BOND FOR ABRASIVE ARTICLES

Raymond C. Benner, Niagara Falls, N. Y., and Garnett H. Porter, Pittsfield, Mass., assignors to The Carborundum Company, Niagara Falls, N. Y., a corporation of Pennsylvania

No Drawing. Application October 3, 1931, Serial No. 566,796. Renewed September 14, 1934

3 Claims. (Cl. 51—288)

This invention relates to abrasive materials, particularly to abrasive materials comprising abrasive grains secured by plastic organic binding agents, and more specifically to abrasive grains bonded by a reversible thermo-plastic material. This application is a continuation in part of our copending application Serial No. 264,568, filed March 24, 1928, which has since matured into Patent No. 1,825,771 wherein a part of the subject matter of this application is disclosed on page 2, lines 76 to 127 inclusive, and on page 4, lines 63 to 70 inclusive.

A bonded abrasive article, obviously, has binding characteristics due to the combined effect of the bonding material and the abrasive grains used. During the grinding process the amount of work performed by the abrasive article is dependent on the ability of the article to clear itself, by which is meant the progressive exposure of fresh grinding surfaces, and incidentally, the removal of the worn particles. In general, the types of materials which afford the qualities necessary in a satisfactory abrasive are few and, consequently, the desired results is obtained by selection, proportioning and treating of the various bonding agents. The various degrees and types of grinding action demanded in the art are obtained, for the most part, by the choice and the amount of a proper bond suitable for the particular production demanded.

Abrasive articles are required to grind all sorts of materials, both metallic and non-metallic, and the service demanded of them varies all the way from a very heavy cutting action, such as the cleaning of fins and gates from castings, to very light work on hard tempered steel where very light, delicate cutting, known as finishing, is required. In any case, it is desirable not to generate an excessive amount of heat. Such heat warps, checks, and consequently destroys the material being ground. As a result, many types of bonding agents have been used with a relatively few types of abrasive material to produce the necessary characteristics required of any article for a given purpose.

A further desirable characteristic is that an abrasive product contains a very large amount of abrasive grain together with a small amount of binder to afford adequate porosity. This feature is for the most part influenced by the fact that the abrasive particles themselves, rather than the bond, should be presented to the material being ground, in order that the proper cutting action may be obtained. Further, the use of a small amount of bond is more conducive to free cutting by the abrasive article.

By varying the amount of bond, the characteristic which is known as grade, or resistance of the particles to removal from the composite mass, is obtained; in general, the more bond the harder is the grade. In obtaining adequate strength, it is sometimes necessary to use a very tough bond. An alternative, as far as strength is concerned, is to use a large amount of bond, but this reacts against the principle outlined above; namely, that of providing a porous, open structure composed of a relatively large amount of abrasive grain and a very small amount of binding agent.

Thus, in practice, some bonds lend themselves to use over only a small range of grades, whereas other bonds might be termed universal grade range bonds inasmuch as it is possible with these bonds to produce articles varying from the hardest to the softest required in practice. The latter type is relatively rare, however, and it is usual to have each specific bond cover only a limited portion of the whole grade range.

These bonds may be classified into organic and inorganic bonds. The inorganic bonds are represented chiefly by ceramic materials such as various types of clays or other earthy substances. Such bonds may represent ceramic articles of various degrees of vitrification including a completely fused glass-like condition. For certain other purposes, a porcelain type of bond may be used. A further type is one made with water glass or sodium silicate solution and used either in the condition of partial dehydration or in one of complete fusion. Such ceramic bonds may be composed of a single clay or more usually of a mixture of mineral ingredients.

In the fabrication of such ceramic articles, the molded article is usually matured by subjecting it to relatively high temperatures; in general, between 800° F. and 2000° F. The bond usually undergoes chemical interaction, and the heat treatment is prolonged for periods of from 6 to 14 days.

Under the classification of organic materials there are several types; such as, shellac, glue, rubber, and phenol-aldehyde synthetic resins, such as "Redmanol".

In the case of glue the curing treatment consists essentially of a drying operation. The cure for some types of synthetic resins includes a transformation of the material to a relatively infusible or thermo-irreversible condition. By this it is meant that reheating at the initial temperatures used in molding will not produce the same
degree of plasticity; further, the bond undergoes a chemical change and consequently, on cooling, the components are not the same as existed originally.

In rubber bonded articles the cure is brought about by means of vulcanization or the reaction of the rubber with a vulcanizing agent, such as sulphur. The resulting components are not the same as in the original mixture. For this reason, they are classified as thermo-irreversible bonds.

Organic bonds are, in general, of two types: the irreversible and the reversible or thermo-plastic bonds. The irreversible group contains such materials as urea-formaldehyde and certain phenol-aldehyde synthetic resins, and includes, in particular, some of the irreversible derivatives of the reversible thermo-plastics such as phenol and rubber hydrochloride vulcanized with another material such as a halogen compound of sulphur. The other group is identified as the reversible thermo-plastics by which it is meant that reheating renders the material plastic within a temperature range used in molding. This type of bond is exemplified by such materials as meta-styrene (a resinous polymer of phenyl-ethyrole) and by various reaction products of rubber when used with materials such as the halogens, phenols, and aldehydes.

This application is particularly concerned with the bonding agent of the reversible type known as meta-styrene.

Meta-styrene, a resinous polymer of phenyl-ethyrole is produced from the liquid parent substance with the aid of heat or other suitable polymerization agent. The hard glassy resin lends itself readily to plastic molding, especially when used in a powdered condition and rendered plastic at approximately 350° F. The material is considerably ductile when heated and a thread can be pulled out to an extreme length. Bonded abrasive articles have tensile strengths of approximately 1200 lbs. per sq. in.

Plasticized or modified styrol may be made by any one of several methods. In general, styrol may be compounded with rubber, gutta percha, balata, and other elastic gums. A preferred practice is to dissolve the rubber or gum, as gutta percha, balata, and the like, in the liquid styrol (phenyl-ethyrole) and polymerize the solutions thus obtained.

Example I—Hot pressed method

10 parts of pulverized resinos meta-styrene of approximately 60 mesh (to the linear inch) are mixed with 90 parts of abrasive grains of 100 mesh. These materials are moistened with water, placed in a mold, pressed at 2000 pounds per square inch while at 350° F., cooled to about 150° F., and removed from the mold in a completed form.

Example II—Cold pressed method with solvent or plasticizer added before binder

1000 grams of 36 mesh crystalline alumina abrasive grain are moistened with 10 cubic centimeters of furfural. 100 grams of a mixture of equal parts meta-styrol and a thermally reversible phenolic condensation product resin of the type known to the trade as "Novolak" are then added to the moistened grain and thoroughly mixed therewith. The resulting mixture is then placed in a suitable mold pressed at approximately 2000 pounds per square inch, removed from the mold, and put into an oven, the initial temperature of which may be about 200° F. The temperature of the oven is then increased at the rate of about 25° F. per hour up to about 350° F. and this temperature is maintained for about 12 hours. The temperature is then reduced in a period of 5–10 hours to about 150–200° F. when the finished article may be removed.

Alternatively, the abrasive grain may be moistened with other suitable liquids such as a liquid phenolic condensation product resin of the thermally irreversible type (in which case the resin becomes an intermediate bond) or other...
suitable liquid, or other bonds may be substituted for the mixture of meta styrol and solid phenolic resin of this example, such as meta styrol alone, meta styrol and shellac, meta styrol and coumarone resin, etc.

Example III—Hot pressed method with intermediate bond

50 grams of the polybasic acid resin known to the trade as No. 1350 “Clythal” are dissolved in 15 cubic centimeters of furfural and this solution is mixed with 1000 grams of 100 mesh silicon carbide abrasive grains. 50 grams of meta styrol, which have been passed through a 100 mesh screen, are then added to the moistened grain and thoroughly mixed therewith. The mixture is placed in a mold and pressed in a “hot press” of conventional type between plates of the temperature of which is raised to 267° F. by the application of 40 pounds steam pressure. The article is pressed at about 2000 pounds per square inch until heated throughout when the temperature can be reduced to “set” the bond and the article may be removed from the mold.

Another method of making a hot pressed article consists in mixing the abrasive grain and the meta styrol meta styrol either alone or mixed with other suitable bond such as shellac or a synthetic resin; heating the mixture until the bond flows, coating the grain; cooling; disintegrating the mix; and pressing the mix while heating as just described.

Example IV—Modified hot press method with mixed bond

1000 grams of 400 mesh crystalline alumina abrasive grain are mixed with 50 grams of shellac and 50 grams of meta styrol in powdered form. The dry mixture is placed in a suitable mold and pressed to approximately 1000 pounds per square inch, whereupon—the movable part of the mold (the plunger) is clamped into place by a suitable device which prevents motion of the plunger with respect to the mold proper. The clamped mold is then placed in an oven, the temperature of which is maintained at about 200° F., left in the oven until it is thoroughly heated to fuse the bond, and then removed. After cooling below the softening point of the bond, the article may be removed.

The intermediate bond referred to in the examples provides a convenient method of varying the grinding properties of the boned abrasive article. By choosing as the intermediate bond (for example, in the cold pressed process illustrated in Example II) a material which adheres readily to abrasive grain, a relatively tough article is secured, whereas conversely the use of a poorly adherent intermediate bond makes a comparatively “soft” article. Instead of the liquid resin in Example II we may use, for example, a solution of a synthetic resin or mixture of resins in a suitable solvent. So-called “solvent rubber” (rubber swollen by a liquid such as benzol), an aqueous dispersion of rubber (either natural or artificial), or the meta styrol (either alone or mixed with another suitable bond) may be dissolved and used as the intermediate bond, the main bond (the powder bond) being of any suitable material in all these cases.

While we have cited specific materials and methods for making articles in accordance with our invention we do not limit ourselves thereto, as other materials and methods as well as different methods for the materials quoted in the examples may be used as will be apparent to those versed in the art.

In the claims the term “modifying agent” is intended to mean a material added to the bond to modify its properties. Examples of modifying agents are: the various resins cited in the examples, plasticizers such as dibutyl phthalate or tricresyl phosphate, and inert fillers such as wood-flour or pulverized flint.

The principal features of the invention which are deemed novel are embraced in the following claims.

We claim:

1. An abrasive article comprising abrasive grains and a bond consisting of meta styrol and a plasticizer.
2. An abrasive article comprising abrasive grains and a resins bond, said bond containing a major proportion of meta styrol and a minor proportion of a modifying agent.
3. An abrasive article comprising abrasive grains and a resins bond, said bond containing a major proportion of meta styrol and a minor proportion of a modifying agent.
4. An abrasive article comprising abrasive grains and a resins bond, said bond containing a major proportion of meta styrol and a minor proportion of a modifying agent.
5. An abrasive article comprising coated abrasive grains and a bond containing a substantial proportion of plasticized meta styrol, the coating on the abrasive grains consisting for the most part of synthetic resin.
6. An abrasive article comprising coated abrasive grains and a bond containing a substantial proportion of plasticized meta styrol, the coating on the abrasive grains consisting for the most part of heat hardenable resin.
7. An abrasive article comprising coated abrasive grains and a bond containing a substantial proportion of plasticized meta styrol, the coating on the abrasive grains consisting for the most part of a phenolic condensation product resin.
8. An abrasive article comprising abrasive grains and a bond containing a substantial proportion of plasticized meta styrol.

RAYMOND C. BENNER.
GARNETT H. PORTER.