ABSTRACT

Bonded core for a cup-type grinding wheel including a predetermined volume percentage of aluminum or copper particles or a mixture thereof, a predetermined volume percentage of tin particles or particles of a tin alloy, a predetermined volume percentage of a resin binder, and a predetermined volume percentage of a solid lubricant.

4 Claims, 1 Drawing Figure
GRINDING WHEEL CORE
CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of U.S. Pat. application Ser. No. 340,578 filed Mar. 12, 1973 now abandoned.

BACKGROUND OF THE INVENTION

1. Field of Invention
This invention relates to the central core of a grinding wheel, and to such a core particularly useful in combination with a peripheral diamond abrasive section attached thereto for dry grinding operations at relatively high temperatures and stresses, since this core comprises a combination of a resin with particles of selected metals characterized by a high degree of thermal conductivity, by high strength at relatively high temperatures, and by ready dressability adjacent to the abrasive section.

2. Description of the Prior Art
The core material presently commonly used in combination with a peripheral diamond abrasive section for dry grinding operations comprises a major quantity of particulate aluminum, an intermediate quantity of resin, and a minor quantity of powdered graphite, the last included to facilitate dressing operations on the core.

U.S. Pat. No. 2,150,886 issued Mar. 14, 1939 discloses a core or mounting, for a diamond grinding wheel, molded from a relatively large quantity of aluminum powder and a relatively small quantity of resin, but not disclosing any material such as graphite to facilitate dressing the mounting, consistent with the fact that the shapes of the mountings illustrated in this patent do not require dressing.

British Pat. No. 1,099,703 published Jan. 17, 1968 discloses a core for use with a diamond or other abrasive section composed of a relatively large quantity of copper powder and a relatively small quantity of resin, again not disclosing any material such as graphite to facilitate dressing the core, consistent with the fact that the core configuration illustrated in this patent does not require dressing.

U.S. Pat. No. 2,243,105 issued May 27, 1941 discloses a combination of materials used in an abrasive section to be molded to the metallic support for an abrasive tool, this abrasive section comprising a quantity of copper powder, a quantity of tin powder, and a quantity of a resinoid bond, all mixed together with a quantity of diamond powder. However, there is no indication this patent contemplates the use of the combination of metals and resin described, without abrasive particles, to form a core of a grinding wheel.

SUMMARY OF THE INVENTION
The present invention contemplates a central core for a grinding wheel composed of up to 90 volume percent of particles of aluminum or copper or a mixture thereof to provide relatively high thermal conductivity through the core, as little as 5 volume percent of resin to serve as a binder, from 2 to 35 volume percent of tin or a tin alloy to serve as a supplemental binder, thereby imparting relatively high strength at relatively high temperatures to the core, and also to impart some dressability to the core, and from 2 to 10 volume percent of solid lubricant to enhance dressability component of graphite, or hexagonal boron nitride, or polytetrafluoroethylene, or a mixture thereof.

An object of this invention is the provision of a grinding wheel core with a high degree of thermal conductivity.

Another object is the provision of a grinding wheel core having relatively high strength at relatively high temperature.

Still another object is the provision of a grinding wheel core with dressability.

Yet another object is the provision of a grinding wheel core effective to increase the performance of a grinding wheel in which it is incorporated, at the same time reducing the power input required.

BRIEF DESCRIPTION OF THE DRAWING
The single FIGURE of the drawing is a side view, partially broken away, of a cup-type grinding wheel to which the core comprising the instant invention is particularly well suited.

DESCRIPTION OF THE PREFERRED EMBODIMENT
The drawing shows a cup wheel generally designated by the reference numeral 10 including a core 12 supporting a diamond abrasive section 14 at its outer periphery. The core includes a tapered conical side wall 16 intersecting a flat rear wall 18 provided at its center with an opening 22 by means of which the grinding wheel is mounted upon a suitable motor driven shaft. Reference numeral 24 designates the area of the side wall 16 adjacent to the diamond abrasive section 14 which must be dressed from time to time as the diamond section is worn down in order to maintain clearance between the core 12 and a workpiece engaged by the diamond abrasive section 14. This dressing operation may be performed most readily by a hand held or fixedly mounted dressing tool, and somewhat less readily by a hand held dressing stick.

On the basis of experimental work completed to date, it appears that the core incorporating the instant invention may usefully be composed of from 40 to 90 volume percent of particles of aluminum or copper or a mixture thereof, of from 2 to 35 volume percent of particles of tin or a tin alloy, of 5 to 30 volume percent of particles of resin, and of 0 to 15 volume percent of particles of a solid lubricant consisting of graphite, hexagonal boron nitride, or polytetrafluoroethylene, or a mixture thereof.

Within the ranges of volume percentages specified above for the various materials included in the core, the preferred percentages vary dependent upon the method of manufacturing a grinding wheel incorporating a core embodying the instant invention.

According to a first method of manufacturing such a grinding wheel, the core is formed first, and then the mixture of materials forming the abrasive section is introduced into a suitable peripheral recess on the core and then formed integrally with the core.

This method of manufacture may be carried out by filling a core mold assembly of the proper size and shape with a thoroughly blended dry mixture of the particulate metal components, the resin, and the solid lubricant forming the core. The core is cold pressed under 7½ tons per square inch pressure. The core is removed from the mold assembly and trued to provide a...
suitably shaped recess on the periphery of side wall 16 for an abrasive section 14. The abrasive section 14 may, for example, consist of a mixture of diamond abrasive particles and a suitable resin serving as a binder therefor, used to fill the recess after the core is returned to the mold assembly. In order to form the abrasive section integrally with the core, the abrasive section is hot pressed at 160°C for 20 minutes under from 1 to 6 tons per square inch pressure, depending on the grade and composition of the abrasive section, the pressure used being determined in a manner well known in the art.

After the combined core and abrasive section are removed from the mold assembly, they are subjected to a post curing operation at from 160° to 220°C, for from 12 to 38 hours depending upon the expected end use of the grinding wheel, the temperature and time used being determined in a manner well known in the art.

Alternatively, this method of manufacture may be carried out by first hot pressing the core material at 160°C and under 4 tons per square inch pressure for 20 minutes. The core is removed from the mold assembly and trued to form a suitable recess in the periphery of side wall 16 for the abrasive section 14. The core is returned to the mold assembly and the recess is filled with the materials forming the abrasive section. Thereafter, the abrasive section is formed and cured as described above, assuming that the abrasive section in this case is also composed of a mixture of diamond abrasive particles and a suitable resin.

The range of compositions of the core material preferred for use in the first method of manufacture described above consists of from 58 to 80 volume percent of aluminum or copper or a mixture thereof, from 8 to 16 volume percent of tin or a tin alloy, from 8 to 16 volume percent of resin, and from 2 to 10 volume percent of the solid lubricant.

If the particles of a solid lubricant are omitted from the core material, the range of compositions of the core material so modified preferred for use in the second method of manufacture described above consists of from 68 to 84 volume percent of aluminum or copper or a mixture thereof, from 8 to 16 volume percent of tin or a tin alloy, and from 8 to 16 volume percent of resin. This modified composition is somewhat less desirable than that described immediately above, because it is characteristically somewhat more difficult to dress.

On the basis of experience to date, the optimum composition for the first method of manufacture seems to be 66 volume percent of aluminum or copper or a mixture thereof, 12 volume percent of tin or a tin alloy, 13.3 volume percent of resin, 0.7 volume percent of lime, 4 volume percent of graphite, and 4 volume percent of polytetrafluoroethylene.

On the basis of experience to date, the optimum modified composition for the first method of manufacture seems to be 76 volume percent of aluminum or copper or a mixture thereof, 12 volume percent of tin or a tin alloy, and 12 volume percent of resin. According to a second method of manufacturing such a grinding wheel, an annular abrasive section of resin bonded diamond particles is first formed and fully cured, then placed in the bottom of a core mold of the proper size and shape with a coating of phenolic or epoxy adhesive applied to its interface with the core, and then the mold is filled with a thoroughly blended dry mixture of the metal and resin particles and particles of solid lubricant forming the core material of the instant invention.

Thereafter, in order to form the core integrally with the annular abrasive section, it is hot pressed at 160°C under 4 tons per square inch pressure for 20 minutes to complete the formation of the grinding wheel.

Alternatively, the second method of manufacturing such a grinding wheel may be employed with an annular abrasive section of resin bonded diamond particles first formed in a ring, but not fully cured, then formed integrally with the core material of the instant invention as described above.

In this variation of the second method of manufacturing such a grinding wheel, after the annular abrasive section and the attached core are removed from the mold assembly, they are both subjected to a post curing operation, as described above in connection with the first method of manufacturing such a grinding wheel.

The range of compositions of the core material preferred for use in the second method of manufacture described above consists of from 54 to 70 volume percent of aluminum or copper or a mixture thereof, from 8 to 16 volume percent of tin or a tin alloy, from 14 to 22 volume percent of resin, and from 2 to 10 volume percent of solid lubricant.

If the particles of a solid lubricant are omitted from the core material, the range of compositions of the core material so modified preferred for use in the second method of manufacture described above consists of from 58 to 74 volume percent of aluminum or copper or a mixture thereof, from 8 to 16 volume percent of tin or a tin alloy, and from 18 to 26 volume percent of resin. This modified composition is somewhat less desirable than that described immediately above, because it is characteristically somewhat more difficult to dress.

On the basis of experience to date, the optimum modified composition for the second method of manufacture seems to be 66 volume percent of aluminum or copper or a mixture thereof, 12 volume percent of tin or a tin alloy, and 22 volume percent of resin.

When, under either method of manufacture, the core comprising the instant invention is attached to the abrasive section before the abrasive section is subjected to its post curing operation, the resin contained in the core will give off volatile gases during the post curing operation which may produce cracks or swelling in the core. In order to prevent such swelling or cracking lime is substituted for up to 15 weight percent of the resin included in the core material, the lime being effective to absorb the volatile gases released by the resin during the post curing operation.

For the broadest range of composition of the core material of the instant invention first referred to above, including up to 30 core volume percent resin, the equivalent volume percent of lime is up to 1.9 core volume percent of lime replacing resin.

For the preferred range of composition of the core material of the instant invention for the first method of manufacture, including up to 16 core volume percent resin, the equivalent volume percent of lime is up to 1 core volume percent of lime replacing resin.

For the preferred range of composition of the core material of the instant invention for the second method of manufacture, including up to 26 core volume per-
percent resin, the equivalent volume percent of lime is up to 1.6 core volume percent of lime replacing resin.

The optimum composition of the core material of the instant invention for the first method of manufacture, including 12 core volume percent of resin, has performed satisfactorily with 0.6 core volume percent of lime replacing resin.

Experimental work performed to date indicates that the particle size of the metallic components of the core material of the instant invention is not critical. However, as a practical matter, it is considered preferable that the size of these particles not exceed 1,000 microns. The maximum size of the particles of resin is of the order of 500 microns or less. Satisfactory results have been obtained with cores containing aluminum particles 32 microns and finer, tin particles 32 microns and finer, and resin particles 76 microns and finer.

Since they have substantially the same thermal conductive properties, particles of aluminum and particles of copper may be used interchangeably or intermixed in the core material of the instant invention. However, particles of solid lubricant is not absolutely necessary, however a core material of the composition described herein, but omitting the solid lubricant, is characterized by somewhat decreased dressability.

Alternatively, the dressability of the core material of the instant invention may be increased by increasing the volume percent of tin or a tin alloy with a corresponding reduction in the volume percent of aluminum or copper or a mixture thereof.

The achievement of increased dressability by increasing the volume percent of tin or a tin alloy as indicated above is relatively undesirable, because this increased volume percent of tin or a tin alloy creates relatively undesirable working conditions as large chips are formed which spray the operator during a core dressing operation.

The relatively high strength at relatively high temperatures of the core material of the instant invention as compared to the relatively low strength at high temperatures of the core material commonly used prior to this invention is indicated in the following table:

<table>
<thead>
<tr>
<th>Core Material</th>
<th>Volume Percent of the Mixture</th>
<th>Flexural Strength (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composition in Common Usage (7 percent porosity)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>aluminum</td>
<td>58.1%</td>
<td>12,400</td>
</tr>
<tr>
<td>graphite</td>
<td>15.8%</td>
<td></td>
</tr>
<tr>
<td>phenolic resin</td>
<td>26.1%</td>
<td></td>
</tr>
<tr>
<td>Composition for 1st Method of Manufacture (10 percent porosity)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum</td>
<td>65%</td>
<td>11,000</td>
</tr>
<tr>
<td>Tin</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>phenolic resin</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>graphite</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>polytetrafluoroethylene</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Modified Composition for 1st Method of Manufacture (12 percent porosity)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>aluminum</td>
<td>76%</td>
<td>12,100</td>
</tr>
<tr>
<td>tin</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>phenolic resin</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>Modified Composition for 2nd Method of Manufacture (12 percent porosity)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>aluminum</td>
<td>66%</td>
<td>12,300</td>
</tr>
<tr>
<td>tin</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>phenolic resin</td>
<td>22%</td>
<td></td>
</tr>
</tbody>
</table>

Thermal conductivity measurements have shown a core of the modified composition described herein, produced by the first method of manufacturing a grinding wheel, to be 78 percent more conductive than the core commonly used prior to this invention, which will enhance wheel performance by reducing the temperature of the grinding surface. In fact, initial results indicate grinding wheels incorporating a core of the modified composition referred to above draw about 10 percent less power than grinding wheels with the core previously commonly used, and are about 10 percent higher in G-ratio, that is the ratio of the cubic inches of metal removed to the cubic inches of wheel wear.

The core material of the instant invention has been formed satisfactorily using phenolic resin, and other thermosetting resins are also considered satisfactory.
for grinding wheel applications such as dry grinding in which the core material should demonstrate relatively high strength at relatively high temperatures. Such resins suitable for this purpose include alkyd, melamine-formaldehyde, polyester, epoxy, silicone and infusible polyimide resins.

For grinding wheel applications in which relatively high strength of the core material at relatively high temperatures is not critical, suitable thermoplastic resins may be used in the core material of the instant invention. While the instant invention has been described particularly with reference to a diamond abrasive section, it should be understood that the core material of the instant invention is also useful with an abrasive section containing other abrasive materials such as cubic boron nitride.

It should also be understood that the core material of the instant invention is useful with abrasive sections incorporating various different types of bonding material. For example, the abrasive section may consist of diamond abrasive particles or other abrasive particles intermixed with a particulate metal or metals as a binder and formed integrally with the core material by the second method of manufacturing a grinding wheel described above, or by cold pressing the core according to the first method of manufacturing a grinding wheel described above. Alternatively, the abrasive section may consist of diamond abrasive particles or other abrasive particles secured in a vitrified bond in turn secured to the core by the second method of manufacturing a grinding wheel described above.

The description of the invention provided herein is illustrative rather than limiting, and the scope of this invention is limited only by the scope of the appended claims.

What is claimed is:

1. In a grinding wheel with a peripheral abrasive section, a core comprising a particulate first metallic component, a particulate second metallic component, and a particulate synthetic thermosetting resin, all bonded together, wherein the first metallic component comprises from 40 to 90 core volume percent of a metal selected from the group consisting of aluminum and copper and a mixture thereof, the second metallic component comprises from 2 to 35 core volume percent of a metal selected from the group consisting of tin and an alloy of tin with a melting point at or less than 350°C, and the resin comprises from 5 to 30 core volume percent.

2. A core as described in claim 1, wherein the first metallic component comprises from 58 to 74 core volume percent of a metal selected from the group consisting of aluminum and copper and a mixture thereof, the second metallic component comprises from 8 to 16 core volume percent of a metal selected from the group consisting of tin and an alloy of tin with a melting point at or less than 350°C, and the resin comprises from 18 to 26 core volume percent.

3. In a grinding wheel with a peripheral abrasive section, a core comprising a particulate first metallic component, a particulate second metallic component, a particulate synthetic thermosetting resin, and a particulate solid lubricant, all bonded together, wherein the first metallic component comprises from 40 to 90 core volume percent of a metal selected from the group consisting of aluminum and copper and a mixture thereof, the second metallic component comprises from 2 to 35 core volume percent of a metal selected from the group consisting of tin and an alloy of tin with a melting point at or less than 350°C, the resin comprises from 5 to 30 core volume percent, and the solid lubricant comprises from 0 to 15 core volume percent of solid lubricant selected from the group consisting of graphite, hexagonal boron nitride, and polytetrafluoroethylene, or a mixture thereof.

4. A core as described in claim 3, wherein the first metallic component comprises from 54 to 70 core volume percent of a metal selected from the group consisting of aluminum and copper and a mixture thereof, the second metallic component comprises from 8 to 16 core volume percent of a metal selected from the group consisting of tin and an alloy of tin with a melting point at or less than 350°C, the resin comprises from 14 to 22 core volume percent, and the solid lubricant comprises from 2 to 10 core volume percent.