

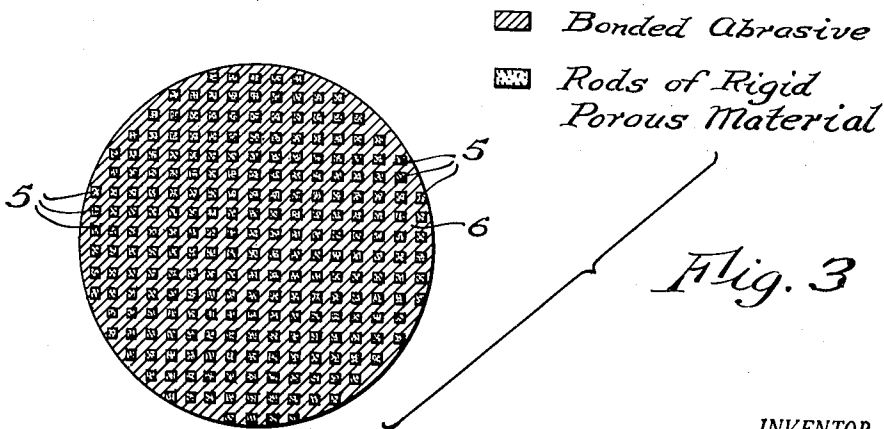
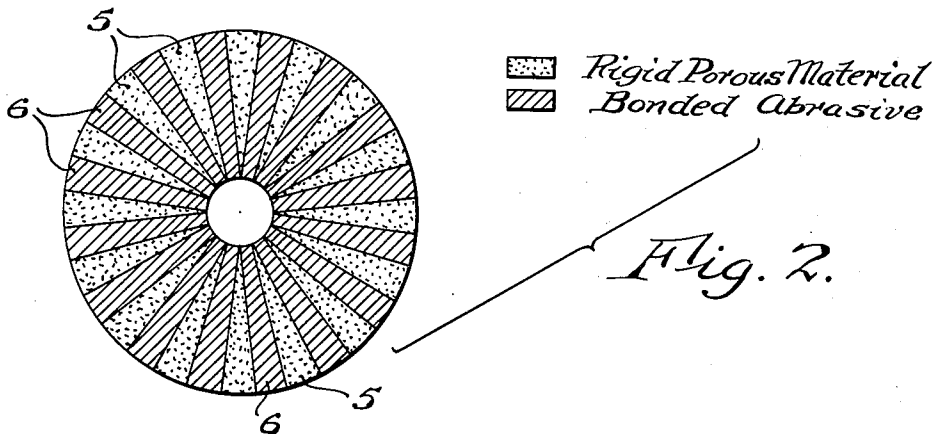
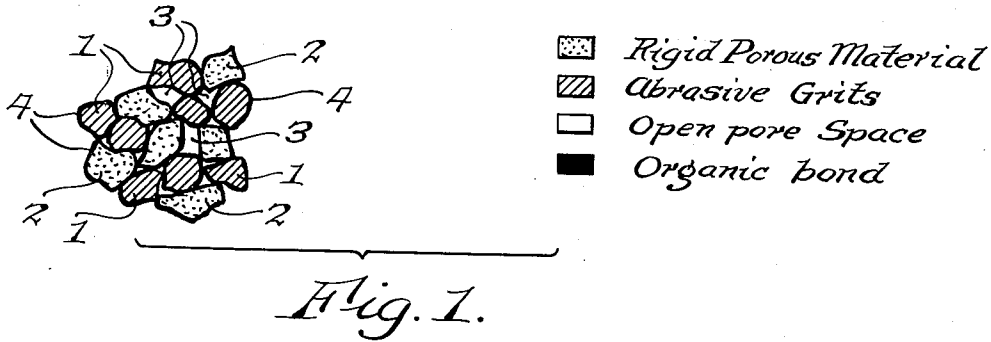
Feb. 14, 1956

N. P. ROBIE

2,734,812

ABRASIVE BODIES

Filed Sept. 21, 1951



INVENTOR.
Norman P. Robie,
BY
Parker, Friedman & Arnold,
Attorneys.

1

2,734,812

ABRASIVE BODIES

Norman P. Robie, Hamburg, N. Y., assignor to Electro Refractories & Abrasives Corporation, Buffalo, N. Y.

Application September 21, 1951, Serial No. 247,651

3 Claims. (Cl. 51—298)

This invention relates to bonded abrasive articles such as grinding wheels, discs, segments, rubs, etc. and more particularly to articles which have a low temperature bond such as sodium silicate, magnesium oxychloride, rubber, synthetic rubber, synthetic resins, shellac or the like.

One object of this invention is to provide faster and cooler cutting grinding wheels. Another object of this invention is to provide a method of making a uniform abrasive article of greater than usual porosity. Another object of this invention is to promote coolness of cutting by incorporating in the wheel a material which will control the friability of the cutting surfaces of the wheel. Another object of this invention is to increase the safety of a grinding wheel by lowering its weight so that centrifugal forces tending to rupture the revolving wheel are materially less.

In the prior manufacture of vitrified ceramic bonded abrasive articles, high porosity is obtained by incorporating combustible particles such as coke, sawdust, nut shells, etc. into the composition. When such compositions are fired at high temperatures, the organic particles are burned out, leaving voids throughout the article. Because ceramic bonded abrasives could be made porous and cool cutting in this way, they have had an advantage over organic bonded abrasives for certain grinding operations.

Recently organic bonded articles have been made porous by incorporating particles such as naphthalene or paradichlorbenzene into the composition so that the naphthalene or paradichlorbenzene will volatilize during the lower temperature baking cycles used to vulcanize or thermoset the resinous binders. Many disadvantages are inherent in the use of this type of pore former. For example, naphthalene and paradichlorbenzene can be sized to the desired particle size with some difficulty but on short storage they tend to cake or coalesce so they have to be rescreened before use. Naphthalene and paradichlorbenzene are very low melting so that at the initial stages of the baking cycle when the binder is fusible these fluid pore formers increase the fluidity of the binder with the result that the article will slump and have bond flow giving an article which is difficult to control as to uniformity and porosity. Further in some sizes of wheels all of the naphthalene or paradichlorbenzene is not completely removed during the baking cycle, resulting in a wheel which gives off a strong odor in use.

I have discovered an alternative method of procedure whereby I realize the advantages of these porous organic bonded abrasive structures without their disadvantages in either manufacture or use. I do this by incorporating in an otherwise normal type abrasive mix particles of rigid sponge like character comprising open pores enclosed between thin supporting walls. These particles, which I designate as pore-support members, support the surrounding abrasive granules and the bond therefor so that they are firmly retained in position during the hardening and thereafter until such time as it is desirable that they be locally removed as discussed below.

2

These sponge-like particles are very porous within themselves yet are devoid of the resilient springiness of natural sponges. They are sufficiently weak to yield locally when the abrasive mix is pressed or otherwise formed in a mold, without being broken or crushed to a state where they do not continue to contact and support the adjacent granules of hard, strong abrasive material. Their roughness and porosity moreover prevents running of the softened resin binder during curing and thus results in a stronger and more uniform wheel structure.

There are numerous rigid sponge-like materials containing 50% by volume or more pore space within themselves which I may use in this way as pore-support members, for example, expanded plastics such as those discussed beginning at page 800 in the 1950 Modern Plastics Encyclopedia and Engineers Handbook or the thermal insulating material of porous glass, such for example as is sold under the trade name of "Foamglas." These may be cut to desired shapes as discussed below or may be crushed, sifted and used in granular form. Other natural or artificial rigid sponge-like masses such as pumice or expanded sodium silicate may be used. The internal porosity of such materials runs from as low as 40 to as high as 75%. I prefer material with at least 50% internal porosity.

One material for the supporting particles which I have found very useful is heat expanded perlite. Perlite and its thermal expansion product is described in the U. S. Bureau of Mines Information Circular #7364 by O. C. Ralston, August 1946. Perlite is a siliceous, volcanic glass containing between 2% and 5% of chemically combined or dissolved water. Perlite may be broadly defined as any siliceous lava containing sufficient volatile material either combined or dissolved to cause it to expand into bubbles when the material is quickly heated to a suitable point in the softening range. The term perlite will hereafter be used to identify the commercially expanded or intumesced material made in this way.

My invention can be applied using perlite or other solid sponge like materials in any type of abrasive body in which the bond is organic or otherwise of such a low temperature nature that it is impractical to burn out oxidizable fillers. The binders may, for example, be organic such as phenolic or alkyd resins, shellac or dispersible rubber or synthetic elastomers, magnesium oxychloride or low temperature ceramic binders such as sodium silicate or bonds of the type disclosed in U. S. Patent No. 2,316,161 although the organic sponge like materials should be avoided when curing temperatures above 500° F. are to be employed.

In the accompanying drawings which illustrate specific aspects of my invention:

Figure 1 shows a magnified cross section of a fragment broken from a grinding wheel in which granules of pore-supporting material are included; Figure 2 shows a side grinding face of an abrasive disc containing shaped inserts of rigid foamed or sponge like material and Figure 3 shows a grinding face of another abrasive disc containing inserted rods of rigid foamed material.

In the drawing of Figure 1, 1 indicates a particle of abrasive grain which may be of fused alumina, silicon carbide or other desired abrasive material, 2 indicates a rough granule of intumesced perlite, 3 an open pore of the type normally occurring between the particles of grinding wheels, and 4 is a film of cured phenolic resin or other organic bond.

As illustrated, the perlite pore supports need not occupy all of the pore space but only sufficient pore space to prevent slumping in structures of very high porosity. With aluminum oxide grain, wheel structures below .0820 lb. per cubic inch are very porous and with silicon

carbide because of its lower specific gravity, wheel structures below .0665 are very porous.

To make an abrasive wheel of the type illustrated in Figure 1, I give the following illustrative example in which compositions are given in parts by weight:

24 grit alumina abrasive-----	83.00
Powdered heat hardenable phenolic resin-----	8.64
Cryolite -----	6.00
Liquid heat hardenable phenolic resin-----	2.36
Intumesced perlite 14-24 mesh-----	2.18

The abrasive was wet with the liquid resin and the perlite then added and mixed to get it wet by contact. Then a mixture of the powdered resin and cryolite was added and mixed in, after which the mix was placed in a mold, leveled off and pressed as usual in the formation of grinding wheels to a density of 0.0777 lb. per cubic inch. The formed wheel was then removed from the mold and cured in the usual way, holding it at 1850 F. for 15 hours and then raising the temperature gradually to 365° F. at which value it was held another 12 hours. After curing, the density of the wheel had risen to 0.0781 lb. per cubic inch and the wheel was strong and sound.

Wheels, 14 x 2 x 1½ inches, made in this way were used to grind plow shares in competition with porous resin wheels of the paradichlorobenzene type which the customer normally use and considered satisfactory. A representative wheel of the latter type produced 8400 pieces, whereas my wheel with pore supports produced between 20,000 and 21,000 pieces at the same production rate as the paradichlorobenzene wheel and with noticeable coolness and freedom of cut.

In this connection it should be noted that although the microscopic appearance of such a perlite filled wheel makes it look rather dense, actually with my improved type wheel the overall porosity of the abrasive body is quite high (because of the internal porosity of the perlite grains). Moreover the pore space at the used face of the wheel is materially higher yet because of the break out of the perlite particles from the face of the wheel. This is because the perlite particles are quickly shattered and thrown from the working face of the wheel as soon as they strike the work being ground. In this way the edges of the abrasive grains are left openly exposed in such a way as to utilize their cutting ability to the utmost, while a supply of cooling air or cutting fluid is entrained in the open pores and wiped against the face of the work being ground giving a highly effective cooling action.

Also my structure is more uniform than the old type when porosities of the two are equal because as explained above the bond in my type remains in place and clings to the grains instead of running to the lower face of the wheel during curing.

In the example which I have recited, the perlite particles were 14 to 24 mesh while the abrasive grains were 24 mesh. I find that in general the diameter of the perlite particles should be from one to two times the diameter of the largest abrasive particles in the mix although at times the perlite may be smaller, down to about ¼ the diameter of the abrasive granules, and in unusual cases may be materially larger, up to about four times the abrasive granule diameter. In the latter cases it is usually better to make an abrasive body of the type illustrated in Figure 2 or 3 rather than by random inclusion of larger perlite grains which is apt to result in poor balance within the wheel.

Expanded perlite is very low in density. Reasonably closely sized particles through 14 on 16 mesh pack together to weigh from 0.4 to 0.2 gram/cc. as compared with approximately 1.85 grams/cc. for silicon carbide of the same particle size. Hence, the amount of perlite required in abrasive wheel formulation is very low when expressed in terms of weight, running from as low as ¼ of 1% by weight to as much as 10% in extreme cases.

In the example cited above the approximately 2% by weight would occupy about 15% of the entire volume of the abrasive wheel beyond which unfilled pores would occupy about the same volume. In the course of ordinary grinding operations we find the use of between 1½ and 3% by weight to be adequate. In the manufacture of abrasive articles by the method described above, the pore support is lightly penetrated by the resin bond. The degree of bond penetration may be increased by preliminary impregnation of the particles before their addition to the mix or by controlling the wetness of the mix and the time of mixing. On the other hand, the bond penetration may be lessened or minimized by suitable means or additional ingredients may be introduced into the wheel within the pores of the pore support particles. These variations produce important changes in the structure and performance of the grinding wheel. In this connection among possible alternatives, I may partially fill the pore support members with resin bond which will reduce resin flow by containing part of the bond or I may take precautions to prevent resin penetration by the method of mixing, by sealing the surface with repellant materials such as graphite, talc, powdered metallic stearates, oils, silicone oils and greases, etc. I may also use these porous pore supports to contain cutting lubricants or wheel fillers to prevent loading such as waxes, greases, oils, rosins, chlorinated compounds and combinations thereof. Mineral fillers of the type common to ordinary abrasive wheels may also be included to modify the organic bond in mixes using my pore supports.

By close microscopic examination of the structure of the wheels made in accordance with my invention, I find that at times the particles of abrasive grain form a series of cellular clusters with particles of perlite as nuclei. This concentrates the strength-giving portion of the body in the walls of the clusters and yields a body which is unusually strong in relation to its effective porosity. This effect can be increased by first coating the perlite particles with a tacky adhesive, then mixing in the abrasive granules and then the remaining ingredients, taking care to avoid too violent tearing action during the mixing procedure.

As a further alternative, I may make abrasive bodies by the means illustrated in Figures 2 and 3 in order to secure soft fast cutting wheels, discs or rubs. In these two views, the rigid sponge-like material 5 is shown in the shape of pre-formed inserts for making which I use one of the rigid sponge-like materials which is available in block or thick sheet form such as an expanded plastic or the frothed or porous glass sometimes called Foamglas. Pieces of the desired shape are cut from this material and may then be located with respect to the wheel to be made by inserting them in cavities in the lower face of a mold which is then filled in with abrasive mix 6 of the desired type, pressed and the wheel completed in the usual manner.

An alternative method of procedure which is useful in handling large broad preforms such as those illustrated as 5 in Figure 2 is to stick these preforms in place with suitable adhesive on a cloth or paper backing which is then laid in the mold with the preforms up and abrasive mix packed around and over the preforms prior to pressing. This is recommended especially in making side grinding discs such as shown in Fig. 2, where the sponge-like material is exposed at only one face of the body. After the body has been cured, the face of cloth or paper should be torn away or otherwise removed. Structures of this type are particularly useful in grinding articles where a large area is in contact with the abrasive face and where it is important that ample chip clearance be provided. The chips temporarily embed themselves in the preform and hence do not scratch the face of the work being ground. Coolants, etc. may also be incorporated in the preformed inserts if desired and thereafter exert an effect throughout the life of the wheel.

I have described my invention in general terms with

5

sufficient detail to permit an understanding of the underlying principles involved. The example given is included by way of illustration and not for limitation.

I claim:

1. An abrasive article composed principally of abrasive granules and a phenolic resin bond therefor, said article comprising also from 1 to 5% by weight of brittle, rigid porous granules containing in excess of 50% by volume of pore space, said granules being selected from the group consisting of expanded perlite, foam glass and expanded plastics.

2. An abrasive article composed principally of abrasive granules and a phenolic resin bond therefor, said article comprising from 1½ to 3% by weight of particles of expanded perlite ranging in size from ¼ to 2 times the average diameter of the abrasive granules.

6

3. An abrasive article composed principally of abrasive granules and a phenolic resin bond therefor, said article comprising from 1½ to 3% by weight of particles of expanded perlite, the pores within said article being filled with a lubricant.

References Cited in the file of this patent

UNITED STATES PATENTS

1,956,905	Merriam	May 1, 1934
2,487,207	Adams	Nov. 8, 1949

FOREIGN PATENTS

294,124	Great Britain	July 16, 1928
473,681	Great Britain	July 16, 1928
316,170	Italy	Mar. 24, 1934