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A. L. BALL ET AL

2,743,559

ABRASIVE BANDS

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2 Sheets-Sheet 1

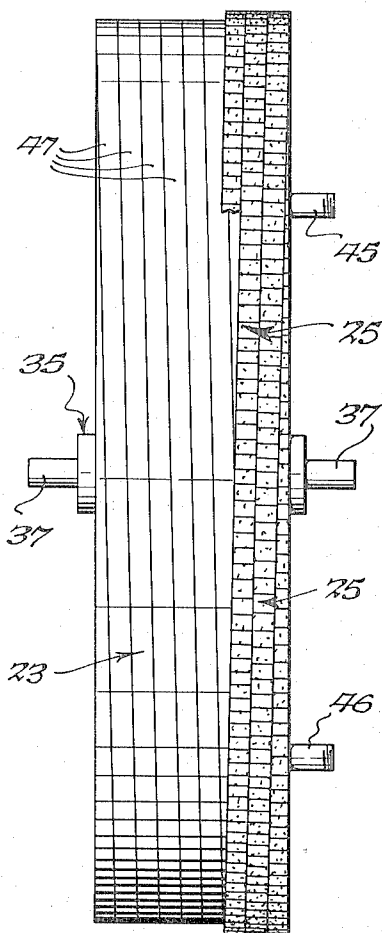


Fig. 6.

Fig. 11a.

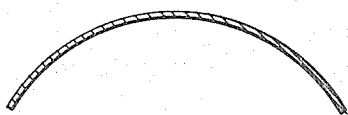
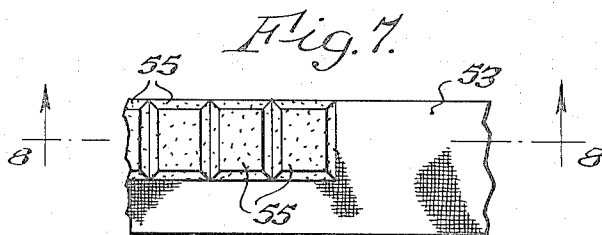


Fig. 8.

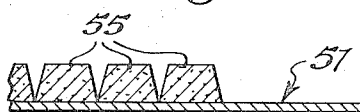
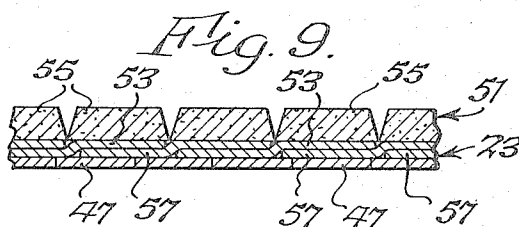


Fig. 10.

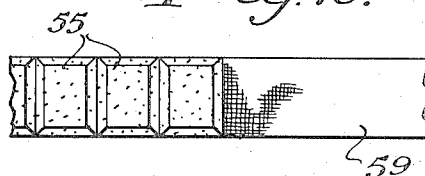


Fig. 11b.



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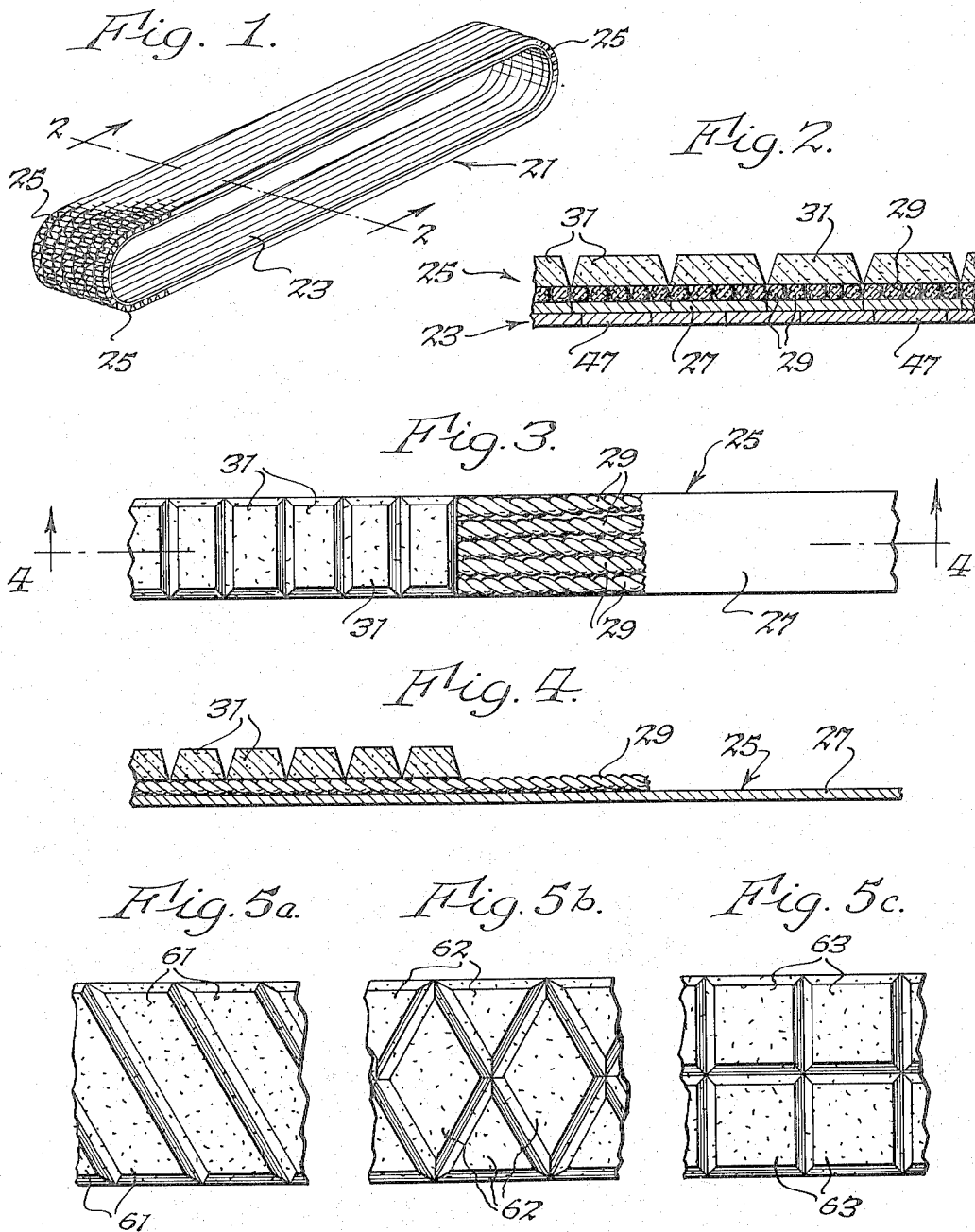
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2 Sheets-Sheet 2



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ABRASIVE BANDS

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Application April 10, 1953, Serial No. 347,932

8 Claims. (Cl. 51—188)

This invention relates to flexible abrasive articles and particularly relates to endless, flexible, abrasive bands such as sleeves, belts, and the like and to processes for making such bands.

It is an object of the present invention to provide a novel endless, abrasive band which may have a thick abrasive layer and also a very high degree of flexibility.

Another object of the invention is to provide an endless, flexible, abrasive band which has a thick abrasive layer but may be formed with either a flat or curved cross-section.

A further object of the invention is to provide an abrasive band of the character described in which the abrasive surface is formed by a plurality of molded abrasive blocks.

Still another object of the invention is to provide an abrasive band of the character described in which the bond for the abrasive may be a metal, ceramic or organic bond.

A further object of the invention is to provide an endless, flexible, abrasive band which may be easily and inexpensively produced and which is economical in use.

An additional object of the present invention is to provide a novel and convenient process for manufacturing endless, flexible, abrasive bands of the character described.

Other objects and advantages of the invention will be apparent from the following description read in conjunction with the accompanying drawings in which:

Figure 1 is a perspective view of a flexible abrasive belt constructed in accordance with the present invention with the abrasive blocks thereon being in part only indicated;

Figure 2 is a fragmentary, enlarged, cross-sectional view of the belt shown in Figure 1 taken on the line 2—2 thereof;

Figure 3 is a fragmentary, enlarged, plan view of an abrasive strip suitable for use in forming the belt shown in Figure 1;

Figure 4 is a longitudinal sectional view, taken on the line 4—4, of the abrasive coated strip shown in Figure 3;

Figures 5a, 5b and 5c are enlarged, fragmentary views showing some of the various designs which may be formed on the strip shown in Figure 3 by abrasive blocks thereon;

Figure 6 is a front elevation of a drum upon which flexible abrasive articles according to the present invention may be manufactured, an outer backing and a portion of an abrasive strip being shown wound thereon;

Figure 7 is a fragmentary, enlarged plan view, similar to Figure 3, of a modified form of abrasive strip;

Figure 8 is a longitudinal sectional view on line 8—8 of the abrasive coated strip shown in Figure 7;

Figure 9 is a fragmentary cross-section, similar to Figure 2, of a flexible abrasive belt formed from the modified abrasive strip illustrated in Figures 7 and 8;

Figure 10 is a fragmentary view similar to Figures 3 and 7 of a modified form of abrasive strip; and

Figures 11a and 11b are reduced, somewhat diagram-

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matic sectional views illustrating flexible abrasive bands having non-planar cross-sections of the type that may be produced in accordance with the present invention.

Abrasive bands such as belts and sleeves are extensively employed in the wood working and metal grinding fields. Heretofore most such bands have been made with substantially only a single layer of abrasive granules adhesively held on the surface of a spliced backing formed of paper, woven cloth or a combination thereof. Although abrasive bands of this type are quite flexible, their abrading life is short and the splice or joint is in many cases a source of trouble or annoyance.

Abrasive bands (meaning thereby, except where otherwise indicated, both abrasive belts which are intended for use with a plurality of pulleys or wheels and abrasive sleeves which are intended for use on a single sanding wheel or drum) may be constructed, according to the present invention, to have an unusually flexible and strong backing together with a substantial thickness of abrasive which provides a long, useful life. In addition, if desired, flexible abrasive bands according to the invention may be formed with curved or irregular instead of straight cross-sections to facilitate the grinding and polishing of surfaces having irregular contours.

Referring to the drawings, in Figure 1 there is illustrated a flexible abrasive band 21 which embodies novel features of the present invention. The band 21 comprises a base or outer backing 23 having adhesively secured thereto an abrasive strip 25 which is preferably spirally wound over the base.

The abrasive strip 25, a preferred form of which is shown in detail in Figures 3 and 4, comprises a support 27, a plurality of twisted cords 29 and a plurality of abrasive blocks 31. The support 27 may be formed from any strong, flexible material although a non-woven, fibrous material is preferred and thin vulcanized fiber has been found to be very satisfactory. The cords 29, each of which is preferably continuous for the length of the strip, are firmly secured to one face of the support 27 by a suitable flexible adhesive or cement. They are arranged parallel and close together in a single layer on the support. Hard twisted cotton cords have been found quite satisfactory, but cords of other fibers such, for example, as linen, nylon, and glass may be used.

The abrasive blocks 31 can be made of any desired type and size of abrasive granules bonded with any desired bonding material. They may be formed either individually or in sections and cemented to the cords 29. With some types of bonds, moreover, the abrasive blocks may be molded and cured in place on the cord layer. In many instances, this is preferred. The following example describes the manufacture of an abrasive strip having resinoid bonded abrasive blocks molded in place.

Example 1

A long strip of vulcanized fiber approximately 0.25 in. wide and 0.020 in. thick was coated on one side with a film of liquid rubber cement. A number of hard twisted cotton cords previously coated with the cement were then laid down, side by side on the adhesive coated surface of the strip to cover the full width thereof. Another coating of rubber cement was applied over the cords and dried. Thereupon the whole assembly was firmly pressed together to form a strip-like backing. The backing thus produced, after being coated on the cord side with a liquid phenolic resin adhesive, was placed in a mold. There a granular mixture of phenolic resin bond and fused alumina abrasive granules was deposited on the adhesive coated cords. After the mix was leveled off, it was cold pressed on the backing under moderate pressure of about 200–300 lbs./in.² and was then hot pressed in a stop mold at a temperature of about 250° F. for a

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brief period using a platen which shaped it into individual small segments or blocks, as shown in Figure 3. As the strip was rather long, it was unfeasible to provide a large enough mold to take the strip as a whole. The application of the adhesive and abrasive mix and the molding of the abrasive mix were therefore carried out on successive sections or lengths of the backing strip, the latter being fed into the mold and moved, after the application and molding of the mix on one section, to permit the mix to be applied to and molded on the next section. After the desired length of the strip-like backing was provided with molded abrasive blocks, the strip carrying the blocks was heated in an oven for about ½ hour at a temperature of approximately 275° F. This resulted in partially curing the phenolic resin abrasive bond as well as in setting of the adhesives employed. The resultant abrasive strip was very flexible although the abrasive segments were tightly bound to the backing formed by the adhesively combined cords and vulcanized fiber.

While the abrasive mix employed may be a simple mixture of abrasive granules and resinoid particles, it is preferred, since better uniformity and structure can usually be thus obtained, to use a mass of abrasive granules which have been given coatings of a heat-setting resinoid material by any of the numerous ways heretofore described and known to those skilled in the art.

As pointed out above, abrasive strips according to the invention may also be formed by securing preformed abrasive blocks to a suitable backing. The following example illustrates that procedure.

Example 2

A strip-like backing similar to the one described in Example 1 was formed from vulcanized fiber covered with a resin modified rubber cement and lengths of cord in the same manner as described therein. A coating of a liquid phenolic resin adhesive was then applied over the cords and a series of small, bonded abrasive blocks, shaped like the blocks 31 shown in Figures 3 and 4, were placed in side by side position thereon. The blocks, previously formed from a mixture of alumina abrasive grain and a heat-setting phenolic resin bond were molded and cured in accordance with well known practice in the abrasive art. The resin adhesive was then partially cured by heating the strip carrying the blocks in an oven at about 275° F. for about ½ hour. The abrasive strip obtained by the procedure of this example was similar in appearance and characteristics to that obtained by the procedure of Example 1.

An endless, flexible abrasive band such as the band 21 illustrated in Figure 1 may be readily formed from abrasive strips 25 of the types described in Examples 1 and 2. Such bands are most conveniently constructed on a hollow mandrel or forming drum such as the drum 35 shown in Figure 6. The drum, which is preferably formed of metal, is provided on each side with an axially disposed stub shaft 37 and a pair of nipples 45 and 46 through which steam or other heating fluid may be introduced into and withdrawn from the drum.

The base or outer backing 23 for the abrasive band is preferably formed by winding a strip 47 of strong, tough, flexible material around the drum 35. Thin vulcanized fiber has been found to be very suitable for this purpose. To obviate difficulty in removing the finished band from the drum the surface is preferably first covered by a layer of cellophane or other smooth, relatively impervious material (not shown). The strip 47 is then wound spirally on the mandrel 35 with the adjacent convolutions thereof in edge to edge contact so that the base 23 completely covers the cylindrical surface of the mandrel or drum. Before applying the abrasive strip 25 over the base or outer backing, the exposed surface of the latter is coated with a suitable flexible adhesive such as a liquid rubber cement. The abrasive strip 25 is coated

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on its exposed fiber face with a film of the same adhesive and is then spirally wound on the base 23 with its convolutions in contact at their adjacent edges so that the whole cylindrical surface of the drum is covered with the abrasive blocks 31 carried by the strip 25.

In Figure 6 the drum 35 is shown with the base or outer backing 23 in place and a portion of the abrasive strip 25 wound in place. Preferably the winding of the abrasive strip 25 is started at the edge of the drum 35 opposite from that at which the winding of the strip 47 was started so that the convolutions of the base and the abrasive strip are angularly disposed to each other. When the winding of the abrasive strip is completed the adhesive may be hardened or set if necessary by covering the outer surface of the abrasive band with an insulating and retaining covering (not shown) while heating the drum by passing steam or hot water through it by suitable connections to the nipples 45 and 46. A convenient covering is formed by several layers of cloth tightly wound on the drum over the abrasive band.

After setting of the adhesive the completed band may be removed from the mandrel. If desired, the adhesive may be only partially set on the mandrel and the hardening may be completed by heating in an oven. Obviously the heating of the band either on the mandrel or after its removal therefrom may be used to complete the cure of the abrasive bond or any of the other adhesives used in forming the band if necessary. Accordingly the temperatures and periods of heating may be chosen or adjusted in accordance with known practice to produce the results required. After final curing or setting of the bond and adhesives both edges of the band are trued. This may be conveniently done with a diamond abrasive wheel. The surface of the band may also be dressed and the band balanced.

It will be noted that both the outer backing or base as well as the abrasive surface of the abrasive band thus produced are endless. Consequently, such bands are exceptionally strong and there is no possibility of their breaking at a splice. Moreover, the absence of a splice in the abrasive layer permits the running of such bands in either direction and with less likelihood of unevenness in operation.

According to a variation of the process described above for making flexible abrasive bands an elongated, expandable split drum (not shown) of desired diameter is employed. The drum may be of any suitable and convenient material such as sheet metal. In carrying out the modified process an outer backing is formed by spirally winding onto the drum in its expanded condition a strip like the strip 47 described above. Then, after the application of an adhesive to both the exposed face of the backing and an abrasive strip of one of the types described herein, the latter is spirally wound on the outer backing preferably in a direction opposite to that of the strip 47, thus forming an axially elongated abrasive band. The drum and band may thereafter be placed in an oven and heated sufficiently to cure or set the abrasive bond and/or adhesives used. Upon removal from the oven the drum is contracted and the elongated tubular band, which may be several feet in width, is easily removed therefrom. Belts or sleeves of any desired width may then be cut or sliced from the tube.

Figures 7 and 8 illustrate another embodiment of the invention in the form of an abrasive strip 51 in which a narrow, flexible, strip support or backing 53 carries abrasive blocks 55 on a portion of the width thereof. In the following example the production of an abrasive strip of this type is described:

Example 3

A long strip of woven cotton tape approximately 0.42 in. wide previously coated with liquid rubber cement and dried, was placed in a mold with approximately ¼ in. of

width of the surface on one side of the strip exposed. The exposed tape surface after being further coated with a thin film of liquid phenolic resin adhesive was covered with a granular mixture of heat setting phenolic resin bond and fused alumina abrasive particles. The loose abrasive mix was first levelled and was then cold pressed against the backing strip under a pressure of about 200-300 lbs./in.² and afterwards hot pressed in a stop mold for a short time at a temperature of about 250° F. with a platen that shaped it into small blocks or segments as illustrated in Figure 7. The application of the resin adhesive and the abrasive mix and the molding of the latter were carried out on successive sections or lengths of the supporting tape strip in substantially the same manner as in Example 1. After the molding of the mix on one section, the strip was advanced in the mold to permit application of the adhesive and mix to the next portion thereof. When the entire length of the strip had been provided with molded abrasive segments or blocks, the strip was removed from the mold and the phenolic resin adhesive and the abrasive bond were cured by heating the strip in an oven for about ½ hour at approximately 275° F. The abrasive strip thus obtained was very flexible although the abrasive segments provided along one edge thereof were securely held to the tape backing.

An abrasive band may be formed from the abrasive strip 51 resulting from the process of Example 3 by a procedure similar to one of those heretofore described for forming abrasive bands from abrasive strips 25. An outer backing or base 23 is provided on a mandrel or an expandible drum like those described above, is coated with a film of suitable adhesive, and is then spirally wound over the backing or base with the abrasive strip 51. The abrasive blocks 55 of each convolution of the strip 51, after the first, overlap that portion 57 of the preceding convolution which is not provided with abrasive blocks. A coating of a suitable adhesive, such as rubber cement, is applied to the exposed portion 57 of the abrasive strip 51 as the winding continues to hold the next succeeding convolution thereto. In some cases when using overlapping convolutions of an abrasive strip as described above, the base or outer backing 23 may be omitted entirely.

Although in the preceding example woven cotton tape was employed as the flexible support or backing for the abrasive strip, other flexible materials may be used instead. Thus, woven fabrics of other fibrous materials such, for example, as linen, silk, nylon, glass, rayon and the like may be used. Felted fabrics of these or other fibers may likewise be employed as may strips of plastic material.

It will be understood that flexible abrasive bands may also be formed from abrasive strips which are like those produced by the procedure set forth in Example 3 but differ therefrom in that the abrasive segments or blocks 55 cover the entire width of the backing strip like the blocks used on the abrasive strips illustrated in Figures 3 and 4. A fragmentary view of such an abrasive strip is shown in Figure 10, the abrasive blocks 55 being secured by suitable adhesive to the flexible backing 59.

Instead of employing abrasive blocks molded in position on the backings or supports 53 and 59, preformed abrasive segments or blocks may be adhesively secured thereon in the same manner as described in Example 2. Preformed abrasive blocks used in forming abrasive strips according to the present invention may employ any desired type of abrasive material such, for example, as silicon carbide, fused alumina, garnet or emery, in any desired grit size or mixtures thereof and bonded with any desired type of bonding material, either organic or inorganic. Obviously, there is thus permitted a wide range of characteristics in abrasive bands formed from abrasive strips according to the invention. With a suitable choice of abrasive and bond, grinding and polishing may be most efficiently carried out by such abrasive bands. It will be realized that when employing a heat setting organic bond for forming abrasive segments or blocks the blocks may

be completely hardened or cured before mounting on a backing strip or may be partially cured only and be fully cured when the abrasive strip is heated to harden a heat-setting adhesive used in assembling it. Ceramic or metal bonds must, of course, be completely cured or heat treated prior to the application of abrasive segments employing them to a backing strip.

It is also contemplated that where abrasive blocks are molded in situ on a flexible backing strip, supplementary means may be employed for retaining the blocks in place. Such means may conveniently be a plurality of outwardly projecting filaments or loops (not shown) carried by the backing, such as are described in connection with the formation of abrasive bands in copending application Serial Number 171,165, filed June 29, 1950, issued as Patent No. 2,682,735, July 6, 1954. The benefits of such reinforcements are fully set forth in that application.

Figures 5a, 5b and 5c show three of the possible arrangements of abrasive blocks 61, 62 and 63, respectively, on a flexible abrasive strip in accordance with the present invention. Of course, numerous other arrangements or designs of blocks may be used to suit the requirements or preferences of the user. When the abrasive segments or blocks are preformed two or more may be molded together in one unit for ease in handling and application to the backing strip.

The width of the strips 47 used for forming the base or outer backing 23 and of the strips 27, 53 and 59 used as supports for the abrasive blocks may vary within rather wide limits. It will be understood that the narrower the strips the more flexible the resultant abrasive band. If, however, the strips are extremely narrow, the manufacture of abrasive bands is rendered somewhat more difficult. In general, therefore, it is preferred to use relatively narrow strips, i. e. ranging in width between about 0.125 in. and 0.75 in., or, expressed another way, from about 5% to 25% of the total width of the abrasive band.

As mentioned above, the high degree of flexibility of abrasive bands constructed in accordance with the present invention permits the production of flexible abrasive bands that are curved or irregular in cross section. Examples of such bands are illustrated diagrammatically in Figures 11a and 11b. Bands so curved are useful in the grinding or polishing of articles of irregular shape and simplify such operations in large scale production of many articles. In making abrasive bands having curved or irregular cross sections the manufacturing procedure is essentially the same as that heretofore described except that the peripheral face of the mandrel or forming drum is correspondingly shaped. The abrasive strip employed as well as the strips of flexible material forming the outer backings or bases should, moreover, be of a width in the lower portion of the range mentioned above. This is necessary with bands having a small radius of curvature since otherwise relatively smooth curves could not be obtained. Abrasive bands of cross section like Figure 11a having a radius of curvature of as little as 2 in. may be formed when using a prepared abrasive strip 0.125 in. in width. For bands having larger radii of curvature wider abrasive strips may be used. The abrasive blocks may, of course, be on either the convex or concave side of the band.

The procedure set forth above for forming abrasive bands from flexible abrasive strips is suitable for use when producing abrasive sleeves of relatively small diameter or abrasive belts of moderate size. When, however, abrasive belts of considerable length are desired, it may be unfeasible to use a mandrel or drum of the necessary diameter as a form upon which to wind the base or outer backing and the flexible abrasive strip. In such case, a plain belt of the desired length and width may be supported on two or more wheels or pulleys and the backing strip and abrasive strip may be wound spirally thereon according to one of the methods hereinbefore described,

Preliminary curing of the adhesive between the base or outer backing and the abrasive strip may be accomplished by clamping successive portions of the belt between heated platens or by any other convenient means. The adhesive and/or the organic bond of the abrasive blocks, if one is used, may if necessary be further cured after the abrasive belt is removed from the supporting belt by heating the former in an oven. In the production of large diameter abrasive belts of the type just described the abrasive strips may be formed according to any of the methods disclosed herein and any desired and suitable abrasive and backing material, bond, adhesives and the like may be employed.

The invention of the present application will be seen to be of great advantage in the production of abrasive bands. In the first place, the bands produced are extremely flexible and thus permit increased efficiency in polishing and grinding operations. Secondly, the bands are endless and contain no splices which are likely to fail. In the third place, since preformed abrasive blocks may be employed in manufacturing flexible abrasive bands according to the present invention, it is possible to use metal or ceramic bonds as well as various organic bonds for the abrasive material thus making available a very wide choice of both abrasive and bond and permitting an extremely wide range of finishes and high grinding efficiencies.

It will be understood that many modifications and changes may be made in the methods of manufacturing flexible abrasive bands set forth above without departing from the spirit of the invention. Thus, for example, other strong, flexible materials may be substituted for vulcanized fiber in the manufacture of such bands. Vulcanized fiber is preferred since it does not stretch appreciably under the loads ordinarily encountered in service, but impregnated paper, fabrics, or plastic material having the necessary strength and flexibility may be employed in some cases. The types of abrasive and bond used are matters of choice limited only by the method employed in forming the abrasive strips. The abrasive may be used in any of the various grit sizes and combinations thereof desired and the abrasive-bond mix may be formed and molded in any of the ways known to the art. As previously indicated, preformed or separately molded abrasive blocks or segments may be manufactured in accordance with any of the various methods known in the art for the manufacture of bonded abrasive bodies. Also, in the molding of abrasive blocks on the strip backings any known or desired procedure may be used. Obviously the conditions set forth in the examples may be varied within wide ranges. Thus, merely for example, the molding pressures may be either higher or lower as desired, the cold molding step may be eliminated, and/or the curing temperatures and times employed may be higher or lower and/or longer or shorter, respectively, than those specified as may be required by the bonds or adhesives used or in order to obtain particularly desired characteristics.

Likewise, for example, the adhesives employed between the base and the abrasive strips and for securing the abrasive blocks or segments on the abrasive strips may be of any suitable types and may be varied as necessary or desired. Flexible adhesives such as rubber cement and the like are preferred for securing abrasive strips to the outer base or backing and for forming the strip backings of the abrasive strips as such adhesives by preventing absorption of harder, more brittle adhesives or bonds used in securing the abrasive blocks to the strip contribute to the flexibility of the bands formed therefrom. For the last mentioned purpose stronger adhesives such as liquid phenolic resins or other adhesives having similar properties are usually preferred. Further, the outer backing or base instead of being formed of a spirally wound strip of strong, flexible material, may be formed of a single sheet of such material with abutting ends or skived,

overlapping ends where the highest degree of flexibility is not required. Moreover, additional backing strips of spirally wound or sheet type may be employed for imparting greater strength if required.

The foregoing are only, as stated, examples of modifications that can be made in the manufacture and structure of flexible abrasive bands according to the present invention. It is desired, therefore, that the invention shall not be considered limited by the description and drawings of the present application but that it shall be interpreted as broadly as permitted by the appended claims.

We claim:

1. An endless, flexible abrasive band comprising an endless base and a spirally wound abrasive strip adhesively secured to said base, said strip having thereon a plurality of abrasive blocks.

2. An endless, flexible abrasive band as set forth in claim 1 in which said abrasive blocks are adhesively secured to said strip.

3. An endless, flexible abrasive band as set forth in claim 1 in which said abrasive blocks are integral with said strip.

4. The process of making an endless, flexible abrasive band which comprises forming an endless, flexible backing from a strip of flexible material by winding said strip spirally on a forming element with the convolutions thereof having their adjacent edges in contact and thereafter spirally winding on said base at an angle to said first mentioned strip an abrasive strip having a plurality of bonded abrasive blocks secured thereto.

5. An endless, flexible abrasive band comprising a spirally wound strip, said strip comprising a relatively narrow, flexible backing, including a continuous base and a plurality of parallel cords extending longitudinally thereof and adhesively held thereto, and a plurality of bonded abrasive blocks adhesively secured to said cords, said cords being held together only by adhesive.

6. An endless, flexible abrasive band which comprises a flexible base having an abrasive strip spirally wound thereon, said strip comprising a backing, formed of a length of flexible sheet material to one face of which there is adhesively secured a plurality of cords arranged longitudinally of said backing, and a plurality of bonded abrasive blocks adhesively secured to said cords.

7. An endless, flexible abrasive band which comprises an endless base of flexible material and an abrasive strip spirally wound on said base, said strip being relatively narrow with respect to its length, having a backing comprising a plurality of cords arranged side by side longitudinally of said backing and a sheet of flexible reinforcing material adhesively secured on one side of said cords, and having a plurality of abrasive blocks adhesively secured on the other side of said cords, said backing being adhesively secured to said base.

8. An endless, flexible abrasive band which comprises an endless base and an abrasive strip spirally wound on and adhesively secured to said base, said base being formed of a spirally wound, relatively narrow length of strong, flexible material and said strip having a backing comprising a plurality of cords arranged side by side longitudinally of said backing and a sheet of flexible reinforcing material adhesively secured on one side of said cords, and having a plurality of abrasive blocks adhesively secured on the other side of said cords.

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