Nov. 6, 1956 J. K. McLAUGHLIN ET AL 2,769,284

COATED ABRASIVE WHEEL MANUFACTURE

Filed April 25, 1956 3 Sheets-Sheet 1

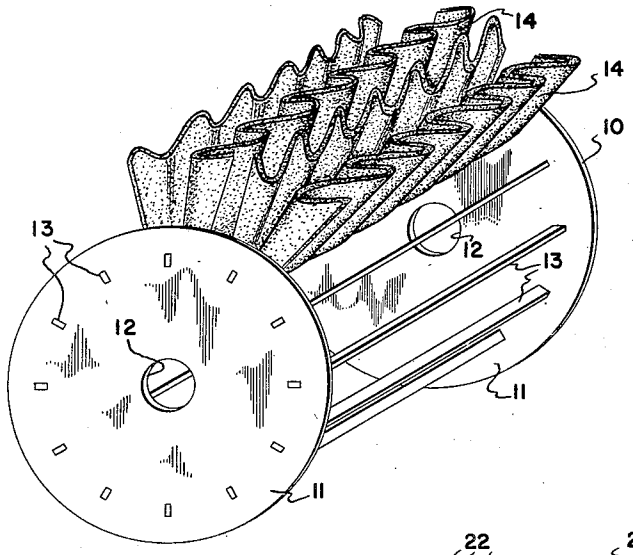


FIG. 1.

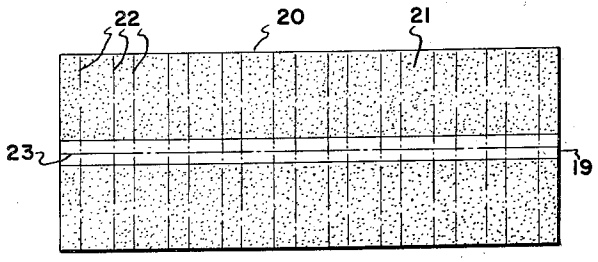


FIG. 2.

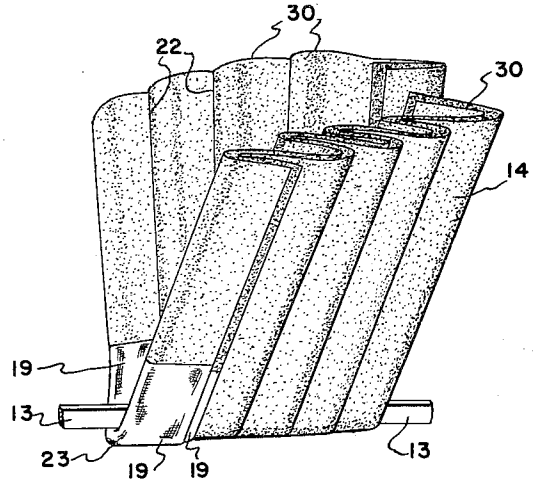


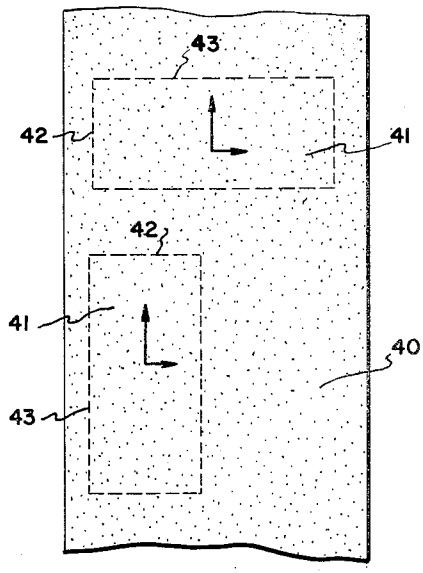
FIG. 3.

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COATED ABRASIVE WHEEL MANUFACTURE

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FIG. 4.



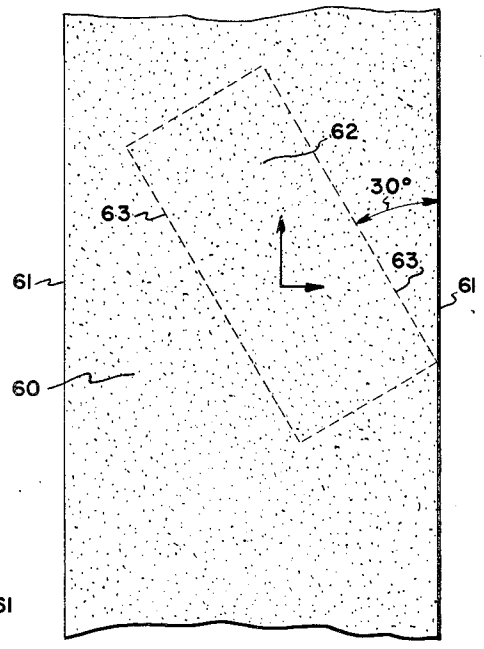


FIG. 6.

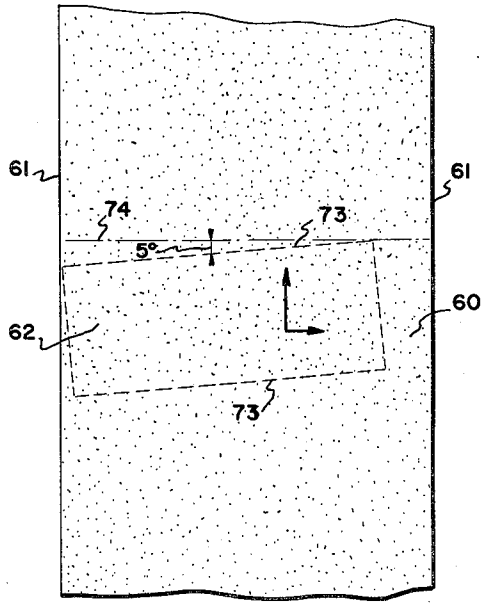


FIG. 7.

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COATED ABRASIVE WHEEL MANUFACTURE

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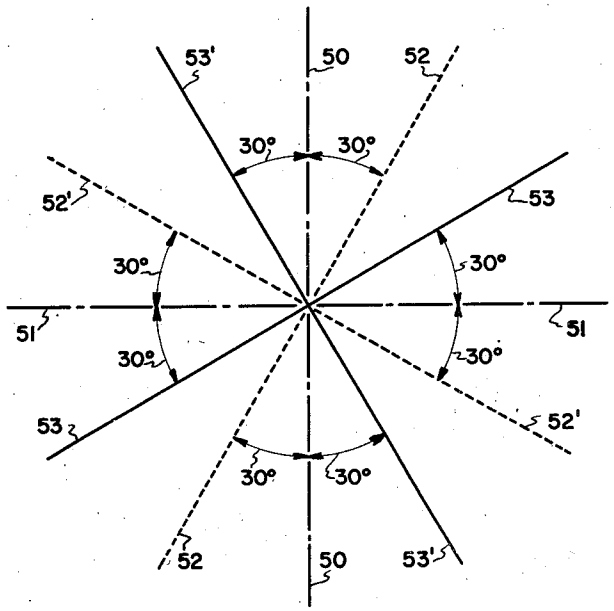
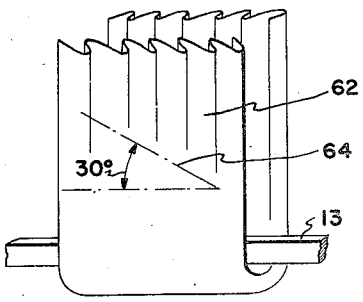


FIG. 5.

FIG. 8.



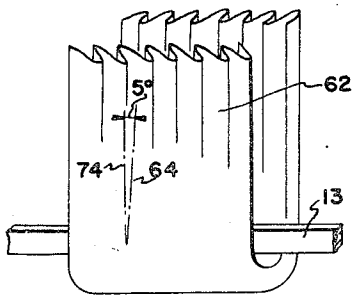


FIG. 9.

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COATED ABRASIVE WHEEL MANUFACTURE

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Application April 25, 1956, Serial No. 580,590

Claims priority, application Canada May 20, 1955

11 Claims. (Cl. 51—193.5)

This invention relates to coated abrasive wheel elements, to coated abrasive wheels made up of a plurality of such coated abrasive wheel elements, and to methods for increasing the efficiency and wear life of such wheels and elements thereof.

Numerous polishing or abrading wheels have been proposed heretofore in which the individual abrading or polishing elements have consisted of pieces of coated abrasive material. By the term "coated abrasive material," as used herein, is meant a flexible woven sheet or sheetlike backing to one or both surfaces of which there is attached by an adhesive a coating of one or more layers of abrasive or polishing grain. The abrasive grains most commonly used in coated abrasives are flint, emery, garnet, silicon carbide and fused aluminum oxide.

These polishing wheels have taken numerous forms and shapes but most practically comprise a central cage or the like having a plurality of mounting bars or other mounting means disposed annularly about a central shaft-receiving hub.

The abrasive elements themselves may be and are often of various sizes and shapes. One quite common type of wheel is the so-called "flap" wheel type which utilizes a plurality of straight rectangular pieces of coated abrasive material extending radially outward from the central hub. Such wheels are illustrated in U. S. Patents Nos. 1,897,971; 2,015,646; 2,164,800 and 2,174,385.

Another very successful type of abrasive wheel and a type in connection with which the present invention is illustrated herein is the pleated abrasive wheel and wheel element disclosed and claimed in the copending applications of Fritz E. Hendrickson, Canadian Serial No. 675,540, filed November 6, 1954, and U. S. Serial No. 388,308, filed October 26, 1953. This wheel and the pleated element therefor is described in detail herein.

However made, all wheels utilizing coated abrasive components face a common problem—rate of wheel wear. As the wheel is used, the coated abrasive elements break down gradually due to shedding of grain and the tearing out or frictional wearing-out of the threads of the woven backing material.

The rate at which the wheel wears down is very critical to the successful utilization of the wheel. If the wheel wears down too rapidly it becomes uneconomical to use, and if it does not wear down rapidly enough the abrasive grain dulls and will not cut or sheds off leaving only the backing which likewise will not cut and fails to bring into action other sharp grains. Heretofore, little could be done to control this rate of wear or break down except to insure that the bond between the grain and the backing would permit the grain to shed before it dulled itself exceedingly.

Another factor which must be considered in connection with the rate of wear of a coated abrasive wheel is the rate of cut of such wheel. A long-wearing wheel which cuts very little is of slight value. These factors are reflected by a comparison of the loss in weight of a given wheel (due to wearing down and loss of abrasive

grain and backing material) with the loss in weight of the article or fixture being abraded by the wheel. As discussed in detail below, the wheel loss and fixture loss enter into the "efficiency" of the wheel.

Therefore, it is an object of the present invention to provide a method for overcoming the above-described difficulties of the prior art.

It is a further object of the invention to provide a method for improving the rate of wear of coated abrasive wheel elements.

It is an additional object of the invention to provide a coated abrasive wheel element which will wear down at a rate calculated to increase the efficiency of the wheel with which it is used.

Another object of the invention is to provide a coated abrasive wheel made of coated abrasive elements which has a high efficiency.

Additional objects, if not specifically set forth herein, will be readily apparent to one skilled in the art from the following detailed description of the invention:

In the drawings:

Figure 1 illustrates a partially completed coated abrasive wheel made up of a central cage and a plurality of coated abrasive elements.

Figure 2 is a face view in elevation of an abrasive-coated sheet before being made into a wheel element by folding along the dotted lines shown thereon.

Figure 3 illustrates a coated abrasive wheel element after being pleated and folded about a supporting member on the wheel.

Figure 4 illustrates the conventional manner of cutting elements from coated abrasive strip material as heretofore practiced in the art.

Figure 5 shows diagrammatically the position of the warp or strong threads of the coated abrasive backing with relation to the axis of rotation and radius of the coated abrasive wheel when the present invention is employed.

Figure 6 shows one method of cutting sheets for abrasive wheel elements from coated abrasive strip material in accordance with the present invention.

Figure 7 illustrates a second method of cutting sheets for abrasive wheel elements from coated abrasive strip material in accordance with the present invention.

Figure 8 schematically shows the sheet, cut as illustrated in Figure 6, mounted in an abrasive wheel.

Figure 9 schematically shows the sheet cut, as illustrated in Figure 7, mounted in an abrasive wheel.

Generally, the present invention comprises the formation of coated abrasive wheel elements in such a fashion that when assembled into a wheel, the warp threads of the coated abrasive backing of each element are at a controlled angle to the radius of the wheel or to the axis of rotation of the wheel.

More specifically, the present invention is illustrated in connection with the wheel and pleated element thereof disclosed and claimed in the aforesaid applications of Fritz E. Hendrickson. Referring to Figure 1 of the drawings, 10 designates a supporting cage having a pair of end plates 11, each containing a centrally-located shaft-receiving aperture 12 therein. Mounting bars 13 are secured by suitable means such as welding or the like to the end plates 11 at spaced intervals annularly about the central apertures 12. Positioned on these mounting bars 13 are a plurality of coated abrasive elements 14, here shown as being of pleated construction and folded about the bars 13. The wheel is shown as only partially filled with the coated abrasive elements 14 in order to more fully illustrate the various components thereof, but it will be appreciated that in actual use the wheel is completely filled with the coated abrasive elements so as to present a substantially uniform periphery.

The abrasive elements 14 may be made, as illustrated in Figure 2, from a preferably rectangular sheet of woven backing material 20 carrying on one or both sides thereof an adhesively-bonded coating 21 of abrasive grain. The sheet 20 is pleated along the fold lines 22—22 so that one pleat partially overlaps an adjacent pleat, effecting a folded sheet of a width narrower than the unfolded sheet. The central portion 19 of the coated abrasive sheet 20 may be free from abrasive grain. This is desirable in that a larger number of sheets may then be folded about the mounting members of the wheel as illustrated in Figure 1, but is not essential to the successful operation of this type of wheel. Once pleated, the sheet is folded upon itself along the fold line 23 extending medially of the sheet. If desired, several pieces of coated abrasive material may be pleated and doubled in combination to effect a single element.

Referring to Figure 3, a coated abrasive element 14 made in the manner described above is shown in position about a mounting member 13 of a coated abrasive wheel. The fold lines 22 and 23 and the bare center 19 described in connection with Figure 2 are identified on this Figure 3 by the same reference numerals. It will be noted that the ends 30 of the pleated and doubled sheets form an undulated edge outline having a wave-like form with successive curves in alternate directions. It will be understood that a number of such elements are usually combined about each mounting member 13 of the wheel, the exact number depending on the size of the wheel, the mounting member diameter, and other factors within the control and discretion of the operator. The mounting member 13 may be rectangular as shown in Figure 1 and in Figure 3, or of other cross-sectional configuration, such as circular, if desired.

The foregoing description of a coated abrasive wheel and pleated elements therefor has been for the purpose of providing an understanding of one type of coated abrasive wheel in connection with which the present invention may be used. Wheels of varying types made up of unpleated coated abrasive material according to the various methods known to the art may also be improved by the present invention which is now particularly described below:

In the manufacture of coated abrasive material per se, it is accepted practice to use a cloth backing in which the warp threads run parallel to the length direction of the backing as it comes from the coated abrasive making machines and the weft or fill threads run at substantially right angles thereto. With this practice, and referring now to Figure 4, of the drawings, it will be seen that the expected manner of cutting a rectangular piece of material 41 from the coated abrasive strip material 40 would place the warp threads (shown by the longer arrow on Figure 4) parallel to one or the other of the edges 42—43 of the cut sheet. This has been the practice in cutting rectangular sheets of coated abrasive material in the past for all uses, including use as an element of a coated abrasive wheel.

However, we have now discovered that a substantial increase in the cutting life of the abrasive material when used as an element of a coated abrasive wheel, e. g. such as that illustrated in Figures 1–3, may be obtained by so cutting the rectangular sheet from the coated abrasive sheet material that when positioned in the wheel, a plurality of threads of each coated abrasive element backing are at a small angle greater than 0° and less than about 30° from the axis of rotation of the wheel. This is diagrammatically illustrated in Figure 5. The broken vertical line 50 represents the radius of the wheel of Figure 1 while the broken horizontal line 51 represents the axis of rotation of such wheel. Using a conventionally cut piece of coated abrasive material as the wheel element, the warp threads of the backing would lie in the direction of either line 50 or line 51. According to the present invention, the warp threads lie at an angle to either line 50 or line 51 of greater than 0° but less than about 30°. The solid lines 53—53′ represent the situation when the warp threads 53 lie at an angle of 30° to the axis of rotation 51 of the wheel and the fill threads 53′ lie at an angle of 90° to such warp threads. The dashed lines 52—52′ represent the situation when the warp threads 52 lie at an angle of 30° to the radius 50 of the wheel with the fill threads 52′ at an angle of 90° to such warp threads. Since all of the warp threads in a particular element backing are substantially parallel to one another, and since in such backing the fill threads are all at substantially right angles to the warp threads, it will be seen from Figure 5 that whether the warp threads lie at an angle of between 0° and 30° to either the radius 50 or the axis of rotation 51 of the wheel, a plurality of threads, either fill or warp, lie at an angle of between 0° and 30° to the axis of rotation of the wheel. The angle referred to may, of course, be either side of the axis of rotation. Illustrative of this would be the situation wherein threads 52′ and 53′ are the warp threads.

Comparative tests conducted on wheels such as that illustrated in Figure 1 have shown that by holding the angle of the warp threads of the coated abrasive element backing from slightly over 0°, e. g. about 5° or slightly less up to about 30° off the axis of rotation of the wheel, the efficiency of the wheel is greatly increased. A similar increase in efficiency occurs when the warp threads are held at an angle of from about 5° to about 30° off the radius of the wheel, although in this latter case, the improvement in efficiency is not quite so pronounced. The term "wheel efficiency" as used herein is defined as the quotient of the fixture loss$\times 10^4$ divided by the wheel loss$\times$square inches of abrasive in the wheel, wherein the fixture loss is the weight in ounces removed from the piece being abraded; the wheel loss is the decrease in weight of the wheel doing the abrading; and the square inches of abrasive is the total abrasive area in the wheel.

Tests conducted with wheels such as that of Figure 1 have shown that at 0° and 90° warp, i. e. with the warp threads of the coated abrasive element backing substantially parallel to either the axis of rotation of the wheel or to the radius of the wheel, as has heretofore been conventional practice, the wheel efficiency is down around 0.360. Altering the position of the warp threads to an angle within the range of about 5° or slightly less to about 30° off either side of the axis of rotation has given efficiencies in the neighborhood of 1.119 to 1.991 or higher. Surprisingly, with the warp threads at an angle of 45° to the radius or to the axis of rotation, the efficiency has dropped to about the same as it is at the 0° or 90° warp, e. g. 0.394. However, further increasing of the angle of the warp threads to the axis of rotation, i. e. to an angle of about 60° to about 85° from such axis, or, as is the same thing, positioning the warp threads within an angle of from about 5° to about 30° off the radius of the wheel, the efficiency of the wheel has again increased.

Following the present invention, coated abrasive wheel elements cut a greater weight of material from the fixture being abraded per weight of abrasive and backing used up while lasting a substantial period of time longer than do coated abrasive wheel elements made in the usual manner with the warp threads of the backings thereof either parallel to the radius or to the axis of rotation of the wheel. For example, two wheels similar to that of Figure 1 were made up, each having 16 pins in the supporting cage and having 4 coated abrasive sheets, pleated as described above, folded about each pin for a total of 64 pieces of coated abrasive in each of the wheels. The abrasive material used for each wheel was grit 220, aluminum oxide abrasive cloth. One wheel "A" was made in conventional fashion with the warp threads of the coated abrasive element backings extending substantially parallel with the axis of rotation of the wheel. The

other wheel "B" was made with the warp threads of the coated abrasive element backings at an angle of approximately 20° to the axis of rotation of the wheel. The abrasive material in each wheel was double-coated, i. e. carried abrasive on both sides thereof. The fixture was a steel cylinder in each instance.

The results were as follows:

Wheel	Time Req'd to Wear Down (hrs.)	Fixture Loss (oz.)	Wheel Loss (oz.)	Sq. Inches of Abrasive	Efficiency
"A"	11.15	19	56	9,416	.360
"B"	46.00	135	72	9,416	1.991

As will be seen from the above, the wheel made of coated abrasive elements prepared in accordance with the present invention, i. e. wheel "B," lasted more than 4 times as long as the conventionally-made wheel; removed more than 7 times the amount of steel from the fixture as compared with that removed by the conventionally-made wheel; and had an efficiency increase of about 5½ times that of the conventionally-made wheel.

Coated abrasive elements are made, in accordance with the present invention, by cutting the sheets from the roll of coated abrasive material as diagrammatically illustrated in Figures 6 and 7. Referring to these drawings, **60** designates a length of coated abrasive material as it comes from the coated abrasive making machines. The warp threads of the backing run in the length direction of the material and substantially parallel to the side edges **61—61** thereof, as shown by the longer arrows on these two figures. With reference to Figure 6, in order to cut a sheet **62** from the strip of coated abrasive material **60** in such a manner that, after assembly into a wheel such as that shown in Figure 1, the warp threads will then run at an angle of 30° to the axis of rotation of such wheel, the long sides **63—63** of the sheet are cut at an angle of 30° to the warp direction of the coated abrasive strip **60**. Reference to Figure 8 will illustrate that the warp threads **64** of the material so cut are then at an angle of 30° to the axis of rotation of the wheel when the material is pleated and folded about the supporting member **13** of the wheel.

When cutting a sheet so as to have the warp threads within the specified angle called for by the claims, as related to the radius of the wheel, the sheet is cut as shown in Figure 7 with the long sides **73—73** of the rectangular sheet **62** at a small angle from the cross-direction of the coated abrasive strip material **60**. In Figure 7, the material is being cut at 5° from the cross-direction which is indicated by broken line **74**. Reference to Figure 9 will show that a sheet so cut, when formed into a pleated element and folded about the supporting member **13** of a wheel, as hereinbefore described, has the warp threads **64** running at an angle of 5° to the radius of the wheel.

Any of the various cloth backings known and used in the coated abrasive art may be utilized in carrying out this invention. Preferably, however, we use the lighter cloths such as "jeans" or open mesh cloths such as "leno" rather than the heavier cloths such as "ducks."

Grain sizes such as those used in making coated abrasives in the United States, Canada, the United Kingdom, France, Germany, Sweden and Australia are preferably used in carrying out the invention but variations of these grain sizes may be used if desired.

Although a wide range of abrasive materials and grades thereof may be used in the practice of this invention, we have found a wide field of usefulness for one or more of grades 120 through 400 silicon carbide or fused aluminum oxide abrasive grain. Frequently, two or more grain sizes are used in sequence from coarse to fine in order to remove defects and secure a good finish on the fixture being abraded or polished. The finish may then be further modified or improved by conventional polishing or buffing with compounds in some instances.

It will be noted that in the case where the coated abrasive element is of the pleated and folded type as hereinbefore described, the medial fold line of the sheet used to make up the element (i. e. fold line **23** of Figure 2) is parallel to the axis of rotation of the wheel into which the element is to be inserted. Accordingly, the angle of the backing threads may be related to such medial fold line in exactly the same manner as to the axis of rotation of the wheel.

While described primarily in connection with a pleated wheel element formed of coated abrasive material, the present invention will improve all coated abrasive wheels and wheel elements therefor wherein the coated abrasive element is presented to the work in edgewise fashion as is true with most wheels of this type.

Where the term "angle" is used in the specification and claims, it will be understood that such term covers both the plus and minus angle as related to the particular reference line given.

Obviously, many modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. A coated abrasive wheel element comprising a woven backing member bearing on at least one side thereof a layer of abrasive grain adhesively secured to the backing member, the threads comprising said woven backing member being so disposed and arranged that when said element is positioned in a coated abrasive wheel a plurality of said threads extend at an angle greater than 0° and less than about 30° to the axis of rotation of said wheel.

2. An element as in claim 1 wherein the plurality of threads are the warp threads of said backing member.

3. An element as in claim 1 wherein the plurality of threads are the weft threads of said backing member.

4. In a coated abrasive wheel wherein a plurality of individual, radially-extending pieces of coated abrasive material having woven backings are fixedly secured about a central hub, the improvement which comprises forming the individual pieces of coated abrasive material so that a plurality of threads of the woven backings thereof are at an angle greater than 0° and less than about 30° to the axis of rotation of said wheel.

5. A wheel as in claim 4 wherein the plurality of threads are the warp threads of the woven backings.

6. A wheel as in claim 4 wherein the plurality of threads are the weft threads of the woven backings.

7. A method for improving the efficiency of coated abrasive wheels of the type utilizing a plurality of individual, radially-extending pieces of coated abrasive material having woven backings fixedly secured about a central hub which comprises: cutting said individual pieces of coated abrasive material from a larger strip of coated abrasive material at an angle to the length of said larger strip as manufactured on a coated abrasive making machine, the woven backing of said larger strip being composed of warp threads running in the length direction of said strip and weft threads running at substantially right angles to said warp threads; and assembling said individual pieces so cut into an abrasive wheel whereby a plurality of the threads of the backings thereof are disposed at an angle greater than 0° and less than about 30° to the axis of rotation of said wheel.

8. A method as in claim 7 wherein the plurality of threads of the backings are the warp threads.

9. A method as in claim 7 wherein the plurality of threads of the backings are the weft backings.

10. A coated abrasive product comprising a substantially rectangular woven backing member bearing on at least one side thereof a layer of abrasive grain adhesively secured to the backing member; said woven

backing member being composed of a plurality of threads, running at an angle greater than 0° and less than 30° to a medial line extending in the length direction of said backing member, and a second plurality of threads running at substantially right angles to said first-mentioned plurality of threads; said backing member being folded upon itself to form a plurality of partially overlapping pleats extending at substantially right angles to said medial fold line; and then being folded upon itself about said medial fold line to form an element adapted to be placed in a coated abrasive wheel.

11. A coated abrasive product comprising a substantially rectangular woven backing member bearing on at least one side thereof a layer of abrasive grain adhesively secured to the backing member; said woven backing member being composed of a plurality of threads, running at an angle greater than 0° and less than 30° to a medial line extending in the length direction of said backing member.

No references cited.