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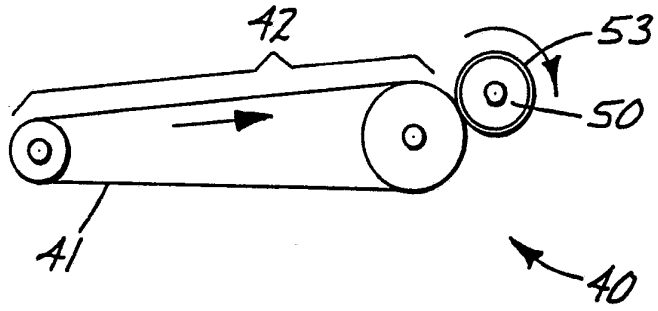

(57) Abstract

A dressing tool for use in methods for "dressing" coated abrasives (e.g. such as an endless belt) is disclosed. The tool has peripheral surfaces with abrasives that are generally as wide as the coated abrasives. The tool affords simultaneous dressing of multiple abrasive belts. Several methods for dressing a coated abrasive are also disclosed.

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Coated Abrasives Dressed By A Multiple Point Cutting Tool

Technical Field

The present invention relates generally to continuous coated abrasive articles of the type having flexible backings with front and rear surfaces and abrasive particles including abrasive grains attached along their front surfaces.

Background of the Invention

The art is replete with abrasive articles used to create new surfaces on objects. Examples of such abrasive articles are the endless abrasive belts used in conjunction with the camshaft grinder disclosed in U.S. Patent No. 4,833,834. Such endless abrasive belts may be constructed using the abrasive agglomerates described in Bloecher et al. U.S. Patent number 4,799,939 which may contain abrasive grains made for example according to the teachings in Schwabel U.S. Patent Number 4,744,802. U.S. Patent 4,215,516 to Huschle et al. discloses a splicing system for butt splicing flexible abrasive belts to form an endless abrasive belt.

Abrasive agglomerates may include a plurality of abrasive grains bonded together by a phenolic resin (e.g. a phenolic based make and size coat) or any other suitable binder to form a shaped mass, and the abrasive grains may be constructed from ceramic aluminum oxide, commercially available from the Minnesota Mining and Manufacturing Company (3M) of St. Paul, Minnesota under the trade designation grade 120 "Cubitron" ceramic aluminum oxide abrasive grains, and may have a particle size of approximately 116 micrometers. As used in this application, the phrase "abrasive agglomerate" is defined as a plurality of abrasive grains bonded together by a binder.

Figures 1 and 2 illustrate a coated abrasive belt 10 (e.g., the abrasive belt sold by Minnesota

Mining and Manufacturing, St. Paul Minnesota, under the trade designation 3M "Multicut" T.M. Resin Bond cloth coated abrasive belts) after it is constructed but before it is used to abrade a workpiece. Such an abrasive belt may be used, for example, in conjunction with the camshaft grinder disclosed in U.S. Patent No. 4,833,834 to grind pieces of metal stock having generally cylindrical portions into camshafts.

The coated abrasive belt 10 includes a flexible backing 11 (e.g. cloth or polymeric film, vulcanized fiber, paper, combinations thereof and treated versions thereof) with front and rear or "back" surfaces, and a mound or mountain-shaped abrasive coating 12 which includes abrasive agglomerates attached along the front surface of the backing 11. The mountain-shaped surface of the abrasive belt includes numerous peaks and valleys. The "height" of a peak is defined in this specification as the shortest distance between the back surface of the backing and the top of the peak along the surface of the abrasive belt.

These and other existing abrasive belts encounter problems during "start up" or during their initial use. Initially, before the belt is used to grind a workpiece, the heights of the mountains along the mountain-shaped surface of the abrasive belt vary widely, as much as forty (40) percent. The uneven thickness of the belt may be due to a variety of factors such as, but not limited to coating variations, backing variations, or splices. The tallest peaks tend to cause undesirable results such as "wild scratches" or a coarse surface finish on the workpieces (e.g. camshafts) which are ground during the initial uses of the abrasive belt. It is believed that pressure is initially concentrated at the tallest peaks until they break or shear from the remaining abrasive agglomerate attached to the abrasive belt. The breakage or shearing of the tallest peaks of the abrasive agglomerate ultimately leads to a more uniform belt

thickness or caliper, but only after the end user risks leaving deep or "wild" scratches or risks creating an undesirably coarse finish on the workpiece.

The endless abrasive belts used with the camshaft grinder disclosed in U.S. Patent 4,833,834 should produce a consistent finish on the surface of camshafts. A coated abrasive belt such as the belt shown in Figures 1 and 2 may not leave the desirable finish on the workpiece until the mountain shaped abrasive is sufficiently worn. Another problem associated with the initial uses of the prior art endless abrasive belts on a camshaft grinder such as the camshaft grinder shown in U.S. Patent 4,833,834 is that the caliper or "thickness" of the belt initially changes rapidly as the mountain-shaped portions are broken and worn away. The camshaft grinder is required to continually adjust for this rapid change of belt caliper until the wear characteristics of the belt stabilizes.

Additionally, existing abrasive belts encounter problems even after their "start up" or initial use. For example, when an abrasive belt is used to abrade a metal workpiece (e.g. a camshaft) the metal pieces which are abraded from the workpiece tend to become welded over the surface of the abrasive. This prematurely ends the useful life of a belt.

Some existing endless coated abrasive belts encounter problems due to their lack of uniform thickness. Known butt splices are used to construct some endless abrasive belts. In a butt splice, two edges of the backing of an abrasive sheet are abutted, and thereafter joined together with a reinforcing strip which is bonded to the underside of the abrasive belt.

Coated abrasive belts which incorporate butt splices may have a thickness which is greater at the splice than elsewhere along the belt. The height of the peaks of the agglomerate at the splice area will generally tend to be greater than the heights of the peaks along the remainder of the endless belt due to

the presence of the reinforcing strip. This additional thickness or "height" in the splice area tends to leave "splice marks" or undesirably deep "wild" scratches in the abraded workpiece.

Another known method of constructing an endless belt is known as a "lap splice" wherein two ends of an abrasive belt sheet are overlapped to form an endless abrasive belt. The thickness of the belt at the joint may be greater than the thickness of the belt elsewhere due to the overlapped ends. Again, the difference in thickness or caliper of the belt at the lap splice tends to result in undesirable consequences such as marks or deeper "wild" scratches in the abraded workpiece.

A known treatment of an abrasive product is disclosed in U.S. Patent No. 1,944,898 to McKee. McKee discloses providing a pair of rolls constructed from a material that is tougher than the abrasive material of the coated abrasive product (Figure 3). The mineral particles of the abrasive article are "broken" down by the tougher rolls.

Known methods for dressing a grinding wheel are described by Kenneth B. Lewis and William F. Schleicher in Chapter 14, pages 149 to 164 of "The Grinding Wheel" A Textbook of Modern Grinding Practice, The Grinding Wheel Institute, Cleveland, Ohio (1976). Grinding wheels are generally dressed to sharpen the wheel by exposing abrasive grains and are sometimes dressed to "true" the wheel.

Disclosure of the Invention

The present invention provides a coated abrasive comprising a flexible backing with front and rear or "back" surfaces, a generally uniform width, and mounds of abrasive particles including abrasive grains attached along the front surface. Initially, the mounds of abrasive particles project different distances in a predetermined range from the front surface of the backing. A multiple point cutting means

having a width at least substantially equal to the width of the backing and having a cutting surface constructed from a material harder than the abrasive grains is used to cut the mounds of the abrasive particles to form generally coplanar surfaces generally parallel to the back surface.

In a preferred embodiment of the coated abrasive, the mounds have heights measured from the back surface of the flexible backing, and the coplanar surfaces have heights measured from the back surface of the flexible backing such that the heights of the mounds before cutting and the height of the coplanar surfaces after cutting are described by the equation:

$$P1 \approx X\,(P2);$$

wherein:

X is between 1.1 and 2; and

P1 = the height of the tallest mound of the abrasive particles before cutting, and

P2 = the height of the tallest co-planar surface of the abrasive particles after cutting by the cutting means. In one embodiment, X is equal to 1.35.

The present invention may be characterized as a method of quickly and conveniently "dressing" a coated abrasive article that may be used in conjunction with automatic dressing mechanisms, which provides a more consistent uniform finish, which significantly reduces the tendency of the resultant coated abrasive article to create wild scratches or an otherwise deficient finish on a workpiece during the initial use of the abrasive article, and which provides a coated abrasive with more predictable wear characteristics and a more uniform caliper or thickness.

The coated abrasive of the present invention may be prepared by the process comprising the steps of: (1) providing a flexible backing with front and rear surfaces and having a generally uniform width, and attaching discrete mounds of abrasive particles

including abrasive grains along the front surface, the mounds of abrasive particles projecting different distances in a predetermined range measured from the rear or back surface of the backing, (2) providing a multiple point cutting means having a width at least substantially equal to the width of the backing and having cutting surfaces constructed from a material harder than the abrasive grains, and then (3) cutting the mounds of the abrasive particles projecting more than a predetermined distance within the range with the cutting means to form generally coplanar surfaces generally parallel to the back surface. The cutting means may have surfaces constructed from diamonds, boron nitride or any other suitable cutting material so long as the material is harder than the abrasive grains.

Additionally, the present invention may be described as a method of grinding workpieces using endless coated abrasive belts each comprising a flexible backing with front and rear surfaces and mounds of abrasive particles including abrasive grains attached along the front surface. The endless coated abrasive belts may be mounted on a means for driving the endless abrasive belt, such as the camshaft grinder described in U.S. Patent No. 4,833,834. A multiple point cutting means having cutting surfaces harder than the abrasive grains is provided.

Next, the abrasive belts are driven past a grinding station and the belts are used to grind several workpieces until the abrasive belt becomes dull, and then the endless abrasive belt is dressed while remaining mounted on the means for driving the endless abrasive belt by cutting the abrasive particles with the cutting means to remove debris and to resharpen the belt. Additionally, each of the coated abrasive belts may be simultaneously dressed while they are mounted on the camshaft grinder described in U.S. Patent No. 4,833,834 and before they are used to grind a workpiece.

Brief Description of the Drawing

The present invention will be further described with reference to the accompanying drawing wherein like reference numerals refer to like parts in the several views, and wherein:

Figure 1 is a cross-sectional photographic view of a prior art coated abrasive before it is used to abrade a workpiece;

Figure 2 is a photograph at a magnification of twenty-five (25) of another portion of the coated abrasive of Figure 1;

Figure 3 is a cross-sectional photographic view of coated abrasive after it has been dressed by the method according to the present invention;

Figure 4 is a photograph at a magnification of twenty-five (25) of another portion of the abrasive of Figure 3;

Figure 5 is a cross-sectional photographic view of a coated abrasive belt after it has been used to grind 19 camshafts on a camshaft grinder;

Figure 6 is a photograph at a magnification of forty (40) of another portion of the coated abrasive belt shown in Figure 5;

Figure 7 is a schematic illustration of a first embodiment of the method of making or "dressing" a coated abrasive according to the present invention;

Figure 8 is a perspective view of one embodiment of cutting means according to the present invention;

Figure 9 is a top view of a means for simultaneously driving a plurality of belts past a dressing/grinding station and the cutting means of Figure 8, which illustrates a technique for simultaneously dressing a plurality of abrasive belts;

Figure 10 is a schematic illustration of a second embodiment of the method of making or "dressing" a coated abrasive according to the present invention;

Figure 11 is a schematic illustration of a third embodiment of the method of making or "dressing" a coated abrasive according to the present invention;

Figure 12 is a cross-sectional photographic view of a coated abrasive such as the coated abrasive of Figure 5 after it has been dressed subsequent to the grinding of (19) camshafts; and

Figure 13 is a photograph at a magnification of forty (40) of another portion of the coated abrasive belt of Figure 12.

Detailed Description

Referring now to Figures 3 and 4 of the drawing, there is shown a coated abrasive according to the present invention generally designated by the reference number 20. The coated abrasive 20 comprises a flexible backing 21 with front and rear surfaces, and mounds of abrasive agglomerates 22 including abrasive grains 23 (e.g. ceramic aluminum oxide, commercially available from the Minnesota Mining and Manufacturing Company (3M) of St. Paul, Minnesota under the trade designation grade 120 "Cubitron" ceramic aluminum oxide abrasive grains with a particle size of approximately 116 micrometers) attached along the front surface (e.g. by phenolic based make and size coats). The mounds of abrasive agglomerates 22 initially project different distances in a predetermined range measured from the rear or back surface of the backing 21.

To begin constructing the coated abrasive 20, the coated abrasive 10 shown in Figures 1 and 2 (e.g., the abrasive belt sold by Minnesota Mining and Manufacturing, St. Paul Minnesota, under the trade designation 3M "Multicut" T.M. Resin Bond Cloth coated abrasive belts) may be selected. The coated abrasive 10 may be constructed using the abrasive agglomerates described in Bloecher et al. U.S. Patent number 4,799,939 which may contain abrasive grains made for example according to the teachings in Schwabel U.S. Patent Number 4,744,802.

Referring now to Figures 7 and 9 there is shown a schematic illustration of a first embodiment of the method of making or "dressing" a coated abrasive according to the present invention generally designated by the reference number 40. The coated abrasives shown in Figure 7 are endless coated abrasive belts 41 which may be formed by utilizing a lap or butt splice. As mentioned above, endless belts having lap or butt splices may be thicker in some portions than others and may tend to leave undesirable marks or wild scratches in the workpiece.

Figures 7 and 9 illustrate the prior art coated abrasives shown in Figures 1 and 2 after they are formed into the endless belts 41 and after they are mounted on a means for driving the endless abrasive belt 41, such as the camshaft grinder described in U.S. Patent No. 4,833,834 schematically illustrated as reference character 42.

Figure 8 illustrates a multiple point cutting means which is preferably constructed from a generally cylindrical piece of metal stock 50 which is similar to the pieces of metal stock which are ultimately ground into the asymmetrical cross-sections of the camshafts.

The use of a multiple point cutting means substantially reduces the time required to dress a coated abrasive when compared with the time required to dress a coated abrasive with a single point cutting tool.

The cutting means is used to cut material from the mountain-shaped surfaces (Figure 1) to form coplanar surfaces 25. The metal stock 50 has cutting surfaces 53 harder than the abrasive grains 23 attached thereto on surfaces which are generally spaced the same as the spacings of the lobes on the camshafts. Alternatively the cutting means may be continuously coated with cutting surfaces 53.

The cutting surfaces 53 may be attached to the periphery of the metal stock by any known method, such as but not limited to flame spraying or plating.

For example, the cutting means may comprise a piece of metal stock 50 having generally cylindrical periphery portions and a metal binder coated (e.g. electroplated or brazed) to selected portions of its generally cylindrical periphery and with cutting surfaces 53 (e.g. diamonds or cubic boron nitride) applied to the metal binder. Another method of making a suitable cutting means comprises the steps of providing a generally cylindrical piece of metal stock and adhesively applying a strip of "DIAPAD" T.M. abrasive (commercially available from Minnesota Mining and Manufacturing, 3M, St. Paul, Minnesota) to the periphery of the metal stock with, for example pressure and a hot melt adhesive.

Additionally, the cutting means may be constructed by laminating (e.g. adhesively) or plating a coated abrasive containing the cutting surfaces 33 harder than the abrasive grain to the cylindrical piece of metal stock 30. Also, U.S. Patent Gorsuch 4,256,467 discloses another method of making a cutting means for use in the method of the present invention by electroplating a metal binder and abrasive grains to a mesh material.

In a preferred embodiment of the coated abrasive 20, the mounds or mountain-shaped portions have heights measured from the back surface of the flexible backing 21, and the coplanar surfaces 25 have heights also measured from the back surface of the flexible backing such that the heights of the mounds before cutting (e.g. 12 of Figure 1) and the height of the coplanar surfaces after cutting are described by the equation:

$$P1 \approx X\ (P2);$$

wherein:

P1 = the height of the tallest mound or mountain-shaped portion of the abrasive particles before cutting, and

P2 = the height of the tallest co-planar surface of the abrasive particles after cutting by the cutting means.

When "Multicut" T.M. Resin Bond cloth coated abrasive belts are used as the abrasive, X is preferably within the range of between 1.1 and 2, since if X becomes less than 1.1 then the resultant abrasive is underdressed and the attendant problems of scratching and rapid belt caliper change are encountered, and if X becomes greater than 2, then the belts tend to be overdressed which prematurely ends the useful life of the belt.

For example, the "Multicut" T.M. coated abrasive may initially have a height of the tallest mound of the abrasive agglomerate 12 of approximately 0.066 inches. Such coated abrasives are useful for a variety of grinding operations and may be used, for example, as an endless coated abrasive belt used to grind camshafts using a camshaft grinder such as the camshaft grinder described in U.S. Patent No. 4,833,834. When using such coated abrasives to grind camshafts, it has been determined that dressing or cutting the height of the tallest co-planar surface 25 of the abrasive particles 22 to about 0.049 inches provides an abrasive belt with a more uniform caliper or thickness, and which significantly reduces the tendency of the resultant coated abrasive article to create wild scratching, damaging or an otherwise deficient finish on a workpiece during the initial use of the abrasive article particularly when using an endless belt which may have a raised abrasive portion proximate its seam. In this example X is equal to 1.35.

Dressing of an abrasive belt also provides a coated abrasive with more predictable wear characteristics in that the useful life of a dressed belt is more readily predicted than a belt that is not dressed. It is believed that the pressures at the abrading interface of a dressed belt are more evenly

distributed over the abrasive surface once the mountain-shaped portions are cut into the plateau shapes.

The width of the periphery of a portion of the metal stock 50 having the individual cutting surfaces 53 attached thereto is approximately the width of a single belt. The total area of the periphery of the metal stock 50 which has cutting surfaces 53 attached thereto is substantially equal to or greater than the total of the widths of each of the endless abrasive belts 41. Such a cutting means affords the user the opportunity to dress multiple belts at the same time which substantially reduces the time required to dress the plurality of abrasive belts 41 when compared with the time required to individually dress individual belts. Optionally a plurality of single-point diamond dressing tools may be used as the cutting means.

To cut the mountain shapes shown in Figure 1 into the shapes shown in Figure 3, the cylindrical piece of metal stock 50 may be rotated clockwise (alternatively the stock 50 may remain stationary) relative to the frame 45 of the grinding means 42 (Figure 7) by any suitable drive means as the belts 41 are driven by the grinding means 42, and then moved toward the abrasive belts 41 in a direction generally perpendicular to the axis of the cylindrical piece of stock 50 into contact with the abrasive until the desired amount of material is removed from the abrasive.

When the abrasive belts 41 become dull or overly contaminated with grinding debris (e.g. after they are used to grind several camshafts), the endless abrasive belts 41 may also be redressed while remaining mounted on the means 42 for driving the endless abrasive belt by simply cutting the abrasive agglomerate with the cutting means 50, 53.

Figures 5 and 6 illustrate a coated abrasive after it is used to grind nineteen (19) camshafts on a

camshaft grinder. At this point, the "Multicut" abrasives tend to begin to become dull. Also, metal particles tend to become welded over the front surface of the abrasive.

Figures 12 and 13 illustrate the coated abrasive of Figures 5 and 6 after it has been redressed to resharpen and to clean the abrasive. Redressing or cutting the abrasive belts with the cutting means after the belts are used to abrade several workpieces is believed to "clean" the abrasive belt by, for example, removing the metal particles which tend to weld themselves to the surface of the abrasive during grinding. Also, redressing the belts at this time provides a belt with a more uniform thickness and thus restricts the likelihood of wild scratches. Also, particularly when the abrasive comprises an abrasive belt with an agglomerate that includes abrasive grains, redressing the abrasive at this time is believed to expose additional grains to thereby sharpen and extend the life of the abrasive belts.

While the present invention has been described in conjunction with a camshaft grinder 42, it should be noted that the present invention may be practiced with any suitable grinding assembly which utilizes a coated abrasive. For example, the formed wheel grinding assembly, conveyorized grinding assembly, centerless grinding assembly, surface grinding assembly, flexible bed sheet grinding assembly, rotary table surface grinding assembly, and swing grinding assembly described on pages 19-21 of Metalworking, Reference Manual, published by the Industrial Abrasives Division of Minnesota Mining and Manufacturing, ISBN #60-4400-0366-7 (1294)JR may utilize the abrasive belts and the dressing methods of the present invention. Also, the backstands, polishing jacks or vertical slack belt machines sold by KLK Industries, Crystal, Minnesota, or G & P Industries, Indianapolis, Indiana may also utilize the abrasive belts and dressing methods of the present invention.

Moreover, it is possible to dress an abrasive before it is mounted on the machine used to grind a workpiece. Figure 10 illustrates a second method of dressing coated abrasives according to the present invention, generally designated by the reference character 18. A multiple point cutting means having a cutting surface 33 constructed from a material harder than the abrasive grains 23 is again used to cut the mounds of the abrasive particles 22 from the front surface to form generally coplanar surfaces 25 (Figures 3 and 4) generally parallel to the front surface.

While Figures 7 and 9 illustrate coated abrasive belts dressed on a grinding machine, Figure 10 illustrates an example of a method of dressing coated abrasives at a location remote from the location of their ultimate use. For example, the coated abrasives 20 may be dressed before they are shipped to the end user.

The coated abrasive 20 of the present invention may be prepared by the process comprising the steps of: (1) providing a flexible backing 21 with front and rear surfaces, and attaching discrete mounds of abrasive particles which includes abrasive grains 23 along the front surface, the mounds of abrasive particles projecting different distances in a predetermined range measured from the back surface of the backing (see Figure 1), (2) providing multiple point cutting means (e.g. 30) having cutting surfaces 33 constructed from a material harder than the abrasive grains 23, and then (3) cutting the mounds of the abrasive particles 12 projecting more than a predetermined distance within the range with the cutting means to form generally coplanar surfaces 25 generally parallel to the back surface.

The cutting means has cutting surfaces 33 constructed from "super abrasives" such as diamonds, cubic boron nitride, metal carbides, metal nitrides or any other suitable cutting material as long as the material is harder than the abrasive grains 23. In

Figure 10, the entire periphery of the cutting means includes cutting surfaces 33, unlike the metal stock 50 which only has selected portions coated with the cutting surfaces.

The width of the metal stock 30 should be at least substantially equal to the width of the coated abrasive 20 to afford efficient, effective dressing of the entire width of the abrasive 20. The method of making a coated abrasive 20 shown in Figure 10 is particularly suitable for dressing large sheets or rolls of an abrasive belt prior to shipment to the ultimate user.

In the embodiment shown in Figure 10, the dressing tool or multiple point cutting means comprises a cylindrical piece of metal stock 30. The stock 30 may be rotated clockwise as the coated abrasive 20 is moved relative to the metal stock 30 from left to right in the figure. Back-up means (not shown) are provided to support the coated abrasive 20. The cutting means may be located proximate the coated abrasive then moved in a direction perpendicular to the axis of the cylindrical stock 30 toward the coated abrasive 20 into contact with the abrasive until the desired amount of material is cut from the coated abrasive 20. The back-up means may comprise a hard flat surface or may comprise a hard cylindrical member adapted for clockwise rotation. Optionally, the cutting means may remain stationery or it may be oscillated.

Referring now to Figure 11 there is shown a schematic illustration of a third embodiment of the method of making or dressing a coated abrasive according to the present invention generally designated by reference character 70.

The method illustrated in Figure 11 is particularly suitable for dressing a wound abrasive from any suitable, known workpiece feed mechanism. The workpiece feed mechanism may comprise an unwind wheel or drum 87 having a sheet of coated abrasives 71 wound

and journaled thereon, a back-up wheel 72, and a take-up wheel 73.

A multiple point cutting means 82 (e.g. a generally cylindrical piece of metal stock) having cutting surfaces 53 harder than the abrasive grains 23 is provided. Like the cutting means shown in Figure 10, the cutting means shown in Figure 11 may comprise a generally cylindrical piece of metal stock 82 having a periphery and a metal binder coated (e.g. electroplated or brazed) to its periphery and with cutting surfaces 83 (e.g. diamonds or boron nitride) applied to the metal binder. Alternatively the cutting means may be constructed by laminating (e.g. adhesively) a coated abrasive containing the cutting surfaces 83 harder than the abrasive grains to the cylindrical piece of metal stock 50.

The width of the metal stock 82 (not shown) should be at least substantially the same as the width of the coated abrasive roll 71. When a cutting means having a width substantially equal to the total of the widths of the coated abrasive 71 is used, a large stock roll of coated abrasives may be quickly, conveniently and efficiently dressed in a relatively short period of time.

In the embodiment shown in Figure 11, the cylindrical piece of metal stock 82 may be rotated counterclockwise as the coated abrasive 71 is moved relative to the metal stock 82 by the take-up wheel 73 in the direction shown by the arrows in the figure. For example, the cutting means 82, 83 is moved in toward the back up wheel 72 into contact with the abrasive to efficiently cut the mounds of abrasive particles 22 until the desired amount of material is cut from the coated abrasive. Optionally, the cutting means may be oscillated while in contact with the abrasive.

The present invention has now been described with reference to several embodiments thereof. It will be apparent to those skilled in the art that many

changes can be made in the embodiment described without departing from the scope of the present invention. For example, while the method of dressing a coated abrasive of the present invention has been described using the abrasive belt sold by Minnesota Mining and Manufacturing, St. Paul, Minnesota, under the trade designation 3M "Multicut" T.M. Resin Bond Cloth Coated Abrasive Belts as exemplary, the method of the present invention may be described with respect to any suitable abrasive such as, but not limited to, the abrasive belts sold by Minnesota Mining and Manufacturing, St. Paul, Minnesota, under the trade designation 3M "Regal" T.M. Resin Bond Cloth Belts, or the abrasive belt also sold by Minnesota Mining and Manufacturing Company, St. Paul, Minnesota, under the trade designation 3M 331D "Three-M-ite" T.M. Resin Bond Cloth Belts, or other abrasive belts that are not agglomerates. Also, the method of the present invention is particularly suitable for use with automatic dressing mechanisms which control the interference between the dressing tool/cutting means and the coated abrasive. Additionally, while the cutting means has been described as a cylindrical piece of metal stock, the cutting means may comprise any suitable shape, such as, but not limited to flat, arcuate, triangular, hexagonal or combinations thereof, as long as the cutting means includes cutting surfaces harder than the abrasive grains 23. For example, the cutting means may comprise Diamond Impregnated Dresser Style No. 556, available from Carter Diamond Tool of Willoughby, Ohio that is intended for use with bonded wheels.

Claims:

1. A method of manufacturing a coated abrasive comprising the steps of:

providing a flexible backing with front and back surfaces and a generally uniform width,

attaching mounds of abrasive particles including abrasive grains along the front surface, the mounds of abrasive particles projecting different distances in a predetermined range measured from the back surface of the backing,

providing multiple point cutting means having a cutting surface constructed from a material harder than the abrasive grains and having a width at least substantially equal to the width of the flexible backing, and

then cutting the mounds of the abrasive particles including the abrasive grains with the cutting means to form generally coplanar surfaces generally parallel to the back surface.

2. A method of manufacturing a coated abrasive according to claim 1 wherein the mounds have heights measured from the back surface of the flexible backing, and the coplanar surfaces have heights measured from the back surface of the flexible backing such that the heights of the mounds before cutting and the height of the coplanar surfaces after cutting are described by the following equation:

$P1 \approx X(P2)$;

wherein:

X is between 1.1 and 2; and

P1 = the height of the tallest mound of the abrasive particles before cutting, and

P2 = the height of the tallest co-planar surface of the abrasive particles after cutting by the cutting means.

3. A method of manufacturing a coated abrasive according to claim 2 wherein X is equal to 1.35.

4. A method of manufacturing a coated abrasive according to claim 1 wherein the step of providing multiple point cutting means having a cutting surface constructed from a material harder than the abrasive grains comprises the steps of:

providing a dressing tool having a generally cylindrical surface and a periphery,

coating the periphery of the dressing tool with a metal binder, and

attaching a diamond abrasive grain to the periphery of the dressing tool.

5. A method of manufacturing a coated abrasive according to claim 1 wherein the step of providing multiple point cutting means having a cutting surface constructed from a material harder than the abrasive grains comprises the steps of:

providing a dressing tool having a generally cylindrical surface and having a periphery,

coating the periphery of the dressing tool with a metal binder, and

attaching a cubic boron nitride abrasive grain to the periphery of the dressing tool.

6. A method of manufacturing a coated abrasive according to claim 1 wherein the step of cutting the mounds of the abrasive particles comprises the steps of:

rotating the cutting means; and

moving the cutting means into contact with the coated abrasive until the desired amount of material is removed from the coated abrasive.

7. A method of grinding workpieces using a endless coated abrasive belt comprising a flexible backing with front and back surfaces, a substantially

uniform width and mounds of abrasive particles including abrasive grains, the abrasive particles having generally coplanar surfaces generally parallel to the back surface attached along the front surface, the method of grinding a workpiece comprising the steps of:

providing a means for driving the endless abrasive belt,

providing multiple point cutting means having cutting surfaces harder than the abrasive grains and having a width at least substantially equal to the width of the backing,

mounting the endless abrasive belt on the means for driving the endless abrasive belt,

grinding the workpiece with the endless abrasive belt until the abrasive belt becomes dull, and

then dressing the endless abrasive belt on the means for driving the endless abrasive belt by cutting the abrasive particles with the multiple point cutting means to resharpen the belt.

8. A method of dressing a coated abrasive comprising a flexible backing with front and back surfaces and mounds of abrasive particles including abrasive grains, the coated abrasive having a generally uniform width, the method of dressing a coated abrasive comprising the steps of:

providing a means for driving the coated abrasive during abrasion of a workpiece,

providing multiple point cutting means having cutting surfaces harder than the abrasive grains and having a width at least substantially equal to the width of the backing,

mounting the coated abrasive on the means for driving the coated abrasive,

driving the coated abrasive past a dressing station, and

then dressing the coated abrasive on the means for driving the coated abrasive by cutting the abrasive

particles with the cutting means to provide uniform belt caliper.

9. A method of dressing a coated abrasive according to claim 8 wherein the step of dressing the coated abrasive comprises the steps of:

rotating the cutting means; and

moving the cutting means into contact with the coated abrasive until the desired amount of material is removed from the coated abrasive.

10. A method of dressing coated abrasives comprising the steps of:

providing a plurality of endless coated abrasive belts each comprising a flexible backing with front and back surfaces, a width, and mounds of abrasive particles including abrasive grains, the endless coated abrasive belts having generally coplanar surfaces generally parallel to the back surface attached along the front surface,

providing a means for driving the endless abrasive belts,

mounting the endless coated abrasive belts on the means for driving the endless abrasive belts,

providing a plurality of multiple point cutting means having cutting surfaces harder than the abrasive grains and having a width at least substantially equal to or greater than the total of the widths of each of the endless abrasive belts, and

then simultaneously dressing each of the endless abrasive belts on the means for driving the endless abrasive belt by cutting the abrasive particles with the multiple point cutting means.

11. A method of dressing coated abrasives comprising the steps of:

providing a plurality of endless coated abrasive belts each comprising a flexible backing with front and

back surfaces, a width, and mounds of abrasive particles including abrasive grains,

providing means for driving the endless abrasive belts,

mounting the endless coated abrasive belts on the means for driving the endless abrasive belts,

providing a plurality of cutting means having a cutting surface harder than the abrasive grains, and

then simultaneously dressing each of the endless abrasive belts by cutting the abrasive particles with the cutting means.

12. A dressing tool adapted to dress a coated abrasive comprising a backing with front and back surfaces, a width, and mounds of abrasive particles including abrasive grains which abrasive is adapted to grind camshafts having spaced lobes, said dressing tool comprising

a generally cylindrical shaft portion,

generally cylindrical portions having generally cylindrical periphery portions spaced along said shaft,

said periphery portions having multiple point cutting surfaces attached along the periphery portions that are constructed from a material harder than the abrasive grains, and

wherein the spacing of the cylindrical portions is approximately equal to the spacing of the lobes on the camshafts.

13. A method of dressing coated abrasives comprising the steps of:

providing a plurality of endless coated abrasive belts each comprising a flexible backing with front and back surfaces, a width, and mounds of abrasive particles including abrasive grains,

providing means for driving the endless abrasive belts,

mounting the endless coated abrasive belts on the means for driving the endless abrasive belts,

providing a plurality of cutting means having a cutting surface harder than the abrasive grains, and

then simultaneously dressing each of the endless abrasive belts by cutting the abrasive particles with the cutting means.

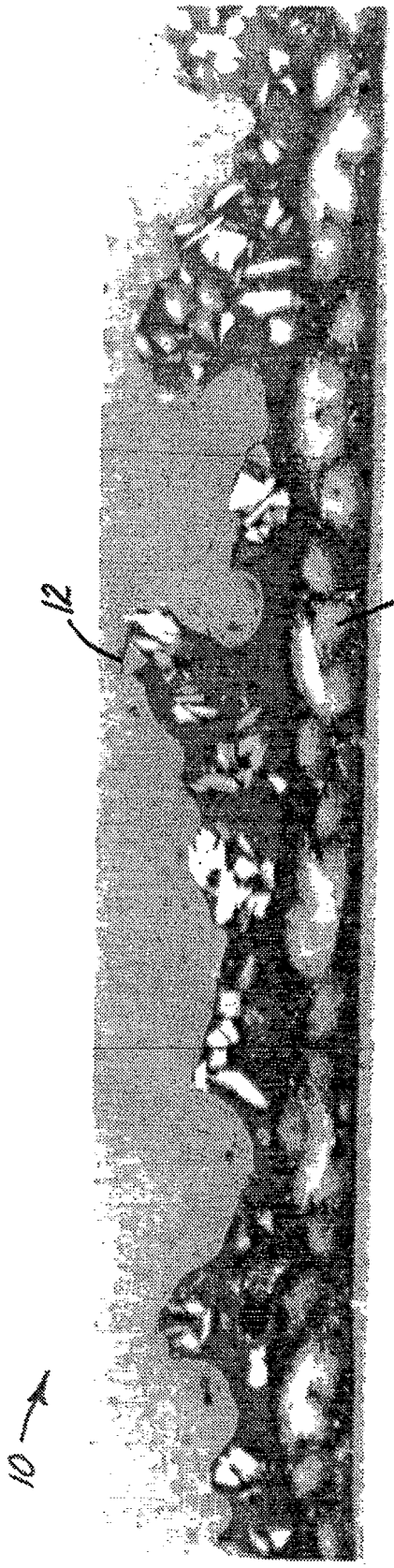

Fig. 1

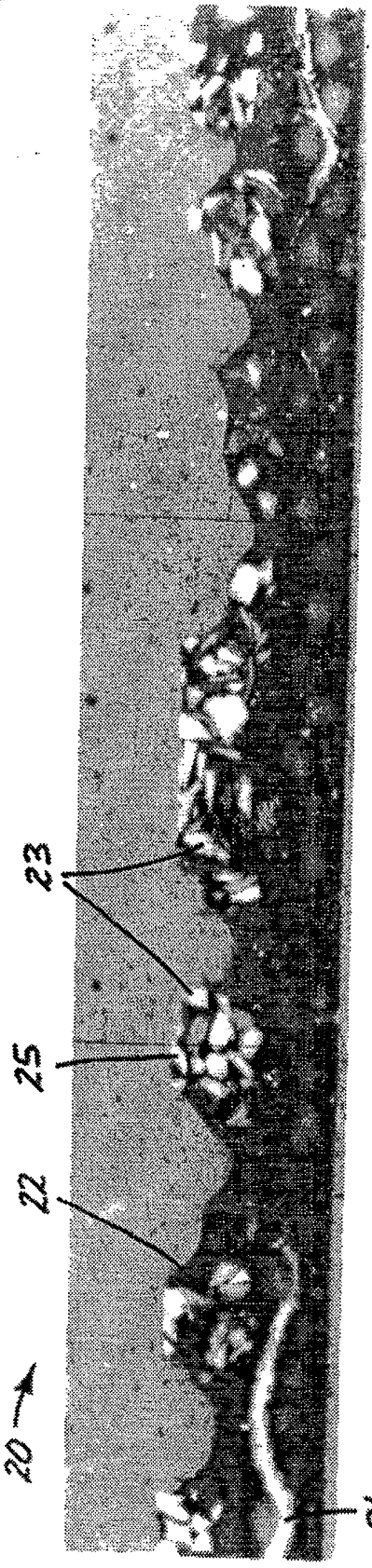

Fig. 3

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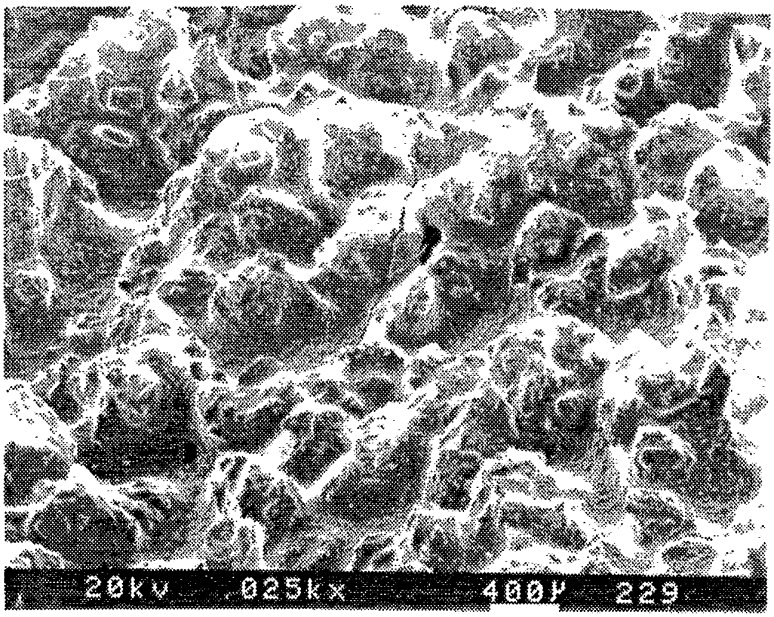

Fig. 2

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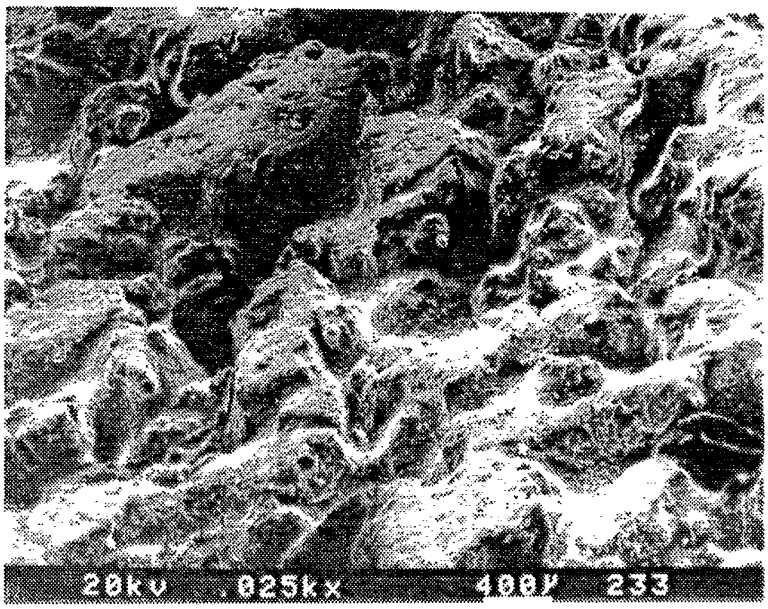

Fig. 4

Fig. 12

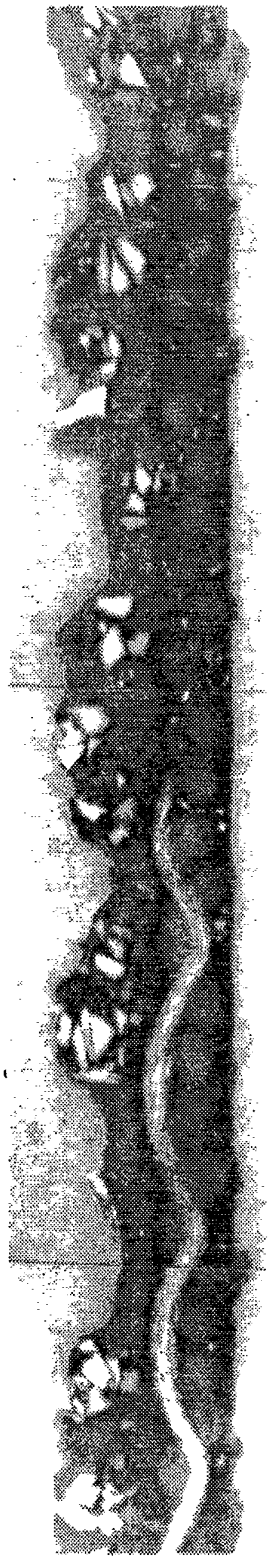

Fig. 5

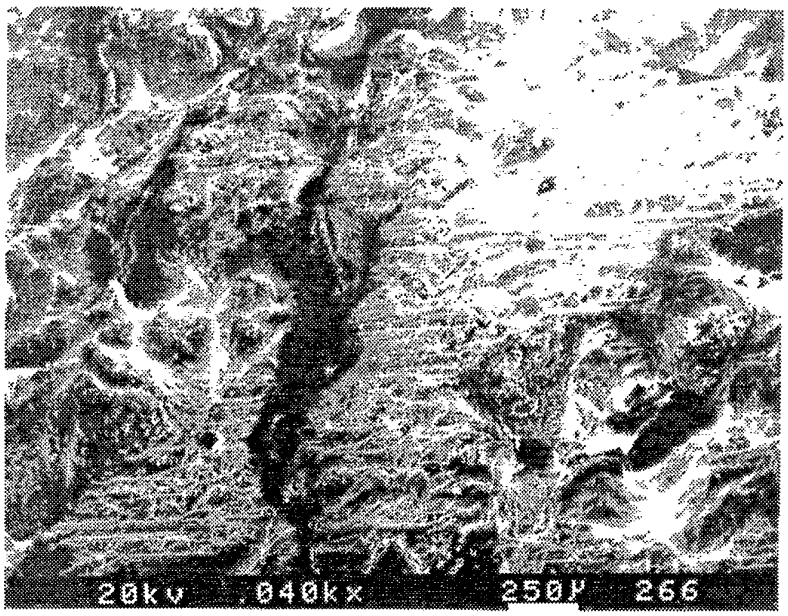

Fig. 13

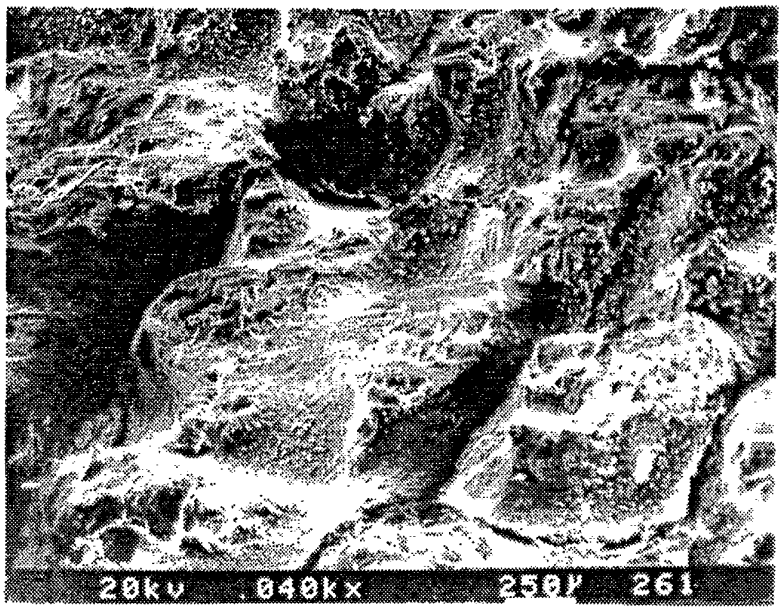

Fig. 6

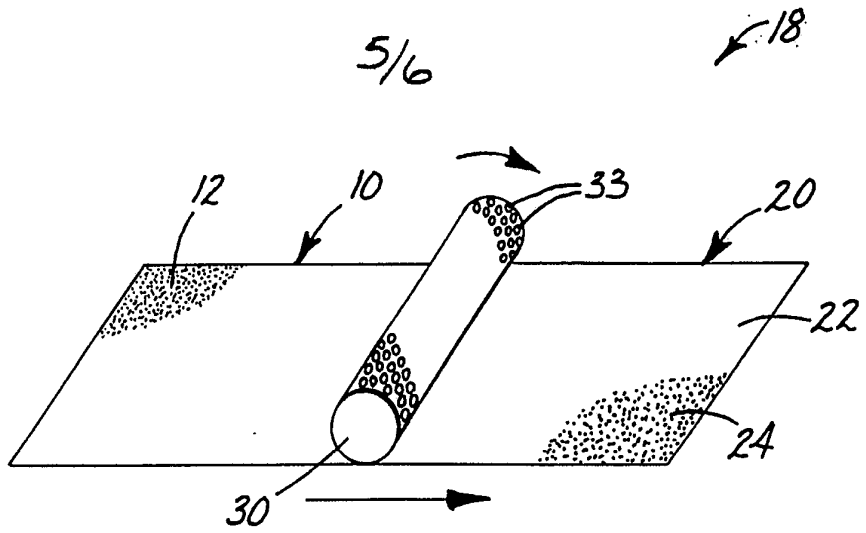

Fig. 10

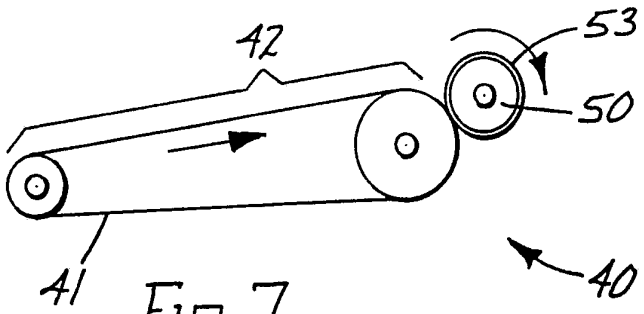

Fig. 7

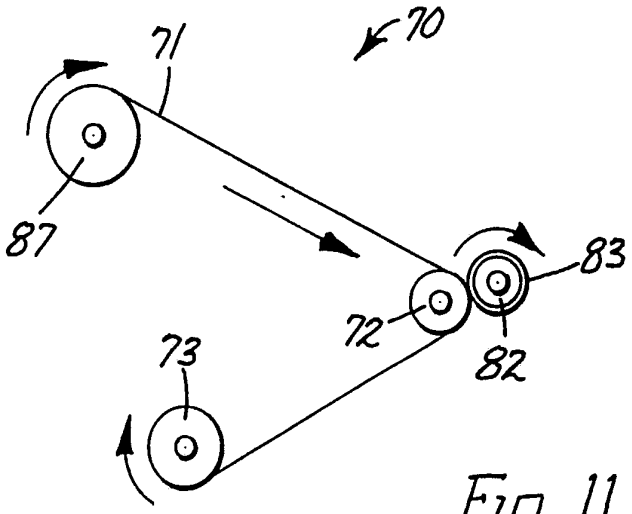

Fig. 11

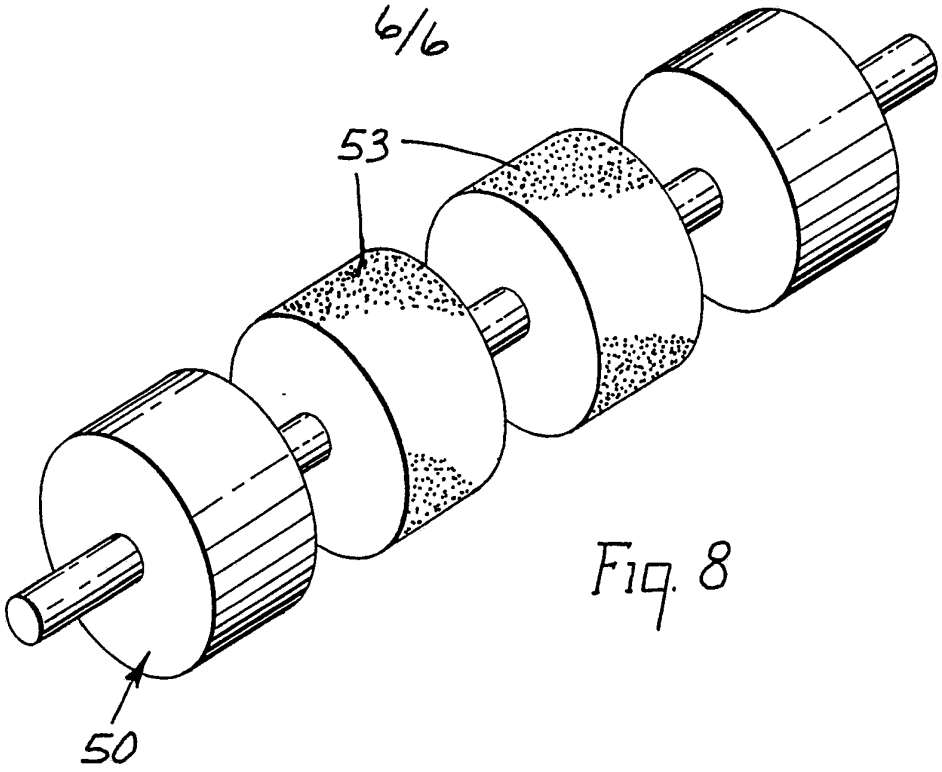

Fig. 8

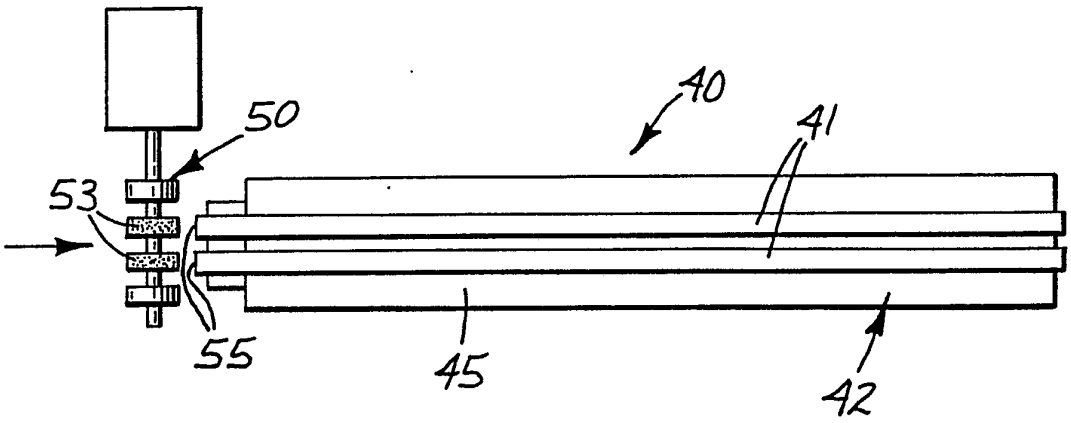

Fig. 9

INTERNATIONAL SEARCH REPORT

PCT/US 92/05827

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B24D3/00; B24B53/10

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	B24D ; B24B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	SOVIET PATENTS ABSTRACTS Section PQ, Week 9027, 15 August 1990 Derwent Publications Ltd., London, GB; Class P, AN 90-208040/27 & SU,A,1 511 098 (SHVEDA I.G.) 30 September 1989	1,8,12
Y	see abstract	11,13

X	PATENT ABSTRACTS OF JAPAN vol. 13, no. 163 (M-816)(3511) 19 April 1989 & JP,A,64 002 865 (KAWASAKI STEEL CORP.) 6 January 1989	7
Y	see abstract	10

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° Special categories of cited documents :[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
20 OCTOBER 1992	02. 11. 92
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	MOLTO PINOL F.J.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
Y	US,A,4 833 834 (HENRY B. PATTERSON ET AL.) 30 May 1989 cited in the application see the whole document	10,11,13
X	SOVIET PATENTS ABSTRACTS Section PQ, Week 9029, 29 August 1990 Derwent Publications Ltd., London, GB; Class P, AN 90-223266/29 & SU,A,1 516 325 (LENGD. METAL WKS.) 23 October 1989	8,9
A	see abstract	6
P,X	US,A,5 096 464 (MOTOKAZU YAMAMOTO) 17 March 1992 see column 1, line 11 - line 56; figures 3-6B	8
A	EP,A,0 389 800 (GENERAL ELECTRIC COMPANY) 3 October 1990 see column 1, line 24 - line 25 see claims 1,6,8	4,5

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. US 9205827 SA 62858

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 20/10/92
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A-4833834	30-05-89	None		
US-A-5096464	17-03-92	JP-A-	3043157	25-02-91
EP-A-0389800	03-10-90	US-A-	4954139	04-09-90
		AU-B-	622766	16-04-92
		AU-A-	4991490	04-10-90
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		JP-A-	3028166	06-02-91