Resin-bonded grinding wheel.

A resin-bonded grinding wheel containing cubic boron nitride abrasive grits wherein the resinous bonding matrix contains, as a filler, (1) iron sulfide and an alkali sulfate in a volume ratio of 1/4 to 4/1, (2) cryolite, or (3) potassium aluminum fluoride, or a mixture of (1), (2), and/or (3), in the amount of 8 to 50% by volume of the abrasive, bond, and filler combination.
This invention relates to organic bonded grinding wheels containing cubic boron nitride abrasive and active fillers.

So-called active fillers such as metal sulfide and halogen salts such as cryolite which have reactivity toward the material being ground have been employed in conventional aluminum oxide abrasive containing organic bonded grinding wheels for many years.

Such grinding aid fillers have not been used in grinding wheels containing diamond grits as the abrasive, because the important use of diamond wheels is in grinding carbides, glass and ceramics, particularly (for resin bonded wheels) in grinding hard carbides. Grinding aids suitable for grinding steel, for example, are of no apparent advantage in carbide grinding.

The development of diamond grinding wheels began in the 1930's, and, until the late 1960's, diamond was the sole "super" abrasive, much harder than the conventional aluminum oxide and silicon carbide abrasives. Concurrent with the development of synthetic diamond by the high pressure-high temperature method taught in General Electric patents issued in the 1960's, the high density cubic form of boron nitride (CBN) having a hardness similar to diamond was discovered, by applying high pressure to hexagonal boron nitride at high temperature and in the presence of a catalyst, as disclosed in U.S. Patent 2,947,617.

While not superior to diamond in the grinding of carbides (e.g. cemented tungsten carbide) cubic boron nitride (CBN) has been found to be superior to diamond when ferrous...
metals, particularly tool steels are being ground. Thus CBN wheels can be superior to diamond wheels in the grinding of tools which combine hard carbides and steels.

Although CBN wheels have been made and tested by others, containing specific grinding aids, so far as is known, no commercial use has been made of grinding aid fillers in resin bonded CBN wheels.

British Patent 834,351, published in 1960 teaches the use of metal sulfides together with alkali-metal salts such as sulfates as fillers in conventional abrasive wheels for grinding alloy steels. While the patent refers to abrasives generally, and lists diamond, such fillers, so far as is known, have never been commercially employed in diamond wheels or in CBN wheels.

German Patent P2230701, to Winter & Sohn discloses employing zinc sulfide with cryolite as a grinding aid in stick form to be applied to the workpiece. No suggestion of incorporating the grinding aids in the wheel bond appears in the patent.

In accordance with the present invention there is provided a resin-bonded grinding wheel containing cubic boron nitride abrasive grits wherein the resinous bonding matrix contains, as a filler, (1) iron sulfide and an alkali sulfate in a volume ratio of 1/4 to 4/1, (2) cryolite, or (3) potassium aluminum fluoride, or a mixture of (1), (2), and/or (3), in the amount of 8 to 50% by volume of the abrasive, bond, and filler combination.

The present invention is the inclusion in CBN organic resin bonded wheels of an iron sulfide filler together with sodium or potassium sulfate. Somewhat inferior to the iron sulfide/alkali sulfate filler are cryolite, or potassium aluminum tetrafluoride, or hexafluoride, in the amount of 8 to 50% by volume of the grinding section of the tool. Obviously, combinations of these fillers can be employed. Such wheels, in dry grinding of tool steels, or grinding of tool steels in combination with cemented carbides, show equivalent or better results.
than the best prior art wheels using bond compositions containing silver and dry film lubricants. Elimination of the need for silver is a major economic benefit. These wheels also are advantageous in providing greater freeness of cut and thus more rapid cut of the workpiece.

Wheels according to the present invention may be prepared as follows:

Wheel Preparation Example

An intimate mixture of fillers and the CBN abrasive is prepared. Fillers are those active materials included as the subject of the application as well as other inert substances. The mixture is then coated with a liquid pickup agent. A finely divided powdered resin is then mixed with the liquid coated abrasive/filler mixture so as to coat the surfaces of the abrasive and filler particles evenly with resin. In the usual practice, phenolic novolak resin with hexamethylene tetramine crosslinking agent is chosen as the resin and furfural as the liquid pickup agent.

A typical formulation which illustrates the invention is:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Percent by Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBN</td>
<td>19</td>
</tr>
<tr>
<td>$K_2SO_4$</td>
<td>20</td>
</tr>
<tr>
<td>FeS$_2$</td>
<td>11</td>
</tr>
<tr>
<td>SiC</td>
<td>8</td>
</tr>
<tr>
<td>Furfural</td>
<td>2</td>
</tr>
<tr>
<td>Resin</td>
<td>38</td>
</tr>
<tr>
<td>CaO</td>
<td>2</td>
</tr>
</tbody>
</table>

This mixture is then distributed evenly in a groove molded or machined around the circumference of a core. The core is composed of finely divided aluminum powder and resin which has previously been compressed either cold or hot. The wheel, which now consists of the core and circumferentially located abrasive section, is hot pressed to melt and fuse the resin bonding both the abrasive section and the core. Pressures to 50 tsi and temperatures from 140 to 200°C. are applied to the wheel during a period of one-quarter to one
hour to form the wheel. Subsequent to this operation the wheel may be heated to a temperature higher than the molding temperature at atmospheric pressure to improve grinding characteristics. Finally, the wheel is machined to prepare a product to standard and fixed dimensional specifications. Other thermosetting resins or equivalents can be employed. The wheels may be straight cylindrical wheels (1Al shape), or may be cup wheels as in the example above, or may be any other conventional shape. The active filler should be present in a total amount of from 8% to 50% by volume of the grinding section of the wheel. The ratio of FeS₂ to alkali sulfate may be from 4/1 to 1/4 by volume, but is preferably from 40/60 to 60/40 by volume. Sodium sulfate may replace all or part of the K₂SO₄.
CLAIMS

1. A resin-bonded grinding wheel containing cubic boron nitride abrasive grits characterized by the fact that the resinous bonding matrix contains, as a filler, (1) iron sulfide and an alkali sulfate in a volume ratio of 1/4 to 4/1, (2) cryolite, or (3) potassium aluminum fluoride, or a mixture of (1), (2) and/or (3), in the amount of 8 to 50% by volume of the abrasive, bond, and filler combination.

2. A resin-bonded grinding wheel according to claim 1, characterized by the fact that the filler comprises finely divided iron sulfide and alkali sulfate.