use, it retains this tensile strength to a high degree. That such a joint is obtained with my invention may be shown by subjecting joints

manufactured in accordance with the invention to conditions of controlled flexing. The joint tensile strength will be found to still be a high percentage of that tensile strength determined initially.

A joint in accordance with the invention is made possible by incorporating therein, in combination with a suitable adhesive, a reinforcing material having unique physical properties. This reinforcing material is of man-made fibers and, in the most preferred embodiment of my invention, is woven from man-made fibrous yarns of certain polyamides.

Quite unexpectedly, it is believed, the butt joints of my invention not only possess desirable resistance to flexural fatigue and high joint tensile strength but coated abrasive belts in which such a joint is provided far out-perform any "lap-jointed" coated abrasive belt tested under actual operating conditions.

BRIEF DESCRIPTION OF THE DRAWING

In the sole FIGURE of the drawing there is shown, in exaggerated scale, a perspective view of a strip or segment of coated abrasive material butt-jointed in accordance with the present invention.

DETAILED DESCRIPTION OF THE DRAWING AND THE PREFERRED EMBODIMENTS

Turning now to the drawing, there is disclosed therein a strip of coated abrasive material **10** in which two free ends **11** and **12** thereof are abutted together and against one another to form a butt joint. Joint line **13**, resulting from the abutted ends **11, 12** is seen to extend laterally across the strip of coated abrasive material making a 90° angle with respect to the longitudinal direction thereof. However, it will be appreciated by those skilled in the coated abrasive art that such a joint line is conventionally, and may extend, if desired, in fact will preferably, at some angle less than 90° with respect to the longitudinal direction of the coated abrasive material. In general, one will find that the lower the joint line angle, the stronger the joint in tensile.

Coated abrasive material **10** is made up of a flexible backing member (usually cloth) **14** to the front side of which is adhered an adhesive layer **15** termed the maker coat. Embedded in maker coat **15** are a plurality of abrasive grains **16.** A layer **17** of the same or a different adhesive termed the size coat, may be provided or not, as desired, and as is conventional in the coated abrasive art. These two adhesive layers constitute the bond for the abrasive grain.

The joint assembly, in accordance with my invention, comprises ends **11** and **12** of the abrasive material **10** butted together, a layer **18** of adhesive which extends for a distance (A) on each side of joint line **13,** and an overlying woven reinforcing patch **19.** The reinforcing patch, described in greater detail below, is positioned on the back side **20** of the backing member **14** of abrasive material **10** and is embedded, at least partially, in the adhesive layer **18.**

Reinforcing patch **19,** it will be appreciated hereinafter, is the most critical component in the joint assembly. In its most preferred aspects, the patch will provide a joint in which the tensile strength initially, i.e., prior to any usage of the coated abrasive article incorporating the joint, exceeds that of the coated abrasive material and, moreover, during usage the tensile strength is retained to a substantial degree. Such a joint will have a joint tensile strength of at least 150 lbs./in. width and

after the joint is subjected to a controlled flexural fatigue test, as hereinafter described, of 10,000 cycles, of at least **50%** of that determined initially.

These requirements are met, it has been discovered, in utilizing reinforcing patches woven from high tensile strength man-made fibrous yarns and, in particular, those of certain polyamides. A highly suitable woven reinforcing patch comprises aromatic polyamide yarns which are available from E. I. du Pont de Nemours & Co. under the trade designation NOMEX. These polyamide yarns are described in their Technical Bulletin N-201 of October 1966.

The manner of manufacture of NOMEX aromatic polyamide, which is believed to be the reaction product of a phthalic acid (iso-or tere-) or the acid halide thereof with m- or p-phenylene diamine, is believed disclosed in U.S. Pat. Nos. 3,063,966 and 3,287,324. In general, and as disclosed in these patents, the manufacture of such a polyamide involves a relatively simple, straight forward manner of solution polymerization of two monomers, e.g., m- phenylene-diamine and isophthaloyl chloride. On the other hand, by properly selecting the reactants one may produce, instead, poly-p-phenyleneterephthalamide. In the last mentioned patent, the manner of manufacture of fibers of poly-meta-phenylene isopthalamide is specifically disclosed. A process for the dry spinning of these aromatic polyamides into fibers is also disclosed in U.S. Pat. No. 3,360,598 which issued on Dec. 26, 1967.

Although in the preferred embodiment of my invention, both the warp and fill yarns of woven reinforcing patch **19** are of NOMEX aromatic polyamide, the patch may comprise, if desired, either warp or fill yarns of an aromatic polyamide and the yarns in the other direction of weave some other suitable yarn material, for example, fibers of a high tenacity nylon polyamide. In this way, as will hereinafter become more obvious, one can still obtain the results desired from this invention, and at a somewhat lower manufacturing cost. However, the manner of positioning the reinforcing patch, described more fully below, becomes more critical to obtain the desired joint properties.

Reinforcing patch **19,** as shown in the drawing, is usually coextensive with adhesive layer **18** and, preferably, will extend at least 1/16 inch, and even more desirably at least ⅛ inch from joint line **13** on each side thereof and will run across the entire width (B) of the belt joint. However, in some instances, as hereinafter more fully explained, adhesive layer **18** may be, in fact will desirably be, noncoextensive with the reinforcing patch.

As pointed out in my earlier above-mentioned application, it is preferred that reinforcing patch **19** be applied over joint line **13** with the warp yarns of the patch extending approximately parallel to the edges of the coated abrasive material. However, where the fill yarns are the more desirable yarns, e.g., NOMEX aromatic polyamide, and the warp yarns are of some different material, it may be more desirable, as hereinafter made more clear, to have the fill yarns in this parallel position. Thus, as is believed obvious, where the joint line extends other than perpendicularly with respect to the longitudinal direction of the coated abrasive material, the reinforcing patch furnished must be cut on the bias, e.g., where the warp yarns are desired parallel, cut from the source material at the same angle with respect to its longitudinal direction as the angle of joint line **13.** The reinforcing patch, in case it is bias cut will be, of course, necessarily of some greater length than the width of the web of coated abrasive material.

In general, where it is desired to use a bias cut patch, a patch of suitable width and length is cut from a longitudinal web of reinforcing material at the desired bias angle. Reinforcing patches, however, can be provided continually for, e.g., a belt making operation, by cutting a plurality of strips of some desired width and bias angle, selvage to selvage, from the source material and adhesively splicing these strips of reinforcing material together into a more or less continuous strip. The continuous strip of reinforcing patch material is then wound into rolls of suitable length for use in the belt making operation after which, if desired, it may be slit into rolls of more suitable width, e.g., rolls ¾ inch wide. In the formation of, e.g., an endless belt, a suitable length of reinforcing patch material is withdrawn from the roll and cut after which it is applied to the coated abrasive material as hereinafter further described. Splices in the continuous strip must, of course, be removed as it is undesirable to use such a strip of reinforcing material in the formation of a joint.

Alternatively, a continuous strip of bias cut reinforcing material, and without undesirable splices therein, can be provided from a tubular woven fabric. Such a strip is provided, in general, by spirally slitting a tubular fabric into a strip or web of material of some desired width and bias angle. Subsequently, the bias cut web is wound into rolls of some desired length of material and may, if desired, be further slit into rolls of lesser width. This can be accomplished, for example, on a bias slitter commercially available from Lever Manufacturing Corporation of Paterson, New Jersey.

With a bias cut patch, as above-described, the warp or fill fibrous yarns, whichever desired, can always be aligned in the running direction of the abrasive material. Thus, where the adhesive used in the joint is elastomeric in nature, this will result in reduced elongation in the patch on application of force during usage of the abrasive material. The reinforcing patch, being so positioned, allows the joint to stretch along with the normal stretch of the coated abrasive backing member. Therefore, the elongation characteristics of the patch will more nearly approximate that of the coated abrasive material. In addition to this, a patch so positioned will always provide the greatest joint strength in that the desired high strength fibers will extend approximately parallel to the edges of the coated abrasive material and in the running direction thereof. A still further advantage results in that greater dimensional stability is obtained in having, for example, the warp yarns of the reinforcing patch parallel to the coated abrasive material edges.

A straight cut patch, i.e., one in which the patch is cut at 90° or 180° with respect to the longitudinal edge of the source of the patch material, is relatively easily distorted when used in a joint construction where the joint line angle is less than 90° and such a joint is subjected to tensile forces. Of course, as will be obvious, the closer the joint line angle approaches 90°, the more suitable a straight cut patch will become. In so-called "wide" belts, e.g., those 15 inches and over in width, the joint line angle is generally likely to be closer to 90° than in the case of narrower belts. A joint in accordance with the invention in such a belt will be found satisfactory, in particular in the wider belts, provided

the warp yarns, i.e., the high strength yarns, of the reinforcing patch are no more than about 20° off the running direction of the coated abrasive material. However, as will be evident, whether the reinforcing patch is straight cut or cut on the bias will be of lesser concern when a high modulus, or less elastomeric, adhesive is used in the joint.

Any adhesive composition which possesses the properties of providing adequate adhesion for the specific patch material of this invention and which, in addition, provides a tough, heat-resistant bond with the coated abrasive backing member material can be used in the practice of this invention. Typical of these types of adhesives are the phenolic resin adhesives, urea-formaldehyde resin adhesive, polyurethane resin and elastomeric adhesives, and epoxy resin adhesives. All of these adhesives are known to those in the coated abrasive art.

The adhesive composition may be applied to either the reinforcing patch or the back side of the coated abrasive material or both, if desired, in either liquid form or in the form of a dry, preformed, adhesive film. In the latter instance, the adhesive film may be, prior to assembly in the joint construction, laminated to the reinforcing patch.

Preferably, the reinforcing patch used in the joint of the present invention is pre-impregnated with a suitable adhesive composition and this adhesive composition is then dried or cured to an essentially tack-free condition prior to joint assembly. The adhesive composition used for pre-impregnation can be of the same or of a different composition than that used to make the actual joint, if desired. However, the pre-impregnating adhesive obviously needs to be of a compatible, heat-hardenable character. Merely by way of example, the pre-impregnant adhesive composition can be of the same composition as the joint bonding adhesive except in a more dilute form.

Impregnating the reinforcing patch will provide greater stability thereto thus enabling the patch material to be more readily handled without distortion. Additionally, and of great advantage, impregnation results in a more abrasion resistant patch and at the same time one that is stiffer, i.e., less flexible. This latter feature aids in reducing the hinging effect which in turn promotes joint failure through peeling.

After application of the adhesive composition, the coated abrasive ends are abutted together, and a reinforcing patch is positioned so as to bridge the abutted ends as shown in the drawing. Heat and pressure, depending on the abrasive material being joined, is usually then applied to the joint assembly — preferably in steps, e.g., a 20 second press at a low pressure, e.g., 90–300 psi, at 175° F.–335° F., preferably 240°–335° F. (bottom bar only) followed by at least one, sometimes two additional pressings, e.g., for from 10–20 secs., using a heated bar top and bottom. In the second pressing stage, the top bar and bottom bar are both heated to 240° F.–335° F. The pressure setting in these two final presses may be as high as 1.5 tons per inch of belt width. Even higher pressures, e.g., 2.0 tons or more, may be used, in some instances, if a thinner joint is desired. Although heat is generally used in the joining operation, a joint can be made satisfactorily without heat (high pressure) provided the adhesive layer has had a relatively low dwell time. As a result of the application of heat and pressure, the adhesive sets up to a tough state and intimately bonds the special reinforcing patch to both ends of the coated abrasive material. Thus, the reinforcing patch and adhesive, in combination, provides a joint which offers advantageous resistance to failure because of forces and temperatures on the coated abrasive material in the grinding operation.

The reinforcing patch must be sufficiently porous and so positioned in the completed joint that the adhesive will penetrate the weave (warp and fill yarns form interstices) of the patch to develop satisfactory adhesion. Although the patch can be applied directly on the surface of the backing member of the coated abrasive material so as to avoid undue weakening of the threads of the coated abrasive backing member, it may be desirable in some instances to roughen the back side or surface of the backing member to break up or remove backing treatment materials which may have been applied previously to the backing member. Where this is done, it may be found desirable, at least in some instances, to provide an adhesive layer which is non-coextensive with respect to, i.e., is wider than, the reinforcing patch. Thus, in use, the backing member of the coated abrasive material will be protected against grinding fluids in the joint area and more likely to resist flexural and other forces in use which have heretofore sometimes lead to premature failure.

The following examples will, it is believed, better illustrate my invention.

EXAMPLE 1

A number of reinforcing patches (¾ inch wide) were cut (45° bias) from a commercially available woven fabric of NOMEX aromatic polyamide continuous filament yarns. This fabric, available from Stern & Stern Textiles, Inc., of Hornell, New York under the trade designation HT-48, is a 2 × 2 chain weave fabric having a yarn count of 100 × 86.5. The NOMEX polyamide yarns are 200 denier. Physical properties of this reinforcing patch material are as follows:

Porosity	13.8 cu. ft./min./sq. ft.
Tear Strength	28 lbs. in warp direction 21 lbs. in cross direction
Tensile Strength	247 lbs./in. in warp direction 211 lbs./in. in cross direction
% Elongation	41% in warp direction 35% in cross direction
TABER Abrasion	75 cycles

The reinforcing patch has an average thickness of 0.0104 percent and weighs 5.05 ozs. per sq. yd.

Several of the patches were saturated, in a conventional dip and squeeze fashion, with a nylon-phenolic adhesive having the following composition:

COMPONENT	% By Weight
Elvamide **8061**	10.7
Thermosetting Phenolic Resin	6
Methanol	66.6
Water	16.7

(The nylon-phenolic adhesive composition is similar to that disclosed in U.S. Pat. No. 3,296,022. Elvamide 8061 is an ethyl alcohol/water mixture soluble nylon polyamide formed from the reaction of hexamethylene-diammonium adipate and hexamethylene-diammonium sebacate with caprolactam.)

After saturation, the wet impregnated reinforcing patches were dried and cured by heating them for ½

hour each at 160° F., 200° F., and 250° F., and for ¼ hour at 275° F. The dried, cured impregnant constituted about 10 percent by weight (dry) of the weight of the patch.

On testing, saturating is found to decrease the tensile strength of the reinforcing patch slightly, i.e., from 247 lbs./in. to 229 lbs./in. in the warp direction and from 211 lbs./in. to 208 lbs./in. in the cross direction. However, the elongation is improved to a slight degree, decreasing from 41 to 36 percent in the warp direction. Elongation in the cross or fill direction also shows a slight improvement dropping from 35 to 28 percent. Abrasion resistance, as measured by the TABER Abrasion Tester, shows a marked improvement, moving up from 75 cycles to 700 cycles.

EXAMPLE 2

A strip of conventional 60X RESINALL METALITE OPENKOTE coated abrasive material was provided of suitable length and the free ends thereof were cut to complement one another at an angle of 45° with respect to the lengthwise direction. The backside of the coated abrasive material was then back rubbed according to usual techniques. Afterwards, a layer of adhesive of the following composition was applied, by means of brushing, to the backside of the coated abrasive material and to a reinforcing patch of Example I which had not been impregnated:

COMPONENT	% By Weight
Bostik 7076	90.9
Mondur CB75	7.9
Dimethyl cocoamine catalyst	1.1

(Bostik 7076 is a hydroxyl-terminated polyurethane-polyester in acetone-toluene solvent (United Shoe Machinery Co.); and Mondur CB75 is a reaction product of toluene di-isocyanate and tri-methylol propane (Mobay Chemical Co.).)

The adhesive coated materials were then assembled, after a 45 minute dwell or open time, and subjected to curing conditions. Sufficient adhesive was applied to result in a dry adhesive film of about 1 mil thickness on both the patch and the coated abrasive material. Curing was accomplished in two cycles. In the first or pre-cure cycle, the assembly was heated under 300 psi pressure for 20 seconds at 240° F. (bottom bar only). Afterwards, the assembly was subjected to 2,10 sec. presses (2800 psi) at 240° F. (both bars heated).

The coated abrasive belt joint thus formed was then subjected to testing in an Instron Tensile Strength Tester to determine the joint tensile strength. Testing was conducted under a load of 500 lbs., a jaw speed of 1 inch/min., a chart speed of 5 inch/min., and a guage (distance between jaws) of 3 inch. Failure occurred in the coated abrasive material rather than in the joint per se indicating, however, a joint tensile strength of more than 187 lbs./in.

A belt joint similarily produced, as above-described, was subjected to testing to determine its resistance to flexural fatigue. In this test, the specimen (½ × 16 inches coated abrasive strip) is held under tension (27 lbs. gage) and moved back and forth at 200 cycles per minute in a 90° change in direction over a ¼ inch diameter roll. Actual tension was 16 lbs. Resistance to flexural fatigue was discovered to be extremely high, 50,000 cycles being achieved without joint failure.

A belt joint manufactured as above was subjected to 10,000 cycles in the flexural fatigue testing apparatus after which it was Instron tested as before. Quite unexpectedly, it is believed, the joint tensile strength was found to be 86 percent of that determined previously. Moreover, failure occurred in the coated abrasive material, not the joint.

By way of comparison, the butt joints in two commercially available competitive coated abrasive belts were evaluated for their resistance to flexural fatigue. The belts were also subjected to tensile strength testing. In one of these abrasive belts — using a patch of Dacron polyester fabric — failure occurred in flexural fatigue after only 9600 cycles. On tensile strength testing, failure occurred in the belt joint per se at 154 lbs./in. The other belt joint, utilizing glass fibers, while failing at higher tensile strength (184 lbs./in.) showed considerably less resistance (1600 cycles) to flexural fatigue than did the joint using a patch of polyester fabric. However, failure in tension occurred in the coated abrasive material in this latter belt rather than in the joint per se.

EXAMPLE 3

A belt joint was produced as in Example 2; however, rather than a NOMEX aromatic polyamide reinforcing patch, a patch of S7016 Nylon (nylon 6,6), a conventional aliphatic polyamide used heretofore in joints, was used. The resulting butt joint failed in flex fatigue after only 2800 cycles. The tensile strength of such a joint was determined to be only 123 lbs./in. making it highly unsuitable as a reinforcing patch in a butt joint construction.

EXAMPLE 4

A reinforcing patch was cut from a high strength woven cotton fabric referred to in the trade as Airplane Cloth and which is available from Westpoint-Pepperell under the trade designation No. 1701. This fabric has a yarn count of 80 × 92 and weighs 4.3 ozs./yd.²

The butt joint resulting from using a reinforcing patch of this material was found to have exceptionally good resistance to flexural fatigue (41,400 cycles to failure). On tensile strength testing, the joint retained, after 10,000 cycles, 89 percent of its initial tensile strength (150 lbs./in.); however, failure occurred undesirably in the joint per se.

EXAMPLE 5

On a commercial J.M. Lancaster Drawer Sanding Machine, using a reinforcing patch of Nylon S7016, the coated abrasive product failed in the butt joint after only 12.0 hours operation. With a NOMEX polyamide patch, the coated abrasive belt held up for over 35 hours. Similarly, using these types of patches in the same butt joint construction and operating the belt so manufactured in a specialized belt testing machine using a small diameter roll (¼ inch) to place maximum stresses in the joint, the coated abrasive belt having the Nylon S7016 patch failed at 38.7 minutes. On the other hand, the belt using a patch of the present invention ran for 223.0 minutes.

EXAMPLE 6

A belt joint was produced with coated abrasive material as in Example 2 except that a nylon-phenolic impregnated patch from Example 1 was used.

On testing for resistance to flexural fatigue, this joint, while showing less resistance (34,320 cycles to failure) than that using a reinforcing patch which had not been impregnated, provides considerably greater resistance than any competitive product of which I am aware. Moreover, the joint tensile strength seems little effected by patch impregnation. Tensile strength after 10,000 cycles controlled flexing, as before described, was found to be 84 percent of that (187 lbs./in.) in a similar joint not so subjected. Failure occurred in both instances in the coated abrasive material rather than in the joint per se.

EXAMPLE 7

Reinforcing patches, as before mentioned, were cut from a fabric commercially available from Stern & Stern Textiles, Inc., under the trade designation A5392. This fabric is a 2 × 2 chain weave fabric having a yarn count of 95 × 86 and is woven from yarns of 210 denier high tenacity nylon polyamide. The properties of the fabric, weighing 5.4 ozs. per sq. yd., and having a thickness of 11.5 mils are as follows:

Porosity	16.0 cu. ft./min./sq. ft.
Tensile Strength	243 lbs./in. in warp direction
	223 lbs./in. in fill direction
% Elongation	52 in warp direction
	45 in fill direction

Several of these patches were impregnated as were the NOMEX aromatic polyamide reinforcing patches before mentioned.

Coated abrasive material (60X RESINALL METALITE OPENKOTE) was butt spliced as disclosed in Example 2, and the joints resulting were tested for resistance to flexural fatigue and tensile strength. These results are indicated below:

Patch	Flex Fatigue (No. of cycles)	Tensile Strength (lbs./in.)	Tensile Strength after 10,000 cycles (lbs./in.)	Strength Retained
Impregnated	32,320	183	154	84%
Not impregnated	50,000+	189	166	88%

One can readily see from this data that the results from using a reinforcing patch material of high tenacity nylon polyamide is somewhat comparable to a NOMEX aromatic polyamide reinforcing patch. Failure occurred in the coated abrasive material rather than in the joint, both before and after controlled flexing.

EXAMPLE 8

A reinforcing patch, as in Example 1, was saturated with the following composition:

COMPONENT	% By Weight
Elvamide 8061	12.2
Epon 828	4.1
Methanol	68.6
Trichloroethane	14.6
Triethylene Tetramine	0.5

(Epon 828 is an epoxy resin resulting from the condensation of epichlorohydrin with bisphenol-A having an epoxide equivalent of 185–192 and is available commercially from Shell Chemical Co.)

The patch, after saturating, was heated for 4 hours at 250° F. to cure the impregnant (10 percent dry pickup) to a dry, tack-free condition. Afterwards, the patch was used to prepare a coated abrasive material belt joint as before described. On evaluation, as before, for resistance to flex fatigue, the joint failed only after 39,200 cycles.

EXAMPLE 9

A strip of coated abrasive material, as in Example 8, was butt-spliced except that the reinforcing patch was impregnated (10 percent by weight dry pick up) with the following composition:

COMPONENT	% By Weight
Bostik 7076	73.6
Mondur CB75	6.5
Dimethyl cocoamine catalyst	1.4
Ethyl Acetate	18.5

The wet coated patch was allowed to cure, prior to assembly, at room temperature (70° F.) for 24 hours. On evaluation for fatigue resistance, the abrasive material was removed, joint intact, after 12,000 cycles.

EXAMPLE 10

Reinforcing patches of NOMEX aromatic polyamide yarnwere saturated with the nylon-epoxy adhesive composition disclosed in Example 8. Afterwards, a preformed adhesive film (3 mil) was laminated to the dried impregnated patch by subjecting the superposed assembly to a pressure of 300 psi while being heated (bottom bar only) for 3 seconds at 240° F.

The preformed film was provided by coating the following polyurethane adhesive composition on a conventional release liner:

COMPONENT	% By Weight
Bostik 7076	91.0
Mondur CB75	4.6
Thylon D-406*	4.4

*A one part blocked urethane system available from Thiokol Chemical Co.

After application to the release liner, the adhesive composition was dried and cured for 4 minutes at room temperature, 13 minutes at 100° F., and 32 minutes at 250° F.

The adhesive film — reinforcing patch assembly was then assembled with a strip of 50X RESINALL METALITE OPENKOTE coated abrasive material to form a butt joint as before disclosed. On testing for resistance to flex fatigue, the joined coated abrasive material was removed, joint intact, after 12,000 cycles.

Similar results were obtained when the polyurethane adhesive film was formed by coating the adhesive composition directly on the nylon-epoxy impregnated patch. Neither of these joints, it should be pointed out, involved application of adhesive to the back side of the coated abrasive backing member thus eliminating this application step.

EXAMPLE 11

A coated abrasive belt was manufactured in accordance with Example 6, except that 50X coated abrasive material was used, for evaluation in a drawer sanding application. The belt was removed after 4 days with the joint intact and the belt still usable. In contrast, belts used prior to this invention in this application using glass fiber reinforcement in the joint construction failed in anywhere from 1 to 3 days.

EXAMPLE 12

A coated abrasive belt was manufactured as disclosed in Example 2 except that the impregnant adhesive composition was the nylon-epoxy composition disclosed in Example 8. On testing, as before described, resistance to flexural fatigue was determined to be outstanding — 39,000 cycles being achieved before failure. Initial joint tensile strength was in excess of 190 lbs./in.; however, after 10,000 cycles in the fatigue testing apparatus joint tensile strength in a similar belt had dropped to 126 lbs./in. (66 percent retained).

EXAMPLE 13

A NOMEX aromatic polyamide fabric (plain weave, 200 denier yarns, yarn count 69 × 64), avilable from Stern & Stern Textiles, Inc., under the trade designation HT3, having the following physical properties:

Porosity	32.3 cu.ft./min./sq.ft.
Tensile Strength	155 lbs./in. in warp direction
	144 lbs./in. in fill direction
% Elongation	35 in warp direction
	30 in fill direction

and weighing 3.62 ozs./sq. yd. (6.5 mils thick), was saturated with the nylon-epoxy adhesive composition in Example 8.

Afterwards, the saturated fabric was air dried for 15 minutes and then cured for 4 hours at 250° F. A dry deposit of 9 percent, by weight of the fabric, was obtained.

The saturated or pre-impregnated fabric was then cut to provide a 55° bias patch, ¾ inch in width. A 3.5 mil dry, preformed, polyurethane adhesive film, provided as in Example 10, was then laminated (13/16 inch width film) to the bias cut reinforcing patch by means of an air operated press at 194 lbs./in.^{2} while being heated at 240° F. for 3 seconds.

The ends of a strip of coated abrasive material (180 X RESINALL METALITE cloth), which were cut at a 55° angle with respect to their running direction, were sandblasted backrubbed after which they were then coated with the polyurethane composition of Example 2. The adhesively coated ends were then allowed to air dry at room temperature, e.g., about 70° F., for 45 minutes.

The preformed adhesive film — reinforcing patch assembly was then assembled with the adhesive coated ends of the coated abrasive material in such a fashion that the warp yarns of the reinforcing patch extended approximately parallel to the edges of the coated abrasive material. This assembly was then subjected, in a conventional platen press, to a 15 second press (bottom platen only heated — 240° F.) at 194 lbs./in.^{2} followed by a 20 second press at 4300 lbs./in.^{2} using a 30 TON press (American Steel Foundry, Elmes Engineering Division, Cincinnati, Ohio) with both platens heated at 240° F.

After the usual conditioning before testing, e.g., 24 hours at 50 percent R.H. — 70° F., the following physical properties were obtained on abrasive belts similarily manufactured:

Physical Property	Value (lbs./in. of width)
Tensile Strength	
a. coated abrasive material	222.4
b. joint tensile	177.0
c. joint tensile after 10,000 cycles	140.0
d. % tensile strength retained after 10,000 cycles	79.0

Thus, from this data, and even though failure occurred in the joint, one can readily see that with a much thinner patch material and a somewhat greater joint line angle than in Example 2, a joint can be produced that will still be found, in many instances, quite satisfactory. Of significance, however, is the fact that even after being subjected to 10,000 cycles, the joint tensile strength is still 79 percent of that determined initially.

As will be appreciated from what has been previously disclosed, a somewhat stronger joint can be produced in providing a joint line of lesser angle, e.g., 45° or less.

EXAMPLE 14

A fabric available from Stern & Stern Textiles, Inc., under the trade designation HT-131, was impregnated by a conventional dip and squeeze method, with the nylon-epoxy saturant disclosed in Example 8.

This fabric, yarn count 99 × 64, is a 2 × 2 twill weave, 200 denier NOMEX aromatic polyamide continuous filament yarns in the warp direction and 333 denier NOMEX staple yarns in the fill direction, fabric having a thickness of 14.4 mils and a weight of 5.64 ozs. per sq. yd. Its porosity is 54.9 cu. ft./min./ft.^{2} and the fabric has a tensile strength of 250 × 158 lbs./in. width, a tear strength (lbs.) of 18 × 18, and an elongation (percent) of 40 × 26.

After a 15 minute air dry, the saturated fabric was heated for 10 minutes at 325° F. to cure the resinous adhesive material. The per cent by weight (dry) pick up was 14.3.

A strip of 60X RESINALL METALITE abrasive cloth was cut at a 55° angle and the cut ends were subjected to a sandblasted backrub. To the abrasive material ends was then applied the polyurethane adhesive composition described in Example 2. Sufficient composition was applied to result in a 1.0 mil thick dry film.

The saturated fabric was cut into ¾ inch wide 55° (off the fill yarns) bias reinforcing patch material so that a 55° joint angle would have the spun or staple yarns in the running direction of the belt produced.

A 3.5 mil (13/16 inch wide) dry, preformed polyurethane adhesive film, coated onto a Weyerhauser Co. No. 662 release paper, was laminated to the reinforcing patch using a pressure of 194 lbs./in.^{2} and a temperature of 240° F. for 3 seconds.

The adhesive coated ends of the abrasive material, after a 60 minute dwell, were abutted together in a platen press, as before described, on the adhesive film-patch (release liner removed) so that the adhesive film was directly against the coated abrasive backing member. This assembly was then subjected to a 15 second press at 194 lbs./in.^{2} at 240° F. (bottom bar only heated) followed by a 20 second press (4300 lbs./in.^{2}) in a 30 TON press, both platens heated to 240° F.

The joint tensile strength was determined before and after controlled flexing, as before described, the results being indicated below:

Patch Material	Initial Tensile Strength	Tensile Strength after 10,000 cycles (lbs./in.)	% Strength Retained
HT-131	216	173	80
HT-48 (control)	216	187	86.5

In the case of the control, where the reinforcing patch is HT-48, failure occurred in the abrasive material rather than in the joint in both tests. However; failure, in the case of the staple fiber yarns, occurred in the coated abrasive material, rather than in the joint, before controlled flexing and in the joint per se after controlled flexing. Nevertheless, the results indicate, it is believed, that while a reinforcing patch of continuous filament aromatic polyamide yarns is preferred, a joint incorporating a patch of staple fiber aromatic polyamide yarns will be satisfactory for less severe applications.

The non-coextensive adhesive film, on examination of the abrasive belt, was seen to have substantially covered over any exposed areas of the backing member due to the backrubbing operation. Thus, in use involving wet conditions, the backing member material is not left exposed to water or other wet grinding aids used. Moreover, such an adhesive film — reinforcing patch assembly results in imparting smoother operation to the abrasive material as the abruptness of the leading and trailing edge of the reinforcing patch is somewhat lessened.

EXAMPLE 15

A 9.7 mil thick blended fabric, i.e., one having high tenacity, 210 denier nylon polyamide yarns in the warp direction and 200 denier NOMEX aromatic polyamide yarns in the fill direction, available from Stern & Stern Textiles, Inc., Style A5424, having a 2 × 2 chain weave (86 × 100), weighing 5.4 ozs. per sq. yd., and having the following physical properties:

Porosity	3.8 cu. ft./min./sq. ft.
Tensile Strength	284 lbs/in. in warp direction
	227 lbs./in. in fill direction
% Elongation	42 in warp direction
	38 in fill direction

was saturated (dry pick up 7.8 percent by weight of fabric) with the nylon-epoxy adhesive composition before disclosed. The wet saturated fabric was then, after air drying for 30 minutes, heated for 10 minutes at 325° F. to cure the pre-impregnant to a dry, tack-free condition.

A reinforcing patch was bias cut (35° off warp direction) from the source fabric and was used in the manufacture of a belt joint as in Example 14 except that, the coated abrasive material was 60X RESINALL METALITE cloth, and, instead of a single 20 second press, two ten second pressings were used. In the assembly, however, and this is deemed critical to obtain the preferred joint of the invention, the reinforcing patch was inverted so that the initially top surface of the patch faced away from the back side of the coated abrasive backing member. Thus, the NOMEX aromatic polyamide yarns extended parallel to the edges of the coated abrasive material.

On evaluation as before, the joint tensile strength was determined to be in excess of 212 lbs./in. width. By comparison, the joint tensile in a control belt in which the reinforcing patch was HT-48 NOMEX aromatic polyamide was determined to be in excess of 208 lbs./in.

Abrasive belts as above manufactured when subjected to an accelerated flex fatigue test (35 lbs. gage tension instead of 27, actual 22 lbs.) failed in 8440 flexes (blend) and 9660 flexes (HT-48), respectively.

The data from both tests indicate that comparable results may be obtained even though the woven reinforcing patch material is not wholly of the aromatic polyamide yarns.

EXAMPLE 16

Abrasive belts (12 × 181 inches) manufactured as in Example 15, except that the abrasive material was 50X RESINALL METALITE cloth, were used in a drawer sanding application. In subsequently tensile testing such a belt, after being used for at least about 3 hours, failure occurred in the coated abrasive material per se leaving the joint in tact.

Although the preferred embodiments of my invention have been limited primarily to reinforcing patches incorporating NOMEX aromatic polyamide fibrous yarns, it will be appreciated that it is not so limited. The NOMEX aromatic polyamide fibrous material is preferred because it, among other things, appears to retain to a high degree, in a coated abrasive joint and at the temperatures attained during grinding, a desirable combination of physical properties, e.g., high initial tensile strength and high initial modulus. However, other fibrous materials may be found useful in the practice of this invention, in particular those of aromatic polyamides such as the ordered aromatic copolyamides obtained by the polymerization of N,N -m- phenylene - bis (m-amino- benzamide) and isophthaloyl chloride with terephthaloyl chloride, and imides, e.g., the reaction product of anhydrous bis (4 - aminophenyl) ether and anhydrous pyromellitic dianhydride.

Obviously, the reinforcing patch may be any of a wide variety of yarn sizes and weaves. However, in certain instances, it need not even be a woven structure. The patch, in the case of a preformed film, for example, may merely be a plurality of yarns assembled with the adhesive film in the direction of travel of the coated abrasive material being joined. Nevertheless, whether an endless belt is being formed or a reinforcing patch is being used in forming some other joint in the abrasive material, e.g., in splicing the ends of two rolls in a continuous operation, or the formation of spiral belts or the like, the patch material used hence the joint ordinarily will be as thin as is consistent with the strength required in any particular application. The reinforcing patch must be sufficiently porous for any pre-impregnant adhesive and joint bonding adhesive to penetrate, at least partially. Thus, abrasion resistance can be somewhat improved. The yarns used for the reinforcing patch material, while necessarily of high tensile strength fibrous material may be mono-or multifilamentary, or even staple fiber yarns, and of any denier provided they meet the requirements set forth herein.

What I claim is:

1. Article of manufacture comprising coated abrasive material in which abrasive grains are adhesively bonded to the front side of a flexible backing member, said abrasive material having two free ends thereof joined together in abutting relationship to each other, a woven reinforcing patch having warp and fill yarns forming interstices therein bridging together said abutted ends, and a layer of adhesive intermediate the back side of the backing member and said patch and extending only for a short distance adjacent each said end,

said patch embedded in the adhesive layer to the extent that the adhesive at least partially fills the interstices in the woven patch, said joined coated abrasive material having a joint tensile strength at least greater than the tensile strength of the coated abrasive material and having relatively good resistance to flexural fatigue.

2. Article of manufacture in accordance with claim 1 in which said joint tensile strength is at least 150 lbs./in. of width and after being subjected to controlled flexing for 10,000 cycles is at least 50 percent of that initially determined.

3. Article of manufacture in accordance with claim 2 in which the warp and fill yarns of said woven reinforcing patch comprise high tensile strength polyamide fibrous yarns.

4. Article of manufacture in accordance with claim 3 in which the polyamide is an aromatic polyamide.

5. Article of manufacture in accordance with claim 4 in which said aromatic polyamide is the reaction product of a member of the class consisting of a phthalic acid or the acid halide with a member of the class consisting of phenylene diamine.

6. Article of manufacture in accordance with claim 5 in which said aromatic polyamide is poly-m-phenylene isophthalamide.

7. Article of manufacture in accordance with claim 3 in which said yarns are filamentary yarns.

8. Article of manufacture in accordance with claim 1 wherein the adhesive layer comprises polyurethane.

9. Article of manufacture in accordance with claim 1 wherein, in addition to said adhesive layer, the woven reinforcing patch includes a previously applied, dried, cured impregnant.

10. Article of manufacture in accordance with claim 1 wherein the woven reinforcing patch is so positioned in the joint that one of said yarns is approximately parallel to the edges of the coated abrasive material.

11. Article of manufacture in accordance with claim 1 in which the coated abrasive material joined forms an endless belt.

12. Article of manufacture comprising coated abrasive material in which abrasive grains are adhesively bonded to the front side of a flexible backing member, said abrasive material having two free ends thereof joined together in abutting relationship to each other, a reinforcing patch bridging together said abutted ends, and a layer of adhesive intermediate the back side of the backing member and said patch and extending only for a short distance adjacent each said end, said joined coated abrasive material having a joint tensile strength of at least about 160 lbs./in. of width of abrasive material and retaining at least 50 percent of this initial tensile strength after being subjected to controlled flexing for 10,000 cycles.

13. Article of manufacture in accordance with claim 12 in which the reinforcing patch is a woven patch material, said patch being embedded in the adhesive layer at least to the extent that the adhesive partially fills the interstices in the patch.

14. Article of manufacture in accordance with claim 13 in which said reinforcing patch comprises fibrous yarns of poly-m-phenylene isophthalamide.

15. An endless coated abrasive belt comprising a flexible, abrasive-coated backing member having two ends positioned in substantially abutting relationship to each other; a layer of adhesive extending for a short distance on the back surface of said backing member adjacent each end thereof; and a woven reinforcing patch positioned on said back surface and embedded in said adhesive layer to the extent that said adhesive at least partially fills the interstices of said woven patch, said patch being composed of yarns made from fibers which are the reaction product of an aromatic diamine with a member of the group consisting of a phthalic acid and phthalic acid halides.

16. A belt as in claim 15 wherein the aromatic diamine is selected from the group consisting of m-phenylene diamine and p-phenylene diamine.

17. A belt as in claim 15 wherein said fibers comprise poly-m-phenylene isophthalamide.

18. A belt as in claim 15 wherein said fibers comprise poly-p-phenylene terephthalamide.

19. A belt as in claim 15 in which said yarns are filamentary yarns.

20. A belt as in claim 15 wherein the woven reinforcing patch is so positioned that some of the yarns extend approximately parallel to the edges of the coated abrasive belt.

21. A belt as in claim 15 wherein, in addition to the adhesive layer, the woven reinforcing patch includes a previously applied, dried, cured impregnant.

22. A belt as in claim 21 wherein said adhesive layer comprises polyurethane.

23. A belt as in claim 22 wherein the impregnant comprises, in combination, a nylon polyamide and a thermosetting phenolic resin.

24. A belt as in claim 22 in which the impregnant comprises polyurethane.

25. A belt as in claim 22 in which the impregnant comprises, in combination, a nylon polyamide and an epoxy resin.

26. A belt as in claim 25 in which the epoxy resin is the condensation product of epichlorohydrin with bisphenol-A, said condensation product having an epoxide equivalent of from about 185 to 192, and said nylon polyamide is a copolymer of hexamethylene diammonium adipate, hexamethylene diammonium sebacate, and caprolactam.

27. A belt as in claim 15 in which said adhesive layer extends laterally some distance on each side of said reinforcing patch.

28. Process for joining coated abrasive material which comprises the following procedural steps:

a. providing a strip of flexible coated abrasive material having two free ends and having a front side with abrasive grains bonded thereto and a back side free of abrasive grain;

b. applying to the back side of said coated abrasive material adjacent said ends an adhesive composition;

c. abutting the two adhesively coated ends together;

d. superimposing on the layer of adhesive so as to extend there across a woven reinforcing patch having warp and fill yarns of high tensile strength man-made fibrous yarns, thereby forming a joint assembly;

e. applying pressure to said joint assembly thereby to embed the patch at least partially within said adhesive layer and to cause the adhesive to form a bond between the reinforcing patch and the back side of said coated abrasive material, the resulting butt joint having a tensile strength of at least 160 lbs./in. of width of abrasive material and relatively good resistance to flexural fatigue.

29. Process according to claim 28 in which, in addition to applying adhesive to the ends of the coated abrasive material, adhesive is applied to said reinforcing patch.

30. Process according to claim 28 wherein the reinforcing patch prior to assembly is impregnated with an adhesive composition and it is cured to an essentially non-tacky state before it is superimposed on the adhesive layer.

31. Process according to claim 30 wherein the chemical formulation of the adhesive composition used to pre-impregnate the patch is different from that of the adhesive layer.

32. Process according to claim 29 wherein the adhesive composition applied to the reinforcing patch is applied to it in the form of a preformed film.

33. Process according to claim 29 in which the layer of adhesive applied to the ends of the backing member is wider than the reinforcing patch.

34. Process according to claim 32 in which said preformed film extends laterally beyond said reinforcing patch on each side.

35. Process according to claim 28 in which the patch is so positioned that one of said yarns extends approximately parallel to the edges of the coated abrasive material.

36. Process according to claim 28 in which heat is applied simultaneously with the application of pressure.

37. Process according to claim 28 in which the adhesive composition comprise polyurethane.

38. Process according to claim 29 in which the adhesive applied to the reinforcing patch comprise polyurethane.

39. Process according to claim 30 wherein said preimpregnant adhesive composition comprises a blend of nylon polyamide and an epoxy resin.

40. Process for joining coated abrasive material which comprises the following procedural steps:

a. providing a strip of flexible coated abrasive material having two free ends and having a front side with abrasive grains bonded thereto and a back side free of abrasive grain;

b. abutting said two ends together thereby forming a joint line;

c. applying to said abutted ends and equally on each side of said joint line a woven reinforcing patch on the front side of which is a laterally non-coextensive preformed adhesive film, said adhesive film being positioned directly against the back side of said abrasive material, thereby forming a joint assembly;

d. pressing said joint assembly while simultaneously applying heat thereto whereby to form a joint in the abrasive material of high tensile strength and resistance to flexural fatigue.

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