

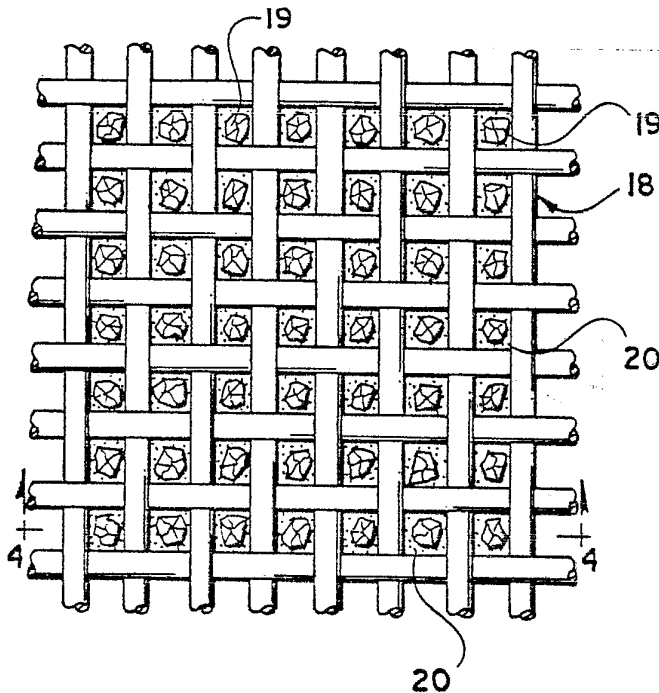


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<p>(21) International Application Number: PCT/US90/00502 (22) International Filing Date: 29 January 1990 (29.01.90) (30) Priority data: 303,924 30 January 1989 (30.01.89) US (71)(72) Applicants and Inventors: DeKOK, Peter, T. [GB/US]; 74 Peachtree Way, Atlanta, GA 30305 (US). TSELESIN, Naum, N. [Stateless/US]; 2900 Lookout Place, Atlanta, GA 30305 (US). (74) Agent: MIDDLETON, James, B.; P.O. Box 1968, Decatur, GA 30031-1968 (US). (81) Designated States: AT (European patent), AU, BE (European patent), BG, CA, CH (European patent), DE (European patent), DK, DK (European patent), ES (European patent), FR (European patent), GB (European patent), HU, IT (European patent), JP, LU (European patent), NL (European patent), NO, RO, SE (European patent), SU.</p>	<p>Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>
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(54) Title: ABRASIVE TOOL AND METHOD FOR MAKING



(57) Abstract

An abrasive material is formed by uniformly spacing particles (16, 19, 22, 30) of diamond or other hard, abrasive material, on a flexible carrier (15, 18), embedding the particles in the carrier, and fixing the particles to the carrier with the particles protruding from the carrier to perform the abrasive action. The particles can be distributed by placing them in the openings of a mesh (18, 21, 26), and, the mesh may be removed or may be a part of the carrier. Since the carrier is flexible, the carrier can be shaped to conform to substrates of complex shapes. A plurality of carriers (34, 35, 39, 40) having different concentrations can be bonded together to form tools having varying concentrations.

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ABRASIVE TOOL AND METHOD FOR MAKING

Technical Field

This invention relates generally to cutting and abrasive tools, and is more particularly concerned with a
5 tool comprising a flexible matrix with particles fixed in the matrix in a predetermined pattern, and a method for providing such tool.

Background Art

It is well known to embed diamonds and other hard
10 substances within a matrix to provide cutting and polishing tools. Cutting tools are commonly made by placing diamond chips in a matrix material such as a metal powder or resin. The matrix material is then compressed and sintered to hold the diamond chips
15 securely. It will be understood that this well known technique yields a product with diamonds randomly distributed therethrough, and there is little that can be done to provide otherwise.

Another technique for providing cutting or polishing
20 tools utilizes electroplating. In general, diamond chips are placed on a metal surface, and a metal is electroplated onto the metal surface, successive layers being plated until the diamonds are fixed to the metal surface. While this technique allows the diamond to be
25 in a regular pattern if desired, the individual stones are usually set by hand. Also, though the electroplated tools have met with considerable commercial success, such tools are somewhat delicate in that the stones are fixed to the tool only by the relatively thin layers of metal,
30 and there can be only a single layer of diamonds to act as the cutting surface. The tool loses its shape as further layers of metal are deposited.

There have been numerous efforts to produce an abrasive tool wherein the carrier for the grit is
35 flexible. Such a tool is highly desirable for polishing non-flat pieces, or for fixing to a contoured shaping

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device such as a router. The prior art efforts at .pn2 producing a flexible tool have normally comprised a flexible substrate, diamonds being fixed thereto by electroplating. For example, small diamond chips have
5 been fixed to the wires of a wire mesh, the flexible mesh providing the flexibility desired. Also, small dots of copper having diamond chips fixed thereto by electroplating have been carried on a flexible foam. The foam provides the flexibility, and the copper dots are
10 separated sufficiently to maintain the flexibility.

The prior art has not provided a flexible cutting or abrasive tool having diamonds of a selected size firmly held in a flexible matrix, with the diamonds being easily arrangeable in a selected, regular pattern.

15 Disclosure of Invention

The present invention provides a flexible abrasive tool having particles of diamond or other hard substance arranged in a selected pattern and embedded in a carrier. The type of the particles and the size of the particles
20 can be selected to yield the desired characteristics of the tool. The carrier may comprise known materials such as metal powders, metal fibers, or mixtures of metal powders and fibers; or, the carrier may comprise a wire mesh, a particle being placed within each opening of the
25 mesh, or within selected openings of the mesh, and the particles are then fixed to the mesh. The carrier is flexible so that it can be shaped to conform to a given substrate.

Brief Description of Drawings

30 These and other features and advantages of the present invention will become apparent from consideration of the following specification when taken in conjunction with the accompanying drawings in which:

Fig. 1 is a perspective view showing a carrier
35 having particles embedded in one surface thereof in accordance with the present invention;

Fig. 2 is an enlarged cross-sectional view taken

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substantially along the line 2--2 in Fig. 1;

Fig. 3 is a plan view showing particles embedded in a wire mesh;

Fig. 4 is a cross-sectional view taken substantially
5 along the line 4--4 in Fig. 3;

Fig. 5 is a view similar to Fig. 4 but showing a modified form thereof;

Fig. 6 is a cross-sectional view illustrating another modified form of the arrangement shown in Fig. 4;

10 Fig. 7 is a plan view showing the carrier of Fig. 3 fixed to a tool;

Fig. 8 is a plan view, on a reduced scale, showing another form of the arrangement shown in Fig. 7; and,

15 Fig. 9 is a cross-sectional view illustrating a composite tool made in accordance with the present invention.

Modes for Carrying Out the Invention

Referring now more particularly to the drawings, and to those embodiments of the invention here chosen by way
20 of illustration, Fig. 1 shows a carrier 15 having a plurality of particles 16 embedded therein. Those skilled in the art will understand that it is known to use preformed structures of metal powders or metal
25 fibers, or mixtures of metal powders and fibers. These materials are readily available, and are well known to those skilled in the art, so no further description is thought to be necessary. With such materials in mind, it will be understood that particles of a hard substances
30 such as diamond can be placed against the carrier 15 and forced into the surface of the carrier to produce the arrangement shown in Fig. 1. After the particles have been positioned as desired, the material can be sintered, with or without pressure.

35 Fig. 2 of the drawings shows the structure of the device shown in Fig. 1. It will here be seen that the particles 16 have been urged into the carrier 15 sufficiently that the particles 16 are well supported.

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As a result, once the carrier 15 has been sintered, the particles 16 are well set and the device is a very effective abrasive.

While the carrier 15 is shown as flat in Figs. 1 and 2, it is known that the material is flexible; thus, the abrasive material can be formed to virtually any shape desired. Also, when the carrier 15 is placed under pressure during the sintering the density of the carrier is increased to provide a firmer hold on the particles 16.

Attention is next directed to Fig. 3 of the drawings which discloses a woven mesh 18 having a particle 19 in each opening of the mesh. The mesh 18 may be any metal, such as copper, brass or nickel. A particle of an appropriate size to fit in the openings of the mesh 18 is used; then, to hold the particles in place, metal powder or the like indicated at 20 is placed into each opening in the mesh, surrounding the particles 19. As before, the metal powder can be sintered to secure the particles 19 in place, the sintered powder 20 being attached to both the mesh 18 and the particles 19. It will also be understood that the sintered powder 20 will secure the wires of the mesh to one another. Those skilled in the art will understand that the particles can be fixed to the mesh by electroplating, gluing, or by other means if desired.

With the construction shown in Figs. 3 and 4, the wire mesh 18 is inherently flexible; and, by placing the particle or particles in each opening in the mesh, flexibility is maintained. Furthermore, as is best shown in Fig. 4, the particles 19 can extend beyond the mesh 18 on both sides, so the material is a two-sided abrasive or cutting tool.

An alternative to the construction shown in Figs. 3 and 4 is shown in Fig. 5. Again, there is the mesh designated at 21, and particles 22 are placed within the openings of the mesh 21. Rather than utilize the metal

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powder as in Fig. 4; however, one might use a mesh 21 made of a metal having a relatively low melting point. The mesh containing the particles can then be heated just until the metal of the mesh flows somewhat. Thus, it will be noted in Fig. 5 of the drawings that the metal of the mesh 21 has flowed to embrace the particles and hold the particles in position.

From the above description it will be understood that hard particles such as diamond, tungsten carbide or the like can be arranged in the desired pattern, and placed into a matrix. The matrix may take the form of a metal powder and/or metal fiber, or may take the form of a wire mesh. In either case, the particles are held in place, and the material is sintered to bond the particles permanently in position. Such materials can be formed with the particles protruding from one side as in Figs. 1 and 2, or protruding from two sides as in Figs. 4 and 5.

Turning now to Fig. 6, one way to arrange the particles in the desired pattern is to put the particles into the openings of a mesh, then place the mesh and particles on the carrier. The mesh can be removed, leaving the particles in the desired pattern. In Fig. 6, the same procedure is used; but, instead of removing the mesh, the mesh is urged into the carrier to become a part of the final tool.

In more detail, Fig. 6 shows a carrier 25, the carrier 25 being formed of metal powder or the like as is discussed above. There are two meshes designated at 26 and 28, one on each side of the carrier 25. In each opening of each mesh, there is a particle, the particles in mesh 26 being designated at 30. The resulting tool therefore has particles 29 and 30 protruding from both sides of the carrier, and further has the mesh 26 and 28 to lend stability to the carrier and to assist in holding the particles 29 and 30 in the carrier. The mesh 26 and 28 can be placed either completely within the carrier 25 or somewhat exposed at the surface of the

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carrier. The exposed mesh protects the diamonds and assists in holding the diamonds as the diamonds wear.

Another form of tool using the present invention can be made as shown in Fig. 7. Fig. 7 illustrates a mesh as shown in Fig. 3, the mesh being fixed to a substrate such as a metal plate or the like. Since the abrasive material is the same as is shown in Fig 3, the same reference numerals are used for the same parts. It will therefore be seen that the mesh 18 has particles 19 held in place by a sintered powder 20 to provide a flexible abrasive material. This flexible abrasive material is then fixed to a metal plate 31 as by welding, brazing or other known means. Since the mesh 18 is flexible, the substrate 31 may be flat, circular, or other desired curved shape. The mesh 18 can be curved to fit the plate 31, and then welded or otherwise fixed to retain the shape. Alternatively, the mesh can be fixed to the substrate by the same material that holds the particles, so both steps are accomplished during the sintering process.

Fig. 8 shows another variation of tool made with the present invention. It is sometimes desirable to allow release space between abrasive portions, and this can be provided as desired with the structure of the present invention. The mesh 18 as shown in Fig. 7 may be cut to the desired shape and fixed into place to achieve the arrangement shown in Fig. 8. Also, the particles may be placed in the pattern shown, and urged into a mass of powder or fiber as discussed in conjunction with Fig. 1. A mesh may be used, particles being placed in selected openings of the mesh. In any case, the desired pattern can be created, and the resulting abrasive material can be fixed to a sanding disk or the like. From the above description it should also be obvious that the disk of Fig. 8 can be made like the product shown in Fig. 3. The mesh 18 would be circular, and selected openings would contain the particles 19.

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Finally, with attention to Fig. 9 of the drawings, it will be realized that two or more pieces of abrasive material made in accordance with the present invention can be stacked, so a multiple layer tool can be made. Using this technique, one might use two of the devices shown in Fig. 2 or Fig. 3 and create a two-sided abrasive material. Many variations are possible, and Fig. 9 illustrates some of the variations.

In Fig. 9, the dashed lines indicate boundaries of the original layers that are used to create the multi-layer material. Thus, it will be noted that the outer layers 34 and 35 have closely spaced particles 36 and 38 on their outer sides. The next layers 39 and 40 have more widely spaced particles 41 and 42, which lie on the boundaries between the layers. The inner, center, layer 44 has widely spaced particles 45 which protrude from both sides, and are on the boundaries of the center and the next layers. It will be obvious that the layers can be bonded together by brazing completed layers, or by sintering unsintered layers, as desired.

While the arrangement shown in Fig. 9 is only by way of illustration, it will be readily understood by those skilled in the art that a saw can be made with this construction. The high concentration of particles at the outer edges of the material will slow the wear of the saw at the edges, while the low concentration of particles towards the center will increase the wear in the center. The result is that the cutting edge 46 will wear as a concave surface, causing the saw to run true.

In the foregoing discussion, the particles that provide the abrasive qualities may be any of numerous materials. Diamonds are often used for such tools, and the present invention is admirably suited to the use of diamonds; however, other materials can be used as desired. Tungsten carbide, cemented carbide, boron nitrite, silicon carbide, or aluminum oxide are usable as the abrasive particles, depending on the qualities

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desired.

While the present invention includes the concept of placing two or more particles in one opening of the mesh such as the mesh 18, the preferred form of the invention
5 comprises the placing of the one particle in one opening. Even if more than one particle is placed in an opening, however, the particles may be of substantial size and do not have to be hand placed.

Those skilled in the art should now understand that
10 the present invention provides a flexible carrier containing the desired concentration of diamonds or other hard particles, the particles being firmly held in the carrier by sintered metal powder or the like. The resulting product can be used singly, or can be layered
15 to provide a tool having a varying concentration as desired. Also, since the carrier is flexible, the product of the present invention can be shaped to conform to the contour of intricately shaped substrates. Thus, form blocks can be made without the requirement for hand
20 placing of diamonds and with the strength of diamonds held in a sintered material. The product of the present invention can therefore be utilized to provide routers, diamond rolls, and virtually any other shaped tool.

It will therefore be understood by those skilled in
25 the art that the particular embodiments of the invention here presented are by way of illustration only, and are meant to be in no way restrictive; therefore, numerous changes and modifications may be made, and the full use of equivalents resorted to, without departing from the
30 spirit or scope of the invention as outlined in the appended claims.

Claims

1. A method for producing an abrasive tool, wherein a plurality of particles (16,19,29,36.38) is fixed to the tool, the particles providing the abrasive quality of the tool, said method including the steps of placing said
5 plurality of particles (16,19,29,36.38) on a flexible carrier (15,18,21) and urging said plurality of particles into said flexible carrier with said particles protruding from said flexible carrier on at least one side thereof,
10 and subsequently fixing said particles in said carrier.

2. A method as claimed in claim 1, said carrier comprising a preformed matrix of sinterable material (15), and wherein the said step of urging said plurality of particles into said flexible carrier includes the step
15 of mechanically forcing said particles into said preformed matrix (15), and subsequently sintering said carrier.

3. A method as claimed in claim 1, said carrier comprising a metallic mesh (18,21) defining a plurality
20 of openings therein, and wherein the said step of urging said plurality of particles into said flexible carrier includes the step of placing one of said plurality of particles in each of said plurality of openings.

4. A method as claimed in claim 3, and further
25 including the step of filling said plurality of openings in said mesh with a sinterable material after the said step of placing one of said plurality of particles (19) in each one of said plurality of openings.

5. A method as claimed in claim 2, and further
30 including the step of placing a mesh (26) defining a plurality of openings therein on said carrier (28) for defining a pattern on said carrier, and placing one particle (29) of said plurality of particles in each opening of said plurality of openings.

35 6. A method as claimed in claim 5, and further including the step of urging said particles (29) and said mesh (26) into said carrier(28), before the said step of

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sintering said carrier.

7. A method as claimed in claim 1, and including the step of conforming said flexible carrier (18) to the shape of a substrate (31) and fixing said carrier(18),
5 with said particles (19) therein, to said substrate (31).

8. A method as claimed in claim 7, wherein the said step of fixing said carrier (18) to said substrate (31) is carried out before the said step of sintering said carrier, and sinterable material is used to fix said
10 carrier to said substrate.

9. A method as claimed in claim 7, wherein the said step of fixing said carrier to said substrate is carried out subsequent to the said step of sintering said carrier.

15 10. A method as claimed in claim 1, and including the steps of producing a plurality of said abrasive tools, and subsequently bonding said plurality of said abrasive tools together as a composite tool.

11. In an abrasive tool, of the type wherein a
20 plurality of particles is fixed to a carrier, said particles providing the abrasive quality of said abrasive tool, the improvement wherein said carrier (15,18) is flexible and said plurality of particles (16,19,29,36.38) is uniformly distributed in a
25 predetermined pattern, and including means (15,20,28) for retaining said plurality of particles in said carrier.

12. In an abrasive tool as claimed in claim 11, the improvement wherein said carrier (15,18) consists of a sinterable material (15,28), and said means for retaining
30 said plurality of particles in said carrier is integral with said carrier.

13. In an abrasive tool as claimed in claim 11, the improvement wherein said carrier comprises a wire mesh (18,26) defining regularly spaced openings therein, and
35 said means (20) for retaining said plurality of particles in said carrier is within said openings in said mesh.

14. In an abrasive tool as claimed in claim 13, the

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further improvement wherein one particle of said plurality of particles is within each opening of said regularly spaced openings in said mesh (18,26).

5 15. In an abrasive tool as claimed in claim 11, the arrangement wherein each particle (16,19,29,36,38) of said plurality of particles protrudes from at least one side of said carrier (15,18).

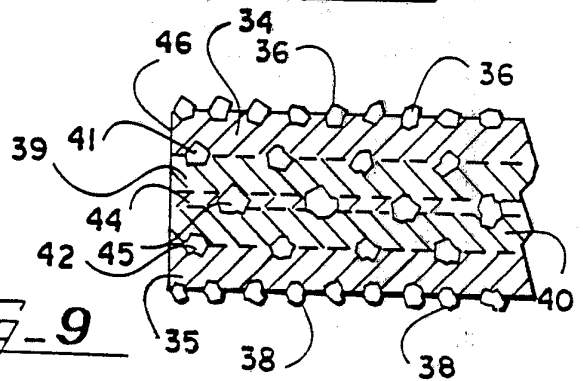
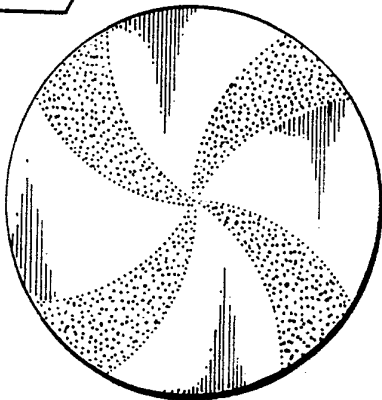
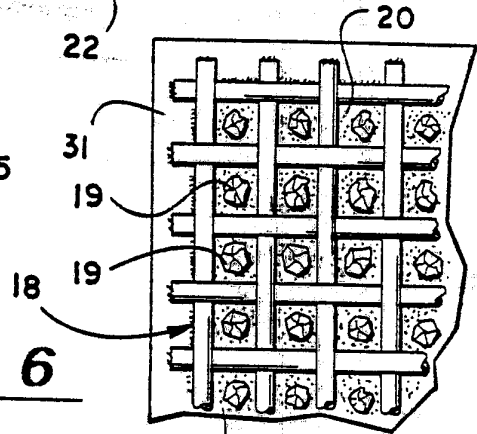
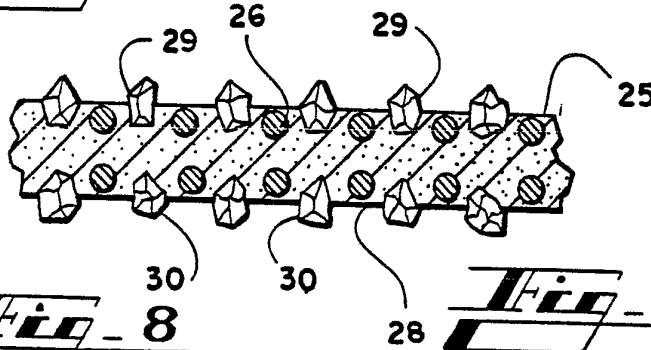
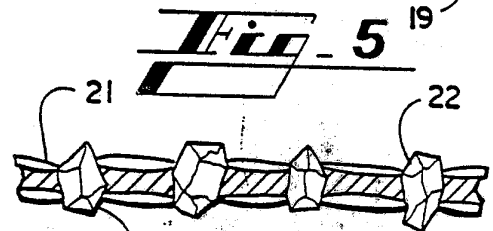
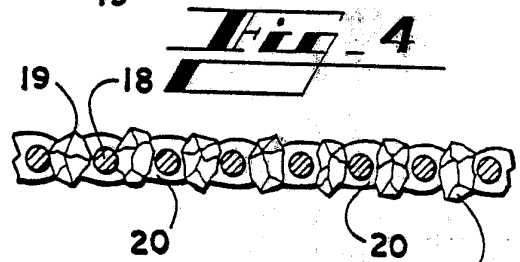
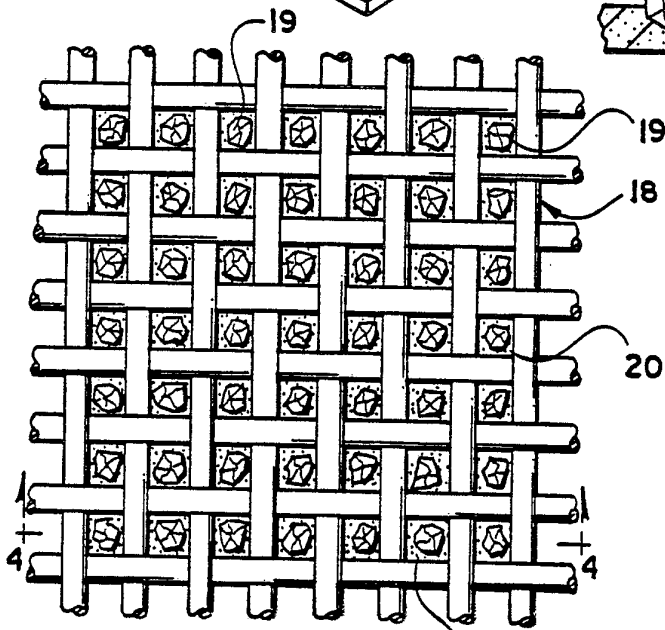
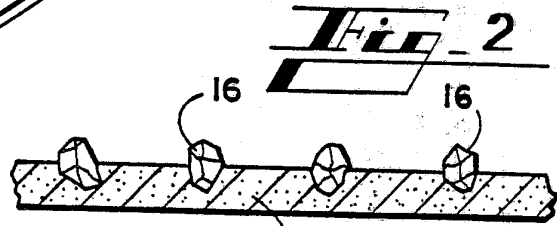
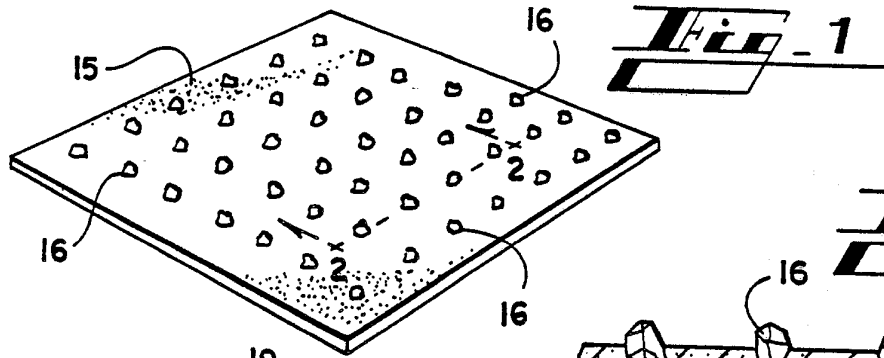
10 16. In an abrasive tool as claimed in claim 15, the improvement wherein each particle (19,22,45) of said plurality of particles protrudes from both sides of said carrier (18,21,44).

15 17. In an abrasive tool as claimed in claim 15, the improvement wherein a plurality of said carriers (34,35,40,44) is fixed together, each carrier of said plurality of carriers having a plurality of particles (36,38,41,42,45) fixed thereto.

20 18. In an abrasive tool as claimed in claim 17, the improvement wherein said particles (16,19,29,36,38) are formed of a substance selected from the group consisting of diamond, tungsten carbide, silicon carbide, cemented carbide, boron nitride and aluminum oxide.

25 19. In an abrasive tool as claimed in claim 18, the improvement wherein said carrier includes a wire mesh (18,21) defining a plurality of regularly spaced openings therein, one particle of said plurality of particles being in each opening of said plurality of openings.

30 20. In an abrasive tool as claimed in claim 11, the improvement wherein said carrier is conformed to the surface of a substrate, and including means for fixing said carrier to said substrate.



INTERNATIONAL SEARCH REPORT

International Application No. **PCT/US90/00502**

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
IPC (5) : B24D 3/02
U.S. Cl : 51/293

II. FIELDS SEARCHED

	Minimum Documentation Searched ⁷
Classification System	Classification Symbols
U S Cl	51/293,295,308,309

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
A	US,A 3,402,514 JOHNSON 24 September 1968	1-20
A	US,A 3,906,684 MARSHALL ET AL 23 September 1975	1-20
A	US,A 3,942,959 MARKOO ET AL 09 March 1976	1-20
A	US,A 4,047,902 WIAND 13 September 1977	1-20
A	US,A 4,163,647 SWIATEK 07 August 1979	1-20
A	US,A 4,317,660 KRAMIS 02 March 1982	1-20
A	US,A 4,543,106 PAREKH 24 September 1985	1-20
A,P	US,A 4,826,508 SCHWARTZ 02 May 1989	1-20

^{*} Special categories of cited documents: ¹⁰

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"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

04 May 1990

Date of Mailing of this International Search Report

05 JUL 1990

International Searching Authority

ISA/US

Signature of Authorized Officer

INTERNATIONAL DIVISION

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