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DRESSABLE HEAT CONDUCTIVE BACKING FOR ABRASIVE WHEELS

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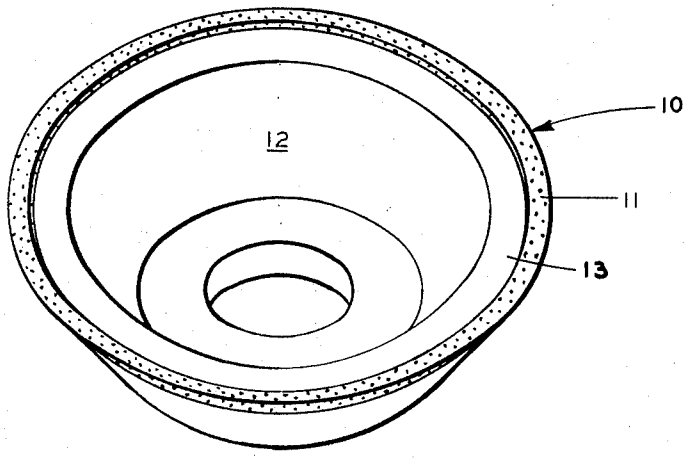


Fig. 1.

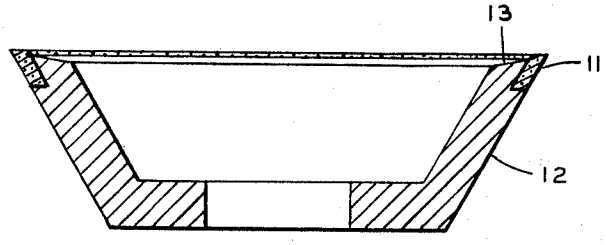


Fig. 2.

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DRESSABLE HEAT CONDUCTIVE BACKING FOR ABRASIVE WHEELS

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This invention relates to grinding wheels and, more specifically, to a dressable, heat conductive backing for resin-bonded diamond abrasive wheels used for grinding carbides and other extremely hard materials. Furthermore, this invention relates to a wheel backing material which is an improvement over previous backing materials as shown, for example, by U.S. Patent No. 2,150,886 and Canadian Patent No. 608,172.

It is customary in the manufacture of diamond grinding wheels to make the center or body of the wheel, sometimes referred to as the backing, out of an inexpensive, high-strength material such as a synthetic resin containing a particulate filler. The expensive, diamond abrasive section of the wheel is in the form of a resin-bonded rim or annulus which is united with the backing to form the abrading portion of the wheel.

In the past, manufacturers of resin-bonded diamond grinding wheels have used both heat insulating and heat conductive backings. The tendency has been to use heat insulating backings wherever possible in order to take advantage of the lower cost of this type of backing. The non-conductive backing, however, tends to trap the heat generated by the grinding action in the abrasive rim. As a result, the rim is apt to crack and the carbide material being ground is liable to check because of the severe local heating. It is apparent, therefore, that a heat conductive backing material which will aid in carrying off the heat generated in the abrasive rim has an important advantage over the heat insulating type of backing. In the patent to Van der Pyl, 2,150,886, referred to above, there is disclosed a heat conductive backing for resin-bonded diamond wheels which is comprised of a mixture of synthetic resin and a powdered metal, preferably aluminum. In certain types of wheels, however, it is desirable that the backing material be readily dressable to enable grinding clearance to be provided for the abrasive portion of the wheel. The aluminum filled resin backing disclosed in the patent just referred to, is not easily dressable since the aluminum metal is soft and will tend to smear rather than be dressed away when a dressing stick is applied thereto.

An important advantage of the backing material made in accordance with the teachings of the present invention is that it enables high flexural strength, good dressability and high heatconductivity to be achieved in the same wheel—a result never before accomplished. In the state of the art as it existed prior to the present invention, it was impossible to provide a wheel backing having good dressability while at the same time affording the high flexural strength required for a "safe" wheel. Likewise, it was impossible with the known backing materials to provide both good dressability and high heat transfer characteristics. All of the previously known backing materials sacrificed either strength or heat conductivity in order to achieve good dressability. Now, for the first time, it is possible to realize all of these desirable characteristics in the same backing material.

It is therefore an object of the present invention to provide a backing material for resin-bonded diamond wheels which is highly heat conductive, is readily dressable, and possesses high flexural strength.

A further object of the invention is to provide an easily dressable heat conductive backing for abrasive wheels

which includes, as its principal heat conductive ingredient, a powdered metal alloy containing a major amount of aluminum and a minor amount of one or more of *the* following: calcium, silver, silicon, the rare earth metals, and those elements contained in Groups VI–B, VII–B or VIII of the Periodic Table of Elements.

Diamond wheels incorporating the teachings of the present invention may be made in various ways. However, in order to provide a clear understanding of the manner in which the invention may be practiced, one procedure which has been found suitable for manufacturing diamond wheels will be described herein. According to this method, a backing compound is made by first blending an aluminum alloy powder with a synthetic resin binder, then sintering the mixture to drive off any volatiles, and finally, crushing the sintered product into a coarse powder. To mold the backing preform, the powder is charged into a preform mold of suitable size and shape after which it is heated under pressure until it is partially cured. The mold is then cooled and the preform removed and cleaned of flash. The area to which the abrasive rim is to be bonded is then lightly coated with phenolic resin and the preform is placed in an abrasive insert mold. A mixture of abrasive and binder is then charged into the mold around the periphery of the preform after which it is heated under pressure until cured. The mold is then cooled and the wheel assembly stripped from the mold. The composite wheel is then subjected to a post or oven cure to insure a relatively complete polymerization of the resin. The wheel is then ready for finishing.

The invention will hereinafter be described in greater detail in conjunction with the accompanying drawings in which:

FIG. 1 is a perspective view of a cup-type grinding wheel having a heat conductive, dressable backing and resin-bonded abrasive rim.

FIG. 2 is cross-sectional view of the wheel shown in FIG. 1.

As shown in FIG. 1 of the drawings, the grinding wheel **10** has an abrasive insert or rim **11** formed integrally with a non-abrasive backing **12**. In the wheel herein illustrated, the rim **11** is made of a resin-bonded diamond abrasive while the backing **12** is comprised of a phenol-formaldehyde resin and an aluminum alloy powder to provide a backing having high heat conductivity. As the rim **11** is worn away, it is necessary to remove material from the backing in the area indicated by reference numeral **13** in order to provide grinding clearance for the rim. Although, as heretofore noted, a mixture of aluminum powder and resin will not produce a dressable backing because the soft aluminum tends to smear over the surface of the backing rather than be removed therefrom when dressed, it has been found that certain aluminum alloy powders provide for easy dressability while at the same time retaining the desirable properties of high flexural strength and good heat conductivity provided by the aluminum powder. The alloying elements useful for the purposes of the present invention are those contained in Groups VI–B, VII–B, and VIII of the Periodic Table of Elements, as well as the rare earth metals and the elements calcium, silver and silicon.

An application of the invention is given by the following example:

EXAMPLE I

	Parts by wt.
Powdered aluminum alloy (95% Al–5% Fe, by wt., —325 mesh)	70
Phenol-formaldehyde resin	30

The backing mix is made by mixing the phenol-formaldehyde resin with the aluminum alloy powder in the pro-

portions given above. The blended mix is then sintered and reduced to a molding powder.

The backing preform is molded by the application of heat and pressure in accordance with known procedures in a wheel mold having a cavity shaped to provide a wheel of the desired cross-sectional configuration. After molding, the preform is removed from the mold barrel and the flash removed. The preform is next placed in a mold provided with a cavity for receiving the diamond abrasive insert. A 100 concentration diamond abrasive mix is then charged into the mold and molded under heat and pressure to produce a complete diamond grinding wheel 10 as shown in FIGS. 1 and 2.

Dressability of the backing material as used in the grinding wheel may be determined by molding the same into 5¼ x ½ x 1¼ inch test discs which are more convenient for test purposes than the cup type wheel. The discs, after post curing, are weighed and mounted on a grinding wheel spindle. A dressing stick is pressed against each of the discs with a constant measured force for 5 minutes. The loss in weight of the discs is used as a measure of dressability. Dressable discs are taken to be those which show weight losses of approximately 6½ grams or more, while discs showing weight losses of less than this amount are considered to be non-dressable.

After completion of the dressability test, each disc may then be cut into four test specimens measuring 2½ x ½ x ½ inch and tested in flexure. The average for the four specimens is then recorded as the flexural strength in pounds per square inch.

From each test disc is also cut a specimen measuring approximately 1⅜ x 1⅜ x ½ inch. Thermocouple leads are epoxy-cemented to one face of the test specimen and, with the temperature of the specimen at 80° F., it is placed on a flat plate heated to 300° F., and the temperature of the opposite face recorded every one-half minute for a period of three minutes. The heat transfer characteristic is then taken as the temperature rise measured by the thermocouple.

The backing prepared according to Example I has a dressability of 8.9; a flexural strength of 18,100 p.s.i., and a heat transfer characteristic, or temperature rise of 100° F. in one minute; 155° F. in two minutes, and 178° F. in three minutes. Thus, this backing is one which is easily dressable, possesses high flexural strength and has a satisfactory heat transfer characteristic.

The following table contains examples of other compounds, similar to the one described in Example I, which are found to be satisfactory for use as backings for abrasive wheels.

TABLE I.—EFFECT OF VARYING RATIO OF ALUMINUM ALLOY TO PHENOLIC RESIN ON DRESSABILITY, STRENGTH AND HEAT TRANSFER

Percent Al Alloy (by wt.)	Mesh Size	Dressability (weight lost), gms.	Flexural Strength (p.s.i.×10³)	Heat Transfer (° F.)		
				1 min.	2 min.	3 min.
Al Alloy—92.6% Al-7.4% Fe (by wt.)						
80.0	−100	8.4	11.4	178	202	207
75.0	−325	9.0	15.0	167	200	201
Al Alloy—95% Al-5% Fe (by wt.)						
72.5	−325	6.9	20.6	140	172	192
70.0	−325	8.9	18.1	100	155	178
67.5	−325	7.7	20.8	115	155	179
65.0	−325	8.3	20.1	85	136	173

It will be understood, of course, that the data given in the above table merely illustrate the range of ingredients which have been found satisfactory and do not include all compositions which are suitable for use as wheel backings. It has been determined from tests that wheel backing compounds containing from 65–80% by weight of aluminum alloy and 20–35% by weight of phenolic resin binder are desirable for this purpose.

A large number of different aluminum alloys have been found to provide suitable dressability, flexural strength and heat transfer properties to the lacking compound. The alloying elements which produce satisfactory results are those which are contained in Groups VI–B, VII–B and VIII of the Periodic Table as well as the rare earth metals and the elements calcium, silver and silicon. The following table sets forth the flexural strength and dressability of compounds employing various alloying elements as well as pure aluminum powder for purposes of comparison.

TABLE II.—EFFECT OF ALLOYING ELEMENT AND MESH SIZE ON DRESSABILITY

[Formulation: 70% alloy—30% phenolic resin]

Alloying Element, percent by wt.	Mesh Size	Dressability wt. lost, gms.	Flexural Strength, p.s.i.×10³
2.0 Fe	−325	8.0	21.4
5.0 Fe	−325	8.9	18.1
7.4 Fe	−325	9.6	19.3
7.4 Fe	−100	16.3	19.4
2.1 Fe, 6.0 Co	−200	13.8	19.5
3.4 Mo, 1.9 Fe	−200	8.7	19.3
0.45–0.8 Fe, 0.9–1.3 Ni	−325	7.6	19.4
5.0 Ni	−200	7.8	20.0
4.9 Cu, 5.6 Mn	−100	9.7	16.6
5.1 Mn	−200	10.2	19.1
5.3 Rare Earths	−200	10.8	18.6
5.3 Cr	−200	13.3	20.7
5.1 Ca	−200	8.2	
5.0 Ag	−325	6.8	13.3
2.0 Si	−325	7.6	19.9
5.0 Si	−325	7.2	19.2
10–13 Si	−325	6.1	17.1
0	−325	5.6	18.0
0	−100	1.5	12.5

The alloying elements can be present in various proportions ranging from 1–30% by weight of the aluminum alloy, although generally it will be found preferable to use from 2–8% of the alloying elements. The elements may be used alone or several of them may be combined to form the alloy. Also, as shown in Table II, the mesh size of the aluminum alloy powder has an effect on the dressability of the backing, the larger mesh size powder imparting greater dressability to the finished product. For this reason, alloys having a nominal mesh size of from 100–325 mesh are preferable for use in the backings of the present invention although powders ranging from 50–600 mesh are usable for this purpose.

It is to be understood, of course, that the foregoing examples are intended to be illustrative only and that changes and modifications may be resorted to without departing from the scope of the invention defined by the appended claims.

What is claimed is:

1. An abrasive wheel backing comprised of a non-abrasive material and a phenolic resin binder, said backing being molded under heat and pressure to form a rigid body of the desired configuration, said backing comprising essentially 20–35% by weight of a phenolic resin binder and 80–65% by weight of a powdered aluminum alloy having a nominal grain size of from 50–600 mesh, the alloying element in the aluminum being selected from the group consisting of the rare earth metals, calcium, silver, silicon and the elements contained in Groups VI–B, VII–B and VIII of the Periodic Table of Elements, and being present either alone or in combination in the alloy to an extent of from 1–30% by weight thereof, to thereby provide an abrasive wheel backing which is easily dressable and has superior flexural strength and heat transfer properties.

2. The abrasive wheel backing of claim 1 wherein the amount of alloying element present in the aluminum alloy is from 2–8% by weight of the alloy.

3. The abrasive wheel backing of claim 1 wherein the alloying element in the aluminum is selected from the group consisting of the elements contained in Group VI–B of the Periodic Table of Elements.

4. The abrasive wheel backing of claim 1 wherein the alloying element in the aluminum is selected from the

group consisting of the elements contained in Group VIII of the Periodic Table of Elements.

5. The abrasive wheel backing of claim **3** wherein the alloying element is molybdenum.

6. The abrasive wheel backing of claim **3** wherein the alloying element is chromium.

7. The abrasive wheel backing of claim **4** wherein the alloying element is iron.

8. The abrasive wheel backing of claim **4** wherein the alloying element is cobalt.

9. The abrasive wheel backing of claim **4** wherein the alloying element is nickel.

10. The abrasive wheel backing of claim **1** wherein the alloying element is manganese.

11. The abrasive wheel backing of claim **1** wherein the binder and aluminum alloy are present in the backing in

a ratio of 30 parts by weight of binder and 70 parts by weight of alloy, and the alloying element represents approximately 5% by weight of the alloy.

12. The abrasive wheel backing of claim **1** wherein the aluminum alloy powder has a nominal grain size of from 100–325.

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