United States Patent

Malloy et al.

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[54] COATED ABRASIVE BELT JOINT

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 823,105, May 8, 1969, abandoned.

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

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

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

[56] **References Cited**

UNITED STATES PATENTS

2,391,731	12/1945	Miller et al.	51/399
2,794,726	6/1957	Riedesel et al.	51/399 X
3,154,897	11/1964	Howard	51/399
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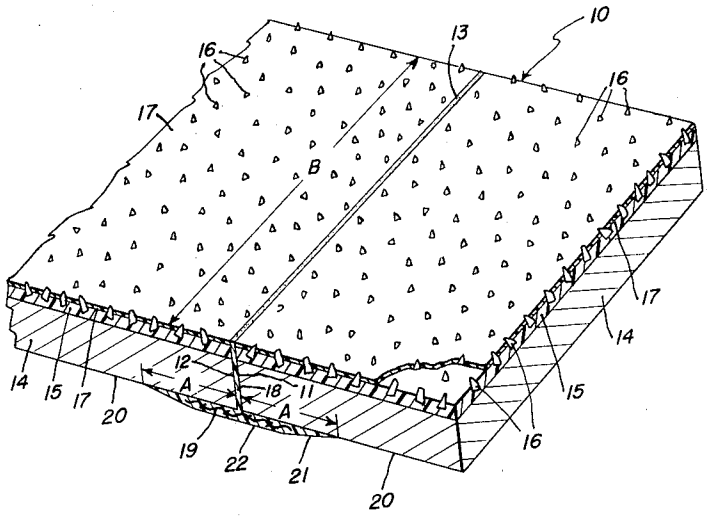
Primary Examiner—Othell M. Simpson

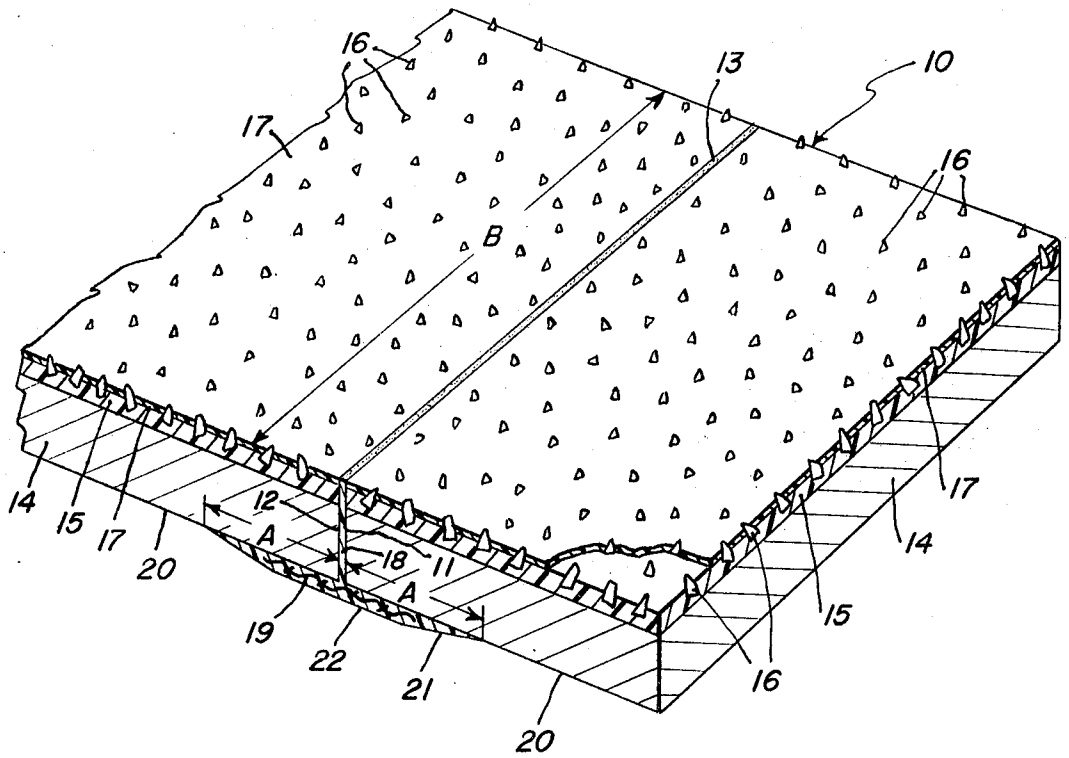
Attorney—Hugh E. Smith and Herbert L. Gatewood

[57] **ABSTRACT**

A coated abrasive material having a butt joint therein in which the abutted ends of the abrasive material are joined together by an initially thermoplastic, heat-hardened adhesive applied to the backside of the coated abrasive material adjacent the line of abutment and the adhesive layer is reinforced with a woven patch of a particular aromatic polyamide fiber which is placed on the backside so as to cross the abutment line. Adhesive fills the crack between the abutted coated abrasive ends and, moreover, forms a tapered surface from the backside of the coated abrasive material up to the outside surface of the reinforcing patch and preferably coats the exterior surface thereof.

16 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 our co-pending application Ser. No. 823,105 filed May 8, 1969 now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the art of joining and, in particular, to the joining together of two free ends of coated abrasive material as, for example, in the formation of endless belts.

2. Description of the Prior Art

Although butt joints have been known to those in the coated abrasive art for a considerable time, and have been used extensively for joining coated abrasive material for some applications, e.g., where fine finishes are required, these joints have found substantially minor usage compared with lap joints in coated abrasive material.

In a butt joint, as the name implies, the ends of the abrasive material joined do not over lap but merely butt one another. On the other hand, in a lap joint one of the joined ends of the coated abrasive material overlies the other. The lap joint traditionally has been considered stronger than the butt joint and, as indicated, is much more widely used despite its tendency to cause marking of work pieces due to the necessarily thicker area of the joint relative to the rest of the material.

Heretofore, and as before mentioned, others have joined together the ends of coated abrasive material using various butt joint constructions. These joints, however, in general have been found unsatisfactory in one or more desired characteristics in particular in coated abrasive belts when used in applications imparting high working stresses on the belt and the joint therein.

An undesirable feature in butt joints often results from the fact that in contrast to an over lap joint, the joint line is less stiff than desired and hingeing results to a pronounced degree. Hingeing is occasioned during usage, e.g., of the belt, with lifting of a tip of the abrasive material as the butt joint thereby resulting in the failure of the joint due to peeling.

A further problem resulting in the very nature of the butt joint configuration is that, during grinding, swarf gets into the joint-line gap or crevice where the two coated abrasive ends are butted together. As usage continues, the swarf becomes impacted in the crevice thus tending to increase joint thickness and contributing to increased stress on the joint.

SUMMARY OF THE INVENTION

We have invented a means of butt-joining together two ends of coated abrasive material as, e.g., in the manufacture of endless belts, whereby the problem above-mentioned are avoided.

This method involves basically the use of, in the manufacture of the butt joint, in combination with a high tensile strength reinforcing patch an adhesive composition that has marked flow properties initially under heat and pressure. However, after the initial application of heat and pressure, the adhesive composition cures to a hardened condition thus offering advantageous resistance to temperature during usage of the coated abrasive material. The adhesive composition on flowing fills up the crevice at the joint line in addition to, and it is believed quite unexpectedly, forming a tapered surface with the reinforcing patch thereby resulting in less bumping or pounding of the coated abrasive belt during use.

A further advantage resulting from the practice of our invention results from the fact that the adhesive composition flows through the relatively porous patch to its exterior surface thus providing a more wear resistant layer.

DESCRIPTION OF THE DRAWING AND THE PREFERRED EMBODIMENTS OF THE INVENTION

The sole FIGURE of the drawing shows a perspective view, in enlarged scale, of a coated abrasive material **10** in which two free ends **11**, **12** thereof are abutted against one another leaving a narrow crevice or joint line **13** there between.

Coated abrasive material **10** is made up of a flexible backing member (usually cloth) **14** to which is adhered a layer of bonding adhesive **15** (the maker coat). Embedded in maker coat **15** are a plurality of abrasive grains **16** with an overlying layer of the same or different adhesive (size coat) **17** as is conventional in the coated abrasive art.

The joint assembly in accordance with our invention comprises ends **11** and **12** of the abrasive material **10** butted together, a layer of adhesive **18** which bridges the two ends together and extends for a distance (A) on each side of joint line **13** and upwards into and fills the joint line crevice, and an overlying woven reinforcing patch **19**.

The adhesive used in the joint of the present invention may be any of a number of known adhesives which possess the properties of flowing on initial application of heat and pressure and thereafter, on further application of heat and pressure, sets up to a flexible, heat-hardened condition. Adhesives of this type are known and have been used in belt joint constructions before, e.g., those disclosed in U.S. Pat. Nos. 3,402,514; 3,154,897; and 2,733,181. Typical of these types of adhesives are the nylon-epoxy and nylon-phenolic adhesives described in these patents. The adhesive compositions for use in the practice of our invention in general should flow under pressure at a relatively low temperature, e.g., less than about 335° F., so as not to cause damage to the coated abrasive backing member.

Our preference is to use a particular nylon-epoxy adhesive composition which gives high peel strength and heat resistance to the butt joint. This preferred adhesive composition is a 75–25 blend (percent by weight solids) of Elvamide nylon 8061 (an ethyl alcohol/water mixture soluble nylon polyamide formed from the reaction of hexamethylene diammonium adipate and hexamethylene diammonium sebacate with caprolactam) and Epon 828 (a polyglycidyl ether which is a condensation product of epichlorohydrin and bisphenol-A having an epoxide equivalent of 185 to 192) in a methanol-chlorinated hydrocarbon solvent plus 12.7 parts by weight per hundred (based on the epoxy resin only) of triethylene tetramine (curing agent).

Preferably, the adhesive composition above disclosed is used to pre-impregnate the reinforcing patch to be used in the joint after which the composition is then dried or cured to an essentially tack-free condition. More adhesive composition is preferably then coated on the backside or surface **20** of the belt ends to be joined and in some instances on the patch itself and the impregnated patch is then placed on the abutted ends.

Reinforcing patch **19** and its manner of location in the joint assembly has been discovered to be a critical aspect of our invention. In the most preferred aspect, this patch is woven from yarns comprising fibers of an aromatic polyamide such as the reaction product of a phthalic acid (iso- or tere-) or the acid halide with an aromatic diamine such as m- or p- phenylene diamine. However, it has been found sufficient in some instances for only the warp yarns to be of this type polyamide and the fill yarns to be of other high tenacity nylon polyamide. In this event, however, the patch must be so positioned in the joint that the aromatic polyamide warp yarns are substantially in, e.g., 20° or less from, the running or longitudinal direction of the coated abrasive belt.

Although the reinforcing patch in our invention is preferably placed on the surface of the backing member of the coated abrasive material, it may be desirable in some instances to roughen the surface to a slight degree to break up or remove any backing material which may have been applied previously. However, this invention makes unnecessary the tapering of the coated abrasive material as by skiving, or grooving of the backing member as often done heretofore.

As shown in the drawing, reinforcing patch **19** though embedded in adhesive layer **18**, does not extend the full distance (A) from joint line crevice **13** on each side **11** and **12** of abrasive material **10** as does the adhesive layer but stops short so that the adhesive **18** forms a taper **21** from the outer surface **22** of patch **19** down to the side **20** of the abrasive material **10**. Preferably, the patch **19** will extend at least one-eighth inch from joint line **13** on each side thereof to provide adequate anchorage to backside **20**. The tapered adhesive "ramps" **21** will usually be about one-sixteenth inch or more in length and these will run laterally across the entire width (B) of the belt joint. As illustrated, in the preferred embodiment of the invention, the adhesive **18** actually penetrates the weave of patch **19** and extends slightly beyond the outer surface **22** of the patch and thereby provides improved abrasion resistance to this patch and the joint so formed.

Other adhesive compositions can be used to impregnate the reinforcing patch, i.e., other than that used to make the actual joint, if desired. The adhesive, however, needs to be of the same initially thermoplastic, thermosetting flexible character. By "flexible" is intended to mean both adhesives which form a flexible film and those which by mechanical flexing can be made flexible. However, the pre-impregnation described above can be accomplished with a composition having the same components as the joining adhesive except in more dilute form as set forth below:

Pre-Impregnant Composition

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

Adhesive Composition

Components	% By Weight
Elvamide 8061	18.5
Epon 828	6.35
Methanol	51.8
Trichloroethane	22.4
Triethylene Tetramine	0.8

Another suitable adhesive - pre-impregnant combination utilizes the above composition as the adhesive with a nylon-phenolic composition, as set forth below, as the pre-impregnant. This nylon-phenolic composition is similar to that disclosed and claimed in U.S. Pat. No. 3,296,022:

Components	% By Weight
Elvamide 8061	10.7
Thermosetting Phenolic Resin	6.0
Methanol	66.6
Water	16.7

Another example of the adhesive composition which can be used with either of the above two pre-impregnants is:

Components	% By Weight
Elvamide 8061	15.0
Beetle 7238–20	15.0
Methanol	59.5
Water	10.1
Citric Acid	1.1

(Beetle 7238–20 is a urea-formaldehyde, water-based resin (American Cyanamid))

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

EXAMPLE 1

A reinforcing patch (three-fourths inch wide) was cut from a commercially available woven fabric of NOMEX polyamide yarn.

This filamentary yarn, believed to be of poly-meta-phenylene isophthalamide, is available commercially from E. I. du Pont de Nemours & Co. and has been described in their Technical Bulletin N–201 of October 1966.

The manner of manufacture of such aromatic polyamides is believed disclosed in, inter alia, U.S. Pat. Nos. 3,063,966 and 3,287,324. In the last-mentioned patent, which issued to du-Pont on Nov. 22, 1966, the manner of manufacture of poly-meta-phenylene isophthalamide is specifically disclosed. Therein the patentee discloses formation of such polyamide by reaction of the diamine with the acid chloride. A process for the dry spinning of such aromatic polyamides into fibers is disclosed in U.S. Pat No. 3,360,598 which issued Dec. 26, 1967. The fibers are formed into yarns and then made into a woven fabric from which the reinforcing patch of the present invention is cut.

Such a fabric, as above mentioned, is available from Stern & Stern Textiles, Inc. of Hornell, New York under the trade designation HT–48. This fabric has a yarn count 100×86.5 and is a 2×2 chain weave fabric, using NOMEX polyamide yarn of 200 denier. It has an average thickness of 0.0104 inch and weighs 5.05 ozs./yd. Physical properties of the fabric are as follows:

Porosity	13.8 cu. ft./min./sq. ft.²
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

A strip of conventional 40X RESINALL DURITE coated abrasive material was provided of suitable length and the free ends thereof were cut to complement one another at an angle of 70° with respect to the lengthwise direction. The cut free ends were then back rubbed (five-sixteenths inch in from each end) according to usual techniques, and nylon-epoxy adhesive composition, as above-described, was then applied. This was accomplished in two brush applications of the adhesive composition.

After an open time of 2 hours at room temperature (R.T.), i.e., 70° F., the pre-impregnated reinforcing patch was then assembled with the adhesively coated abutted ends. The patch (70° bias cut) was so located that one group of yarns extended in substantially the longitudinal or running direction of the coated abrasive material. The patch was not coextensive in the longitudinal direction of the abrasive web with the adhesive layer and this layer extended about one-eighth inch beyond the reinforcing patch at each end thereof.

Impregnation was accomplished by saturating the fabric with the Elvamide 8061–Epon 828 composition before-mentioned in a conventional dip and squeeze manner after which the impregnating composition was fully cured by a 15-minute room temperature **250°**and heating for 4 hours at 150° F.

On testing, the physical properties of the patch when impregnated were found to change as follows: Tensile strength decreased from 247 lbs./in. to 216 lbs./in. in the warp direction and from 211 lbs./in. to 198 lbs./in. in the cross direction. However, the elongation was improved to a slight degree, decreasing from 41 to 34.1 percent in the warp direction. Elongation in the cross or fill direction also showed a slight improvement going from 35 to 27 percent. Abrasion resistance as measured by the TABER abrasion tester showed a marked improvement, moving up from 75 cycles to 1,895 cycles.

To the dried cured impregnated patch was then applied a 15-mil wet coat of the nylon-epoxy adhesive composition. This application of adhesive was allowed to dry for 2 hours at room temperature such resulting in a 1-mil surface film of adhesive. The patch was then assembled with the adhesively coated butted ends of the coated abrasive strip.

Heat and pressure was applied to the joint assembly-preferably in steps, i.e., a 15-second press at 90 psi at 335° F. followed by three additional 15-second pressings using a heated bar, top and bottom. The top bar is heated to 240° F. and the bottom bar to 335° F. The pressure setting in these second pressings is 1 ton per inch of belt width.

As a result of the application of heat and pressure, the adhesive initially flows filling the joint line crevice substantially completely and forming a tapered surface leading from the backside of the coated abrasive material to at least the top or outer surface of the reinforcing patch and the adhesive hardens then to a flexible but tough insoluble condition.

Quite unexpectedly, a coated abrasive belt having a joint in accordance with the present invention has been found to far out-perform any lap joint belt tested in actual severe operating tests. For example, in running cloth belts on a commercial plywood operation, coated abrasive belts made with the joint as above-described ran an average total of 29,000 panels each whereas a variety of competitive lap joint belts failed at a maximum of 17,600 panels per belt. This is believed particularly unusual because tensile tests run on the joints of essentially identical lap jointed belts showed a failure at 195 lbs./in. (web break) whereas the coated abrasive material in which the belt joint of the present invention was used failed at 188 lbs./in. Thus it would appear that in using a belt joint in accordance with our invention not only does the joint itself stand up much better than other known joints, but there also results some sort of improvement in the life of the coated abrasive material which is connected to this joint.

EXAMPLE 2

A reinforcing patch as in Example 1 except that the patch was straight cut rather than on the bias, after impregnation and curing (Elvamide 8061–Epon 828), was coated with an adhesive composition having the following formulation:

Component	% by Weight
Elvamide 8061	18.6
Epon 828	6.35
Methanol	59.4
Water	14.9
Epon Curing Agent D*	0.75

*(Epon curing agent D is a liquid tertiary amine salt available from Shell Plastic & Resin Division and is described in their Technical Bulletin SP26A).

Coating was accomplished by applying, in two passes, a 25-mil wet coat of adhesive composition. After application of the first 25-mil coat, the adhesive composition was allowed to dry for 20 minutes at room temperature. Subsequent to the second application, the wet adhesive layer was dried for 20 minutes at room temperature and for 15 minutes at 125° F. The tack-free adhesively coated patch (dried and partially cured) was then assembled with the abutted ends of a strip of coated abrasive material as before (70° end cut) and the assembly was then subjected to heat and pressure as in Example 1 to complete the joint. The patch, however, being straight cut was so located that the fill yarns were about 20° off from the running direction of the coated abrasive belt.

In the event it is desired to stock pile the adhesively coated reinforcing patches, this can be accomplished by storing the patches under refrigeration at 0° F. until ready for use.

On visual examination of the completed joints, the adhesive was determined to have filled the joint line crevice and quite surprisingly to have formed tapered ramps as before described, despite the fact that the adhesive layer was coextensive initially with the patch material.

Coated abrasive belts manufactured in the above fashion when subjected to flex fatigue tests over a ⅝-inch roll failed only after being subjected to more than 12,000 cycles. In Instron Tensile Strength Testing, the joint strength was found to exceed that of the coated abrasive material.

EXAMPLE 3

A reinforcing patch was cut (straight) from a woven fabric in which the warp yarns (200 denier) were NOMEX polyamide and the fill yarns (210 denier) were of a high tenacity nylon polyamide. This fabric was obtained from Stern & Stern Textiles Manufacturing, Inc. under the trade designation Style HT334 and has the following properties:

Tensile Strength	235 lbs./in. in warp direction 273 lbs./in. in fill direction	
Elongation	45% in warp direction 41% in fill direction	
Thickness	0.011 inch	

This patch, impregnated with the nylon-epoxy composition before described, was assembled, after adhesively coating as in Example 1, with adhesively coated butted coated abrasive ends (70° cut) as also disclosed in Example 1. The NOMEX polyamide warp yarns of the patch extended in a longitudinal direction (about 20° off from).

This joint assembly was then heated under pressure as before and on visual examination of the completed joint, the adhesive was determined to have formed tapered ramps at the edges of the reinforcing patch and to have filled the joint crevice as shown in the drawing.

On evaluation, according to usual techniques, coated abrasive belts so manufactured were found to exceed more than 12,000 cycles in flexing before failure. Peel strength was determined to be 22 lbs./in. of width. Tensile strength of the belt was determined to be 218 lbs./in. with failure occurring in the coated abrasive material rather than in the joint.

However, in contrast, a joint in which the high tenacity nylon polyamide fill yarns were located in the longitudinal direction (20° off) resulted in separation under flexing conditions in less than 12,000 cycles. Peel strength was also found to be somewhat lower, e.g., 18 lbs./in. of width. The joint failed, however, under tensile stress at the butt line at a tensile strength of 200 lbs./in. This patch exhibited excessive elongation which makes a joint so manufactured objectionable.

Obviously, a variety of yarn sizes and weaves can be used in forming the reinforcing patch from the specific fibers required. The patch will ordinarily be as thin as is consistent with the strength required but must be sufficiently porous for the pre-impregnant and the bonding adhesive to penetrate through the interstices formed by the woven yarns. As beforementioned, the reinforcing patch is preferably applied so as to bridge the joint line formed by the butted coated abrasive ends with either the warp or fill ends of the yarns extending approximately parallel to the edges of the coated abrasive material. The term "fibers" as used herein is meant to include monofilaments as well as multi filaments both being capable of being formed in the yarns suitable for weaving into a cloth construction.

We claim:

1. Coated abrasive material having a front and backside and in which two initially, free ends thereof are in abutting relationship to each other; a layer of adhesive bridging said ends and extending there between and for a short distance on the backside of the coated abrasive material adjacent each end thereof; and a woven reinforcing patch positioned on said backside and embedded in said adhesive layer to the extent that said adhesive substantially fills the interstices of the woven patch; said adhesive layer having a tapered surface extending from at least the outer surface of said reinforcing patch to the backside of the coated abrasive material on each of said ends.

2. Coated abrasive material according to claim 1 in which the adhesive is of a character such that upon initial application

of heat and pressure it will flow and which upon continued application of heat and pressure will cease to flow and will cure to a flexible-tough-hardened state.

3. Coated abrasive material according to claim 2 in which the adhesive is the dried, cured product of a composition comprising a blend of nylon polyamide and an epoxy resin.

4. Coated abrasive material according to claim 3 in which said nylon polyamide is a copolymer of hexamethylene diammonium adipate, hexamethylene diammonium sebacate, and caprolactam.

5. Coated abrasive material according to claim 4 in which said epoxy resin is a condensation product of epichlorohydrin and bisphenol-A having an epoxide equivalent of from about 185 to 192.

6. Coated abrasive material according to claim 5 in which the composition blend comprises, based on weight of solids, 75 percent said nylon polyamide and 25 percent said epoxy resin.

7. Coated abrasive material according to claim 6 in which the reinforcing patch is woven from continuous filament yarns of aromatic polyamide.

8. Coated abrasive material according to claim 7 in which the aromatic polyamide is poly-m-phenylene-isophthalamide.

9. Coated abrasive material according to claim 7 in which only the yarns in a direction substantially that of the longitudinal direction of the coated abrasive material are of aromatic polyamide.

10. Coated abrasive material according to claim 1 in which the reinforcing patch has been pre-impregnated with an adhesive composition which flows on initial application of heat but thereafter on further heat application sets up to a hardened state.

11. Method for joining together two free ends of coated abrasive material which comprises:

a. abutting together two free ends of coated abrasive material having a front side with abrasive grains bonded thereto and a backside free of abrasive grain;

b. applying to said backside adjacent each said free end an adhesive composition having the characteristics of being initially flowable on application of heat and on further application curing to a heat-hardened adhesive;

c. superimposing on the adhesive layer so as to extend across said abutted ends a woven, porous, reinforcing patch the yarns of which in at least the direction substantially longitudinally of the coated abrasive material being continuous filaments of aromatic polyamide;

d. applying heat and pressure to the assembly formed in (c) thereby embedding said patch within the adhesive layer and causing said adhesive to flow between the abutted ends and to form a tapered surface from the outer surface of the patch at each end thereof to the backside of the coated abrasive material.

12. Method according to claim 11 wherein the patch is pre-impregnated with an initially flowable, heat-hardenable adhesive and this adhesive composition is dried and cured to an essentially non-tacky state before the impregnated patch is superimposed on said adhesive layer.

13. Method according to claim 12 wherein the chemical formulation of the adhesive composition used to pre-impregnate the patch is the same as that of said adhesive layer.

14. Method according to claim 13 wherein said aromatic polyamide is poly-m-phenylene-isophthalamide.

15. Method according to claim 11 wherein said adhesive composition comprises a blend of nylon polyamide and an epoxy resin.

16. Method according to claim 13 wherein adhesive composition is applied additionally to said non-tacky pre-impregnated patch prior to superimposing it on the adhesive layer on the backside of said free ends.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,665,660 Dated May 30, 1972

Inventor(s) John F. Malloy et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 1, line 44, "as" should read --at--.

Col. 1, line 57, "problem" should be plural.

Col. 4, line 64, change "250°" to --dwell--;

Same line, change "150°F" to --250°F--.

Signed and sealed this 5th day of September 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

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* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334