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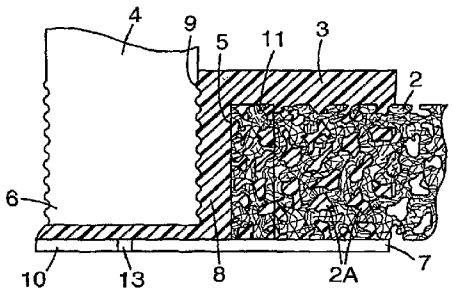
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(54) Title: SLEEVE FOR USE IN MAKING ABRASIVE ARTICLES



(57) Abstract: An abrasive article (1) comprises a body (2) of fibrous, non-woven abrasive material, a sleeve (7) positioned in a central opening (5) of the body of abrasive material, and a hub of polymeric material (8) located within the sleeve, wherein the sleeve has a plurality of spaced gateways therein through which the polymeric material of the hub extends into the abrasive material to secure the hub and the abrasive material together. A method of making the abrasive article comprises the steps of: positioning the sleeve (7) in the central opening (5) of the body (2) of abrasive material; injecting molten polymeric material into the sleeve so that it passes through the gateways into the abrasive material; and allowing the polymeric material to cool and solidify whereby it forms, within the sleeve, a hub that is secured to the abrasive material.

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SLEEVE FOR USE IN MAKING ABRASIVE ARTICLES

FIELD

The present invention relates to a method of making abrasive articles of the type comprising a body of fibrous non-woven abrasive material secured to a central hub.

BACKGROUND

Abrasive articles comprising a disc of fibrous non-woven abrasive material secured to a central metal shaft by a solid hub are known, one example being the articles available, under the trade name "CLEAN 'N STRIP" Abrasive Disc, from 3M Company of St. Paul, Minnesota, U.S.A. One method of making abrasive articles of that type includes the steps of: inserting one end of a metal shaft into a central aperture in the disc; closing the central aperture on the side of the disc adjacent the shaft end with a circular label; pouring an epoxy resin into the central aperture from the other side of the disc so that the resin surrounds the shaft and penetrates the non-woven abrasive material of the disc; and curing the epoxy resin to form a solid hub that secures the shaft to the disc. In this method, the label acts as a barrier to prevent the resin flowing out of the central aperture in the disc.

Also known are abrasive articles comprising a plurality of flaps secured to a shaft. Examples of such products are those available from 3M Company of St. Paul, Minnesota, USA under the names "Scotch-Brite™ Flap Brush" and "Coated Flap Wheel". These products are made from a plurality of flaps of abrasive material, one edge of each of which is bonded to a central core. One method of manufacturing this type of product requires a plurality of flaps to be cut and arranged into a circular array so that the inner edges of the flaps define a cylindrical shaped bore in the centre of the array. An end of a shaft is positioned in the bore and the flaps are secured together and to the shaft to form a circular brush by a central core made by pouring two-part epoxy resin into the bore.

JP 11320423A describes a method of manufacturing an abrasive article of the type that comprises a fibrous non-woven disc having a central boss with a threaded aperture by which the abrasive article can be secured to a grinding machine. The method comprises

placing the disc in a mould and forming the boss by injection moulding a thermoplastic material.

SUMMARY OF THE INVENTION

The present invention is concerned with reducing the costs of manufacturing abrasive articles of the type comprising a body of non-woven abrasive material secured to a central hub, while enabling the consistency of the finished product, in terms of both quality and appearance, to be maintained.

The present invention provides a method of making an abrasive article comprising a body of fibrous, non-woven abrasive material secured to a central hub, the method comprising the steps of;
(i) positioning, in the central opening of a body of abrasive material, a sleeve that has a plurality of spaced gateways in its wall;
(ii) injecting molten polymeric material into the sleeve so that it passes through the gateways into the abrasive material; and
(iii) allowing the polymeric material to cool and solidify whereby it forms, within the sleeve, a hub that is secured to the abrasive material.

In a method in accordance with the present invention, the use of a sleeve in the central opening of the body of abrasive material enables the flow of injected polymeric into the abrasive material to be regulated, thereby enabling the production costs of the abrasive article to be reduced while enabling the consistency of the finished product, in terms of both quality and appearance, to be maintained.

In a method in accordance with the invention described herein, a predetermined amount of polymeric material only is injected into the sleeve, the amount being sufficient to form the hub and to allow the polymeric material to penetrate into the abrasive material to an extent sufficient to fix the hub to it but without filling the abrasive material. More generally, accordingly, the present invention also provides a method of making an abrasive article that comprises a fibrous, non-woven abrasive part and an injection-moulded polymeric part fixed to the abrasive part, the method comprising the step of forming the polymeric

part by injecting a predetermined volume of molten polymeric material in contact with the abrasive part and allowing the polymeric material to cool, the said predetermined volume being sufficient to form the polymeric part and to allow the polymeric material to penetrate into the fibrous non-woven abrasive material to an extent sufficient to fix the polymeric part to the abrasive part but without filling the abrasive material.

The polymeric material may be a thermoplastic material, for example a polyamide. The sleeve may be a moulded component formed, for example, from polystyrene, polypropylene or polyamide.

A method in accordance with the invention may comprise the steps of providing a mould having first and second mould plates which together define a mould cavity dimensioned to accommodate the body of abrasive material with the sleeve positioned in the centre thereof, at least one of said first and second mould plates having a channel for injection of molten polymeric material into the mould cavity. One of the mould plates may have a bore formed therein to accommodate the shaft so that one end of the shaft projects into the sleeve in the mould cavity. In one embodiment, in which the sleeve has a cap at one end that extends over the central opening of the body of abrasive material, the molten polymeric material enters the sleeve through a bore in the cap.

By way of example, embodiments of the invention will be described with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of an abrasive article in accordance with the present invention;

Fig. 2 is a cross-sectional view on an enlarged scale of part of the abrasive article of Fig. 1, diametrically through the disc and the shaft;

Fig. 3 is a view from one end of a sleeve that forms part of the abrasive article of Figs. 1 and 2;

Fig. 4 is a view of the sleeve of Fig. 3, from the other end;

Fig. 5 is a diagrammatic cross-sectional view of a mould used to make the abrasive article of Figs. 1 and 2;

Figs. 6 and 7 show alternative forms of the sleeve of Figs. 3 and 4;

Fig. 8 is similar to Fig. 5 but shows a mould used to make another form of abrasive article

in accordance with the present invention; and

Fig. 9 is a cross-sectional view of an article made using the mould of Fig. 8.

The abrasive article 1 shown in Figures 1 and 2 comprises an abrasive disc 2, a hub 3 and a metal shaft 4. The hub 3 is located in a central opening 5 in the abrasive disc 2, and an end 6 of the shaft 4 is received in the hub 3, thereby mounting the disc on the shaft with the latter extending in a direction generally perpendicular to the plane of the disc. The abrasive disc 2 is made from fibrous non-woven material and may, for example, be a resin-bonded, fibrous, abrasive disc available under the trade name "Scotch-Brite™" from 3M Company.

More generally, the abrasive disc 2 can be made from a uniform lofty web of continuous three-dimensionally autogenously bonded filaments, which may be impregnated with an adhesive binder and may contain a multitude of abrasive grains or granules dispersed throughout the web. The thickness, length and composition of the filaments and the type of adhesive binder and abrasive particles may be selected depending upon the intended application of the abrasive article. Suitable webs from which the abrasive disc 2 can be cut are known and disclosed, for example, in US 2,958,593, US 4,227,350, US 5,928,070 and US 6,302,930.

The hub 3 extends through the entire thickness of the abrasive disc 2 and comprises a pre-formed sleeve 7 (not visible in Fig. 1) and an injected thermoplastic material 8 that fills the space in the central opening 5 not occupied by either the end 6 of the shaft 4 or the sleeve 7. The thermoplastic material 8 also penetrates for a short distance into the abrasive disc 2, filling some of the voids 2A between the fibres of the non-woven material, and thus forms a mechanical connection between the shaft 4 and the disc. The end 6 of the shaft 4 is provided with a roughened or knurled surface 9 to enhance the mechanical engagement between the shaft and the thermoplastic material 8.

The sleeve 7 (also shown separately in Figs. 3 and 4) has a circular cap 10 at one end, which extends over the central opening 5 in the abrasive disc 2 on the opposite side of the latter to the shaft 4. The cap 10 has a central aperture 13 that is employed during the

manufacture of the abrasive article 1 as described below and, to enhance the appearance of the abrasive article 1, may have a beveled periphery (not shown). The sleeve 7 also comprises a cylindrical portion 11 that extends from the cap 10 through the central opening 5, against the wall of the latter, for the entire thickness of the abrasive disc 2. A plurality of equispaced openings, or gateways, 12 is formed around the cylindrical portion 11 so that the latter has the appearance of a circle of upstanding pillars on the cap 10, as can be seen in Fig. 3. During the manufacture of the abrasive article 1, the sleeve 7 functions (as described below) to regulate the flow of the thermoplastic material 8 into the non-woven material of the abrasive disc 2.

The abrasive article 1 is formed using the mould 19 shown in Figure 5. The mould comprises a first plate 20 and a second plate 21, which together form a mould cavity 22. The second plate 21 has a bore 23 in which the shaft 4 is positioned. The length of the bore 23 is such that the end 6 of the shaft 4 protrudes into the mould cavity 22. The abrasive disc 2 is provided and the central portion is removed by die-cutting to form the opening 5. The sleeve 7 is then positioned on the abrasive disc 2, with the cylindrical portion 11 extending into the central opening 5 and the cap 10 located against one side of the disc to close the opening. The abrasive disc 2, with the sleeve 7 in position, is then placed in the mould cavity 22 so that the end 6 of the shaft 4 is located in the central opening 5, within the cylindrical portion 11 of the sleeve. The mould plates 20, 21 are then closed.

The mould plate 20 is formed with a channel 24 through which a shot (i.e. a predetermined amount) of molten thermoplastic material 8 is injected into the cylindrical portion 11 of the sleeve 7, through the aperture 13 in the cap 10. The molten thermoplastic material surrounds the end 6 of the shaft 4 and flows through the gateways 12 in the cylindrical portion 11 of the sleeve 7, into the interstices between the fibres of the non-woven material of the abrasive disc 2. The thermoplastic material 8 is then allowed to cool and solidify, following which the mould 19 is opened and the completed abrasive article 1 is removed.

The moulding process results in the shaft 4 being firmly secured in the hub 3 which itself is firmly anchored to the abrasive disc 2. A recess 25 in the centre of the mould plate 21 results in the hub 3 extending beyond the surface of the abrasive disc 2 on the shaft side, as shown in Fig. 1, although that is not essential.

During the moulding process, the gateways 12 in the sleeve 7 function to regulate the flow of molten thermoplastic material 8 out of the central opening 5 in the abrasive disc and into the non-woven material of the disc itself. It has been found that, through a suitable choice of the shape (including, for example, the width) of these gateways 12 and appropriate control of the amount of thermoplastic material that is injected, it can be ensured that the thermoplastic material 8 penetrates into the abrasive disc 2 comparatively evenly around the opening 5 and only to the extent necessary to bond the disc adequately to the hub 3. That, in turn, enables the amount of thermoplastic material used in the process to be reduced to the minimum necessary to bond the shaft 4 securely to the disc 2, thereby enabling the cooling time in the mould 19 also to be reduced to a minimum.

The cap 10 of the sleeve 7 may be formed with indicia to provide product information to the user. Alternatively, an adhesive label carrying product information may be applied to the cap 10 after the abrasive article 1 has been removed from the mould 19.

In a moulding process as described above, the amount of thermoplastic material that is injected into the mould 19 can be controlled by means of a suitable valve (not shown) located in the channel 24 of the mould. The channel 24 is connected to a suitable supply of molten thermoplastic material under pressure so that, if the valve is opened for a predetermined interval of time, a predetermined amount of the thermoplastic material will be injected into the mould 19. The process thus differs from a conventional injection moulding process in which the injection of molten thermoplastic material into the mould 19 would continue until the mould cavity has been filled. The process may, nevertheless, be carried out using a conventional injection moulding machine suitably-adapted for the purpose although, because the mould cavity is never filled with the injected thermoplastic material, it is not actually essential for the mould to be closed.

Suitable injection moulding machines for carrying out the method described above with reference to Fig. 5 may have vertical r horizontal moulding orientations, provided that they permit the injection repeatedly of predetermined amounts of molten material into the mould cavity 22 with reasonable accuracy. A vertical orientation moulding machine provides advantages, however, since it facilitates positioning of the shaft 4 and assists the function of the sleeve 7 in regulating of the spread of the injected molten thermoplastic material. A suitable vertical orientation machine is commercially available, under the trade name "BATTENFELD BA500 (50T)", from Battenfeld Kunstsoffmaschinen of Kottingbrunn, Austria. The valve used to control the amount of thermoplastic material injected into the sleeve 7 in the abrasive disc 2 may be of any suitable type, one being an electromagnetically-controlled needle valve known for use in sprueless injection moulding. A suitable valve is an electromagnetic needle valve available, under the trade name "Z 1081" from HASCO Hasenclever GmbH + Co KG of Lüdenscheid, Germany. The opening of the valve can be controlled by the injection machine itself.

Fig. 6 shows an alternative form of the sleeve 7, which has fewer and wider gateways 12 in the cylindrical portion 11.

Fig. 7 shows yet another form of the sleeve 7, in which the gateways 12 in the cylindrical portion 11 are closed by thin walls, or membranes, 27 that must be broken before molten thermoplastic material 8 can flow into the abrasive disc 2 during the moulding process. Rapid breakage of the membranes 27 can be ensured by forming them from a material that melts at a substantially lower temperature than the process temperature of the molten thermoplastic material 8. The presence of the membranes 27 in the sleeve 7 enables a higher injection pressure to be applied to the molten thermoplastic material 8 and, in some circumstances, may further assist in controlling the flow of the molten material into the abrasive disc 2; however, the thickness of the membranes 27 must be carefully controlled during manufacture of the sleeve to ensure that they will all be broken substantially simultaneously during the moulding process.

Although Fig. 7 shows the sleeve 7, including the membranes 27, as a one-piece component it could alternatively be formed by fitting an appropriate length of thin-walled tube around the cylindrical portion 11 of a sleeve of the type shown in Fig. 3 or Fig. 6.

The sleeve 7 of Fig. 7 may be further modified by omitting the cap 10. In that case, the thermoplastic material 8 will also be visible, in the finished abrasive product 1, on the side of the abrasive disc opposite the shaft 4.

To assist in positioning the shaft 4 in the central opening 5 of the disc 2 prior to the injection of the molten thermoplastic material 8, the thickness of the wall of the cylindrical portion 11 of the sleeve 7 may be increased to define the location of the shaft. However, to achieve a good bond between the shaft 4 and the hub 3 of the finished abrasive article 1, it is preferred that the inside surface of the cylindrical portion 11 of the sleeve is not in direct contact with the shaft 4.

The thermoplastic material 8 selected for use in the moulding process described with reference to Fig. 5 will have a suitable viscosity at the injection temperature, for example 200 to 280 °C, to enable it to penetrate between the fibres of the abrasive disc 2. It is preferred that the thermoplastic material contracts slightly when cooled from its molten state since this improves mechanical interlock with the end of the shaft 4. Suitable thermoplastic materials include polyamides, for example nylon 66 e.g. commercially available from LATI Industria Termoplastic S.p.A. under the trade name "LATAMID". The thermoplastic material may optionally contain filler and/or reinforcing fibres.

The injected material 8 need not, however, be a thermoplastic material: other polymeric materials suitable for injection moulding could be used including thermoset materials (for example, a blocked epoxy resin).

The sleeve 7 is preferably a moulded component, formed from a material resistant to the injected molten material 8. Suitable materials for the sleeve include polystyrene, polypropylene and polyamide.

It is also not essential that the moulding process described with reference to Fig. 5 is used to bond an abrasive disc 2 to a shaft 4: if desired, the shaft 4 could be omitted and the moulding process used simply to form a hub 3 in the form of a hollow core, possibly with an internal thread by which the abrasive disc 2 can be attached to an abrading machine. To that end, a mandrel (which could be part of the mould plate 21) would be positioned at the centre of the sleeve 7 prior to the injection of the molten thermoplastic material 8, the mandrel being removed from within the sleeve when the mould is opened.

A moulding process similar to that described above with reference to Fig. 5 could be used to make an abrasive article comprising two or more abrasive discs mounted on a single shaft, although the shape of the sleeve 7, including the gateways 12, may have to be modified to ensure the equal distribution of the thermoplastic material 8 between the two discs. A similar process could also be used to make an abrasive article in the form of a flap brush rather than an abrasive disc: in that case, the abrasive flaps would be arranged in a circular array around the sleeve 7 prior to the injection of the thermoplastic material 8.

The mould 30 shown in Figure 8 is used to make another form of abrasive article in accordance with the invention. In this case, the channel 24 for the injection of thermoplastic material is formed in the mould plate 21, where it replaces the recess 23 that was used in the mould of Fig. 5 to receive a metal shaft. The sleeve 7 is similar to that described above with reference to Figs. 3 and 4 except that there is no aperture 13 in the cap 10. The metal shaft 4 of Fig. 5 is not used and, instead, thermoplastic material 8 is injected not only to fill the central opening 5 of the disc 2 and to penetrate through the sleeve openings 12 into the disc as described above, but also to fill the channel 24. Consequently, when the thermoplastic material in the mould 30 is allowed to cool, the finished article removed from the mould will appear as shown in Fig. 9 with the thermoplastic material from the channel 24 forming a thermoplastic shaft 4' which is integral with the hub 3' formed within the sleeve 7.

EXAMPLE

A method of making an abrasive article as shown in Figs. 1 and 2 is described in greater detail in the following non-limiting Example, in which the materials used were as follows:

The shaft 4 was a zinc plated steel shaft commercially available from BEROD COLLET of Vougy 74130, France. The shaft had a length of 50mm and a diameter of 6mm, and was knurled at one end over a length 10mm to a depth of 0.2mm.

The abrasive disc 2 was a fibrous non-woven a disc having an outer diameter of 100mm and an inner diameter of 20 mm, available as "Blue CLEAN 'N STRIP Abrasive Disc", from 3M Company of St. Paul, Minnesota, U.S.A.

The sleeve 7 was a moulded component having the shape shown in Figs. 3 and 4, formed from a high-impact polystyrene available, under the trade name "STYRON A Tech 1200 from The Dow Chemical Company of Midland, MI, USA. The cylindrical portion 11 was a close fit in the 20 mm diameter central opening 5 in the abrasive disc 2, and the gateways 12 were each 4 mm wide (measured on the outside of the sleeve).

The thermoplastic material 8 was a polyamide injection moulding homopolymer available, under the trade name "CAPRON 8202HSBK102" from BASF CANADA, of Mississauga, ON, Canada.

The shaft 4, disc 2 and sleeve 7 were assembled in a mould 19 as illustrated in Fig. 5 and the mould plates 20, 21 were closed. A 50T vertical orientation injection moulding machine available, under the trade name "BATTENFELD BA500 (50T)", from Battenfeld Kunstsoffmaschinen of Kottingbrunn, Austria was then used, with the above-mentioned "Z 1081" magnetic needle valve installed in the gate channel of the mould, to inject a shot of between about 4.00 and 6.00g of the thermoplastic material 8, at a temperature of 235°C, into the mould cavity 22. The injection moulding machine was operated at such a speed that the injection time for the shot of molten thermoplastic material was 0.46s. The mould 19 was then allowed to cool for a period of 10s, following which the abrasive article 1 was removed and inspected. It was found that the thermoplastic material 8 was well bonded to the shaft 4 and had penetrated, substantially uniformly through all of the gateways 12 in the sleeve 7, into the abrasive disc 2 in an amount and to an extent sufficient for it to bind effectively to the abrasive disc 2.

The sleeve 7 employed in each of the embodiments of the invention described above enables the predetermined amount of thermoplastic material used in the injection moulding process to be controlled and utilized efficiently not only to form the polymeric part of the abrasive article but also to ensure that it is effectively fixed to the abrasive material. That in turn allows the amount of thermoplastic material to be reduced to the minimum necessary, thereby reducing raw material costs and the cooling time required in the mould. At the same time the sleeve 7 imparts a neat appearance to the finished product because it controls how, and the extent to which, the thermoplastic material penetrates the non-woven abrasive disc 2. The provision of a cap 10 on the sleeve, to close the end of the central opening 5 of the abrasive disc 2, further enhances the appearance of the abrasive product 1. The sleeve may be modified by the provision of features such as lips and/or guide walls to adjust the flow of the injected thermoplastic material as required.

In the moulding process described above, as already stated, the injection moulding machine is employed, not in the conventional manner to fill the mould cavity, but to inject a predetermined amount only of polymeric material. In that way, it can be ensured that the injected polymeric material does not permeate throughout the non-woven abrasive material and, because the abrasive material is not subjected to the high pressures normally generated in the mould cavity of an injection moulding machine, the risk of structural damage to the abrasive material is minimized. A process based on that principal (i.e. of injecting a predetermined amount only of polymeric material into a mould cavity) could be employed to make other forms of abrasive articles that comprise a fibrous non-woven abrasive part and an injection-moulded polymeric part fixed to the abrasive part including, for example, abrasive articles as described in our published patent application WO 2006/023178 and our co-pending PCT applications entitled:
"AN ABRASIVE ARTICLE FOR HAND-HELD, OR SIMILAR, USE AND PREPARATION THEREOF" (claiming priority from UK patent application No. 0603275.9 of 17 February 2006);
"AN ABRASIVE ARTICLE HAVING A BACKING, SUITABLE FOR ATTACHMENT TO A ROTATABLE SHAFT, AND PREPARATION THEREOF" (claiming priority from UK patent application No. 0603277.5 of 17 February 2006);

"SURFACE TREATMENT ARTICLE COMPRISING A PLURALITY OF FLAPS, AND PREPARATION THEREOF" (claiming priority from UK patent application No. 0603280.9 of 17 February 2006); and

"ABRASIVE ARTICLE COMPRISING INDIVIDUAL ABRASIVE ELEMENTS SUCH AS FLAPS, AND MANUFACTURE THEREOF" (claiming priority from UK patent application No. 0603278.3 of 17 February 2006).

CLAIMS:

1. A method of making an abrasive article comprising a body of fibrous, non-woven abrasive material secured to a central hub, the method comprising the steps of;
(i) positioning, in the central opening of a body of abrasive material, a sleeve that has a plurality of spaced gateways in its wall;
(ii) injecting molten polymeric material into the sleeve so that it passes through the gateways into the abrasive material; and
(iii) allowing the polymeric material to cool and solidify whereby it forms, within the sleeve, a hub that is secured to the abrasive material.

2. A method as claimed in claim 1, in which a predetermined amount of polymeric material is injected into the sleeve.

3. A method as claimed in claim 1 or claim 2, in which the sleeve has a cap at one end that extends over the central opening of the body of abrasive material.

4. A method as claimed in any one of the preceding claims, in which the gateways are constructed to regulate the flow of molten polymeric material into the abrasive material.

5. A method as claimed in any one of the preceding claims, in which the sleeve is generally cylindrical.

6. A method as claimed in any one of the preceding claims, in which each gateway is closed by a membrane that is broken and/or melted by the injected polymeric material.

7. A method as claimed in any one of the preceding claims, also including the step of positioning a shaft at the centre of the sleeve prior to the injection of the molten polymeric material whereby, when the polymeric material cools, the hub secures the shaft to the abrasive material.

8. A method as claimed in any one of claims 1 to 6, including the step of positioning a mandrel at the centre of the sleeve prior to the injection of the molten polymeric material, the mandrel being removed when the polymeric material cools whereby the hub is in the form of a hollow core.

9. A sleeve for use in a method as claimed in claim 1, the sleeve being shaped to be positioned in the central opening of a disc of non-woven abrasive material, and having a plurality of spaced gateways formed therein through which molten polymeric material, injected into the sleeve, can pass into the abrasive material.

10. A sleeve as claimed in claim 9, the sleeve being generally cylindrical in shape and the gateways being equi-spaced around the cylindrical portion.

11. An abrasive article comprising a body of fibrous, non-woven abrasive material, a sleeve positioned in a central opening of the body of abrasive material, and a hub of polymeric material located within the sleeve, wherein the sleeve has a plurality of spaced gateways therein through which the polymeric material of the hub extends into the abrasive material to secure the hub and the abrasive material together.

12. An abrasive article as claimed in claim 11, in which the sleeve comprises a cap at one end, which extends over the central opening of the body of abrasive material.

13. An abrasive article as claimed in claim 11 or claim 12, in which the sleeve is generally cylindrical.

14. An abrasive article as claimed in any one of claims 11 to 13, including a shaft one end of which is secured in the hub.

15. An abrasive article as claimed in any one of claims 11 to 13, in which the hub is in the form of a hollow core.

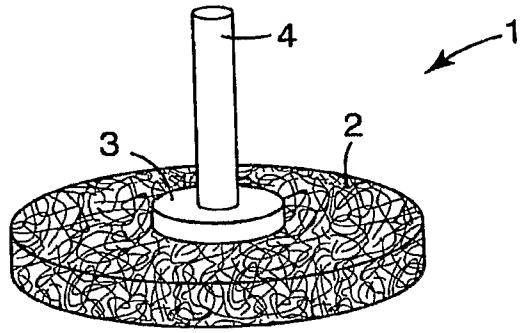


Fig. 1

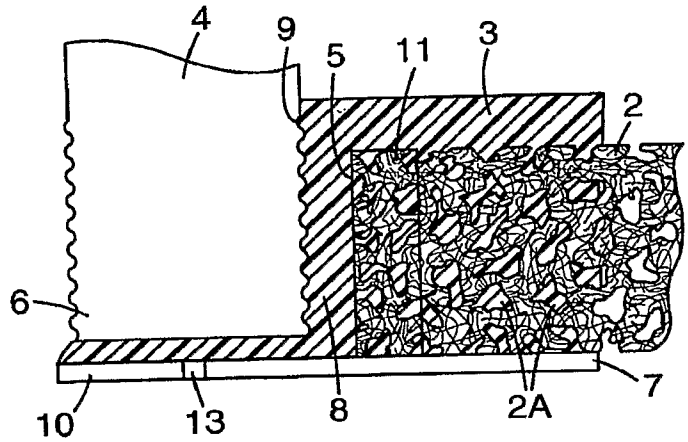


Fig. 2

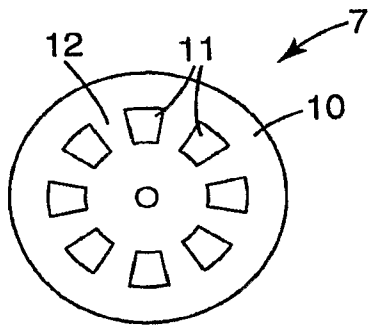


Fig. 3

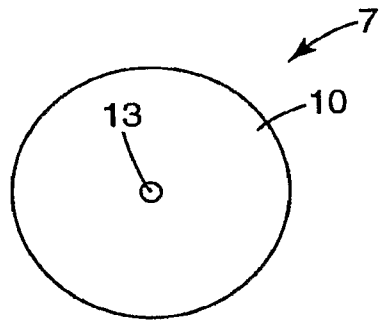


Fig. 4

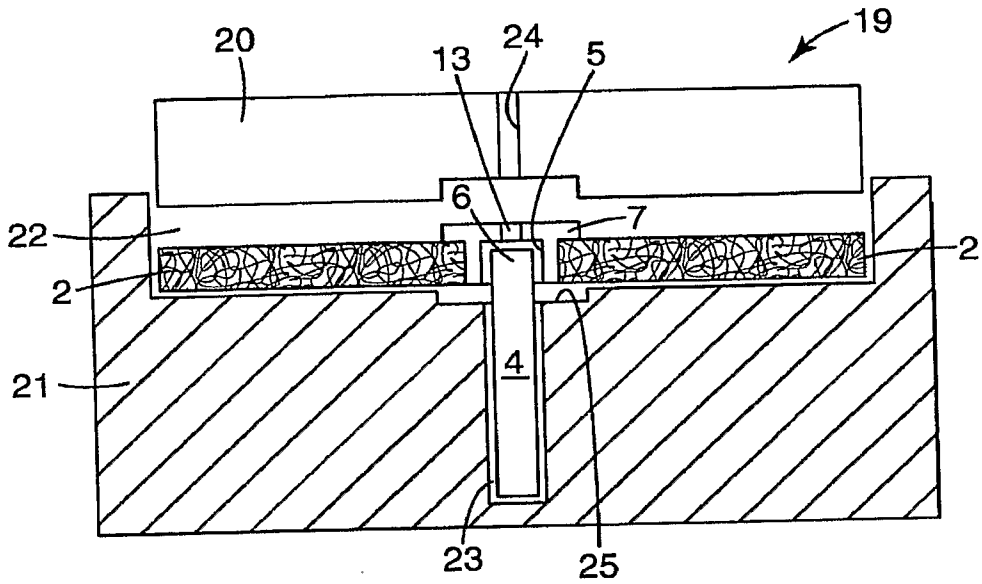


Fig. 5

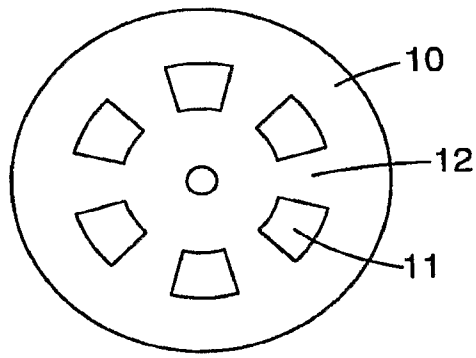


Fig. 6

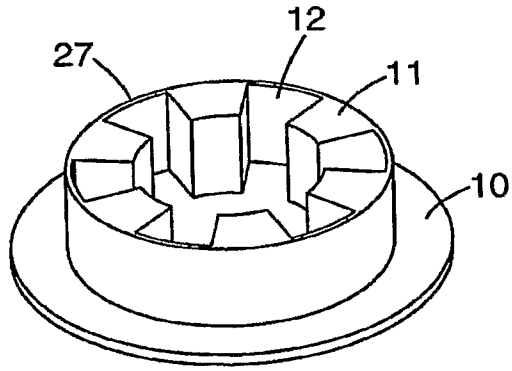


Fig. 7

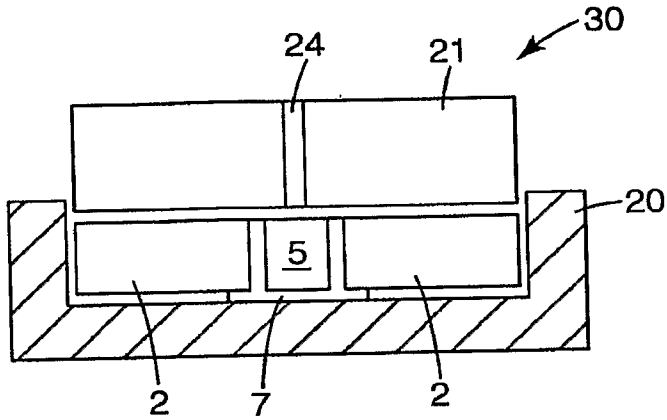


Fig. 8

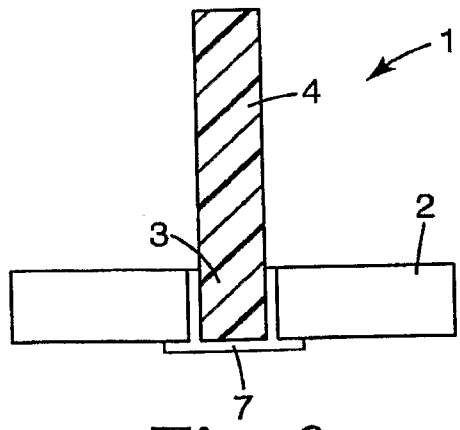


Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2007/004166

A. CLASSIFICATION OF SUBJECT MATTER

B24D 13/00(2006.01)i, B24D 13/12(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 8: B24D 13/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility Models and applications for Utility Models since 1975
Japanese Utility Models and applications for Utility Models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS (KIPO internal) "abrasive", "sleeve", "polymeric"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 11-320423 A (SUMITOMO 3M LTD.) 24 NOVEMBER 1999 See Abstract; Figures 1 and 2	1-15
A	EP 0790880 B1 (NORTON COMPANY) 23 FEBRUARY 2000 See Claims 1, 2 and Figures 1 and 2	1-15
A	US 2001/0011108 A1 (3M INNOVATIVE PROPERTIES COMPANY) 2 AUGUST 2001 See Paragraph [0033] - Paragraph [0048]; Figure 1	1-15
A	KR 10-2002-0095941 A (HYUNG-RAE JO) 28 DECEMBER 2002 See Figure 1	1-15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
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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

Date of the actual completion of the international search	Date of mailing of the international search report
25 JULY 2007 (25.07.2007)	**25 JULY 2007 (25.07.2007)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2007/004166

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