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ABRASIVE ARTICLE AND METHOD OF MAKING

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Fig. 1

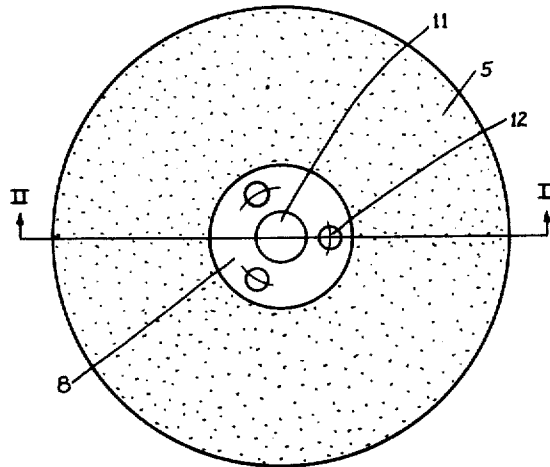
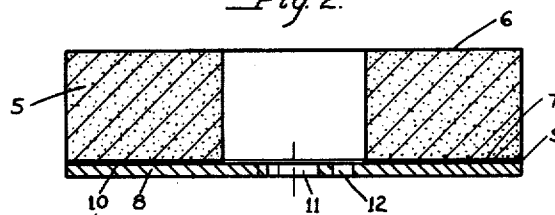


Fig. 2



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ABRASIVE ARTICLE AND METHOD OF MAKING

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6 Claims. (Cl. 51-209)

This invention relates to the manufacture of composite articles and to compositions for and methods of uniting or combining the components thereof, as well as the products resulting therefrom. It is especially adaptable and pertinent to the manufacture of bonded abrasive articles, and more particularly to the manufacture of composite abrasive articles, as for example, bonded abrasive bodies provided with metallic or other external supporting means such as metal backing plates or elements, or side plates secured to the flat faces of the abrasive bodies.

The invention has been found particularly applicable to the making of disc-shaped grinding wheels adapted to be mounted for grinding with the flat side face of the wheel. Therefore, for the purposes of simplicity and clarity, the invention will be described mostly as it applies to the making of such disc wheels. It is to be understood, however, that the invention can be similarly employed more broadly for the manufacture of other composite articles in which the components are united by means of solid tie bond layers.

In the manufacture of abrasive articles, such as the above-mentioned side-grinding discs having a rigid backing attached thereto, it is essential not only that the bonded abrasive body be secured to the supporting element with sufficient tenacity to withstand the high stresses and strains to which it is subjected in grinding operations but it is also desirable, if not even essential, that the intervening layer of material, herein referred to as the "tie bond" or "tie bond layer," be of sufficient thickness and elasticity or resilience to absorb or dampen the mechanical shocks of grinding instead of transmitting them to the backing and thence to the machine upon which the abrasive article is mounted or to the operator. Such supporting elements should also be secured by a means which will retain its strength at high temperatures and thus stand up under the heat generated during heavy duty grinding. It is further desirable that the material be resistant to water and the various hydrocarbon coolants used in wet grinding processes.

The above combination of properties has been approached in the past by attaching the supporting element to the bonded abrasive body by means of an intermediate layer of natural or synthetic rubber of appreciable thickness, the latter being secured by means of one or more coatings of a liquid adhesive or cement applied to both the backing element and to the bonded abrasive body prior to combining the various parts of the article. It has been found necessary to use a liquid adhesive with all substances heretofore employed as the intermediate combining layer in order to obtain a sufficiently high strength of adhesion of the combining layer to the abrasive body and to the rigid support.

It has long been the desire, in those operations which unite two surfaces by means of an intermediate layer of resilient material, as for example the attachment of a rigid backing plate to the side face of a bonded abrasive grinding wheel, to accomplish an adequately high strength of union without the use of auxiliary adhesives or cements. The wide variety of cements marketed for such adhesive purposes is indicative of their widespread use in this type of application where high adhesion strengths are essential. The ideal way, heretofore unattained, of promoting high tensile strengths of adhesion would be to have a tie bond of such composition as to provide the desired adhesive qualities by reason of the ingredients contained therein so that the use of auxiliary cementing adhesives could be avoided.

The present invention provides such a means and method for combining the components of composite articles, as for example, securing rigid elements such as backing plates and the like to bonded abrasive bodies in which the preliminary application of liquid adhesives or cements to the surfaces to be combined is eliminated and at the same time the tensile strengths of adhesion between the intermediate tie bond layer, the rigid supporting element and the bonded abrasive body is as great as, and even greater, than those obtained by the methods heretofore used which included, as an essential step, the application of liquid adhesives and cements for the purpose of promoting and maintaining the necessary strengths of adhesion.

In accordance with the present invention a rigid supporting element is secured to a bonded abrasive body or in its broader aspects, the components of other composite articles of manufacture, are secured, by means of an intermediate bonding layer (herein referred to as a tie bond) comprising suitably compounded polychloroprene and a phenolic resin such as a phenol formaldehyde condensation product. The amount of resin varies and constitutes from 1 to 30% by weight of the tie bond layer, based on the polychloroprene. Following the procedure of the present invention, the tie bond layers of the above compositions, when used to combine a bonded abrasive body and a supporting element, are inserted between and applied directly against the surfaces to be combined without the application of liquid adhesives or cements to the combining surfaces or to the tie bond material, and without requiring any other preparation of the combining surfaces other than that required to put the surfaces in a clean condition. When so composed and applied in accordance with the present invention the tie bond layer is strongly adherent to both the abrasive body and the supporting means, possesses the necessary resilience and elasticity to absorb grinding shocks, and retains the greater

part of its strength and resilience in the presence of cooling agents and alkalis and the severe temperatures often present in wet and dry grinding operations.

In the drawing, which illustrates one embodiment of the invention:

Figure 1 represents a front plan view of a disc-shaped grinding wheel embodying the present invention; and

Figure 2 is a sectional view taken along the line II-II of Figure 1.

The disc-shaped grinding wheel illustrated in Figures 1 and 2 consists of a bonded abrasive section 5 of any desired thickness and diameter, having a flat grinding face 6 and an opposite supporting face 7. The abrasive section 5 is composed of abrasive grain such as crystalline aluminum oxide, silicon carbide, or other granular abrasive material of the desired grit size or sizes, suitably bonded. The bond may be a vitrified ceramic material, or it may be a silicate, or a resin or a natural or synthetic rubber compound. As a support to provide a means for mounting, the abrasive section 5 is provided with a steel backing plate 8 attached to the supporting face 7 of the abrasive section 5 by means of an intermediate layer of tie bond 9. The tie bond 9 is secured to the abrasive section 5 and metal plate 8 with adequate strength of adhesion thereto without the application of any auxiliary adhesive coatings to the tie bond layer or to the supporting face 7 of the abrasive section or the inner face 10 of the steel plate prior to assembly. The backing plate 8 is provided with a center arbor hole 11 and three bolt holes 12 for fastening the backed wheel to a mounting plate on the grinding machine. (The mounting plate is not shown.)

As the above description and drawings show, the final grinding wheel is composed of three main parts, namely, the bonded abrasive section, the backing plate, and the tie bond uniting the abrasive section and the backing plate.

The bonded abrasive sections can be united to the metal or other rigid supports by means of the tie bonds of the present invention irrespective of the type of bond used in the abrasive section; highly satisfactory results have been obtained with resin, vitrified, silicate and rubber-bonded abrasive sections. The abrasive sections are molded and formed by any one of the well-known methods of making bonded abrasive shapes. The abrasive section of the specific wheel illustrated consists of a single disc of bonded abrasive material which can be any desired diameter and thickness. However, this continuous disc of abrasive may be replaced by a plurality of segments with the adjoining abrasive segments either suitably cemented at their adjacent faces or separated by clearance spaces so as to present in use a discontinuous grinding surface.

In the wheel illustrated, the backing plate is of $\frac{1}{8}$ " mild steel cut the same diameter as the abrasive section. The backing plate does not necessarily have to be of a size to cover the entire back of the abrasive section and may be of a different material and thickness. It may also have other means of machine mounting than the centrally-located bolt holes of the depicted embodiment. The rigid backing plate, if properly cleaned to remove all oil, dirt, and when metallic, rust and scale, requires no other preliminary treatment.

The intermediate layer referred to herein as the tie bond consists of a layer of soft, pliable,

resilient material in the form of a thin sheet approximately $\frac{1}{16}$ " to $\frac{1}{8}$ " in thickness, although the thickness may vary somewhat from these figures. By selection of the proper composition and thickness of this intermediate layer, the desired degree of resilience, i. e., resistance to mechanical shock, of the wheel can be closely controlled. A satisfactory tie bond composition for carrying out the present invention comprises polychloroprene and a phenolic resin of the phenol formaldehyde resinous condensation type properly compounded by the addition of substantial amounts of a filler such as soft carbon black, and the other customary compounding ingredients such as vulcanizing agents, antioxidants, stabilizers, plasticizers and the like. It has been found that for satisfactory results the phenolic resin should be incorporated into the polychloroprene in the form of a liquid resin; a phenolic resin such as that sold by the Bakelite Corporation under the trade designation of liquid Bakelite resin No. BR 10190 has been found highly satisfactory. Another liquid phenolic resin suitable for use herein is Vacuum liquid resin No. 925 A sold by the Vacuum Chemical Corp. of Niagara Falls, New York. Fillers which may be used to replace part or all of the soft carbon black include, for example, channel black or mineral fillers such as blanc fixe, natural whiting, Dixie clay and the like, although soft carbon black is the preferred filler and produces the best results. Also, a part of the polychloroprene can be replaced by a natural or a reclaimed rubber.

A tie bond material comprising polychloroprene and a liquid phenolic resin, which is highly satisfactory for the present purposes is made of the following ingredients compounded and sheeted to the desired thickness on a roll mill.

	Parts by weight
Polychloroprene	100.0
Liquid phenolic resin (Bakelite BR 10190)	5.0
Soft carbon black	100.0
Hard carbon black	50.0
Light calcined magnesia	4.0
Zinc oxide	5.0
Neosone D (phenyl-beta-naphthylamine)	1.0
Stearic acid	1.0
Sulphur	.50
Circo (light process) oil	5.0

Another tie bond material which has shown very satisfactory strengths of adhesion and which has retained its adhesion strength at elevated temperatures and in the presence of water and hydrocarbon coolants is the following. The higher percentage content of resin in the composition below renders it especially suited for tie bond applications in which a very high resistance at elevated temperatures and to alkalis and various hydrocarbon coolants is desired, although the resilience of the article is sacrificed to a slight degree.

	Parts by weight
Polychloroprene	100.0
Liquid phenolic resin (Bakelite BR 10190)	20.0
Soft carbon black	150.0
Extra light calcined magnesia	4.0
Zinc oxide	2.0
Sulphur	0.5
Altax (benzothiazyl disulphide)	1.0
Neosone D (phenyl-beta-naphthylamine)	1.0

Another example of a tie bond composition embodying the present invention and which has

been found satisfactory in use is that given below.

	Parts by weight
Polychloroprene	100.0
Liquid phenolic resin (Varcum #925A)	5.0
Soft carbon black	100.0
Hard carbon black	50.0
Light calcined magnesia	4.0
Zinc oxide	5.0
Neosone D (phenyl-beta-naphthylamine)	1.0
Stearic acid	1.0
Sulphur	.5
Circo (light process) oil	5.0

After a tie bond composition such as one of those given in the examples above has been prepared in sheet form and has been cut to the desired size for use with the backing plate and abrasive section, the three parts are assembled. The sheet of tie bond is placed upon the rigid backing plate and smoothed down as by running a roller over its surface, to insure complete contact with the plate and to remove any air bubbles which may be trapped between the sheet and the backing. The abrasive section which has been kept in an oven at 250° F. is then removed and, while still hot, is placed on the tie bond sheet and rigid backing plate. The assembly is centered on a mandrel to hold the parts in place during cure and the whole placed in a hot press. The tie bond is cured in the hot press under a pressure of 100-600 pounds per square inch, and usually 150 pounds per square inch, at a temperature of 275-325° F. usually at about 300° F. Thirty minutes is usually sufficient to adequately cure the tie bond. For best results, the tie bond should be cured always under a pressure and temperature sufficient to cause it to extrude slightly at the edges from between the backing plate and the abrasive body.

The development of a means and method for attaching bonded abrasive bodies to rigid supporting elements, such as the mounting of disc side-grinding wheels on metal backing plates without the use of an auxiliary cementing adhesive as provided by the herein-described invention is a distinct advance in the manufacture of articles of this type. The elimination of cementing removes the variables of cements and their application, which are a potential source of error unless properly supervised at all times. Any process which reduces man hours is highly desirable, especially when the quality of the final product is not only maintained but even improved, as is the case with the present invention. The present means and method of securing bonded abrasive bodies to rigid supports decreases the cost of mounting by a reduction in labor, by a simplification of operations, and by a reduction in the amount of materials used. Too, the parts after preparation do not require immediate assembling, but can be stored for later assembly at the convenience of the operator and availability of presses. Also, in curing the present articles, the temperature and pressure of cure can be varied considerably without the danger of overcuring and its resultant loss of strength. These and other features lead to economies of manufacture not heretofore attainable.

Abrasive wheels and discs of the present invention possess several beneficial and enhanced properties which extend their field of usefulness. For example, the present abrasive wheels have a long temperature range of serviceability extending from -30° to 300° Fahrenheit. Their retention of mechanical strength at high temperatures

results in an increased factor of safety at normal operating speeds and also permits of higher speeds of operation when desirable. Also by reason of the high heat conductivity of the tie bond material, much of the heat generated in the abrasive section during use is quickly conducted through the tie bond layer to the rigid support, where it is more easily dissipated by radiation, thus removing much of the danger of localized build-up of heat in the abrasive portions with its consequent increase in stresses which tend to break the wheel.

Another important property of wheels of the present invention is their ability to absorb energy, a feature which is particularly important in grinding wheels which in the process of grinding are subjected to a repeated series of vibrations or shocks from contact with the work being ground. This ability to absorb energy is directly related to the ability to take up mechanical shock without damage to the wheel. This ability of the present wheels to absorb energy is coupled with a high rate of damping, so that, as a result, any vibrations from the shocks of grinding are damped out quickly. As a result, the wheels are possessed of high strength and resistance to the shocks of grinding and can endure severe operating conditions.

It is not intended that the invention should be limited to the particular embodiment of wheel illustrated, as like objects and advantages are obtained in various other abrasive articles where it is necessary to secure bonded abrasive sections to metal or other rigid supporting or mounting means. For instance, similar disc wheels can be made in which the abrasive section is made of a plurality of individual segments properly spaced, one from the other, to present a discontinuous grinding surface. Likewise, wheels for peripheral grinding may have supporting plates similarly secured to their flat side faces for added strength.

Although the invention has been described mostly as applied to the manufacture of disc-shaped side grinding abrasive wheels, it is not to be construed as being limited thereto. In its broader aspects it is useful in the uniting or combining of components of various other composite articles of manufacture. For example, it is suitable for use in the production of laminated products such as in the manufacture of laminated metal sheets in which two or more layers of a metal or an alloy of the same or different compositions in sheet form are united to provide a composite metallic sheet; or, similarly, the present invention is applicable to the formation of other laminated sheet products in which the various laminations may be the same or different materials and may be fabric, wood such as in plywood, metal, or ceramic in nature. Also, the invention can be adapted for the combining of various elements of composite articles such as the attachment of the backing or supporting elements, mountings, handles and the like to the functional elements of the products to provide the desired final articles.

Having described the invention fully, it is desired to claim:

1. A bonded abrasive article having a supporting element and a bonded abrasive body, the supporting element thereof being secured to the bonded abrasive body by a tie bond layer containing as an essential ingredient a substantial proportion of a mixture of polychloroprene and a phenolic resin, the proportion of phenolic resin being 1-30% based on the polychloroprene.

2. In an abrasive article having a rigid supporting means secured thereto, a resilient tie bond between the supporting means and the abrasive body containing as an essential ingredient a substantial proportion of a mixture of polychloroprene and a phenol aldehyde resin.

3. In an abrasive article having a rigid supporting means secured thereto, a resilient tie bond between the supporting means and the abrasive body containing as an essential ingredient a substantial proportion of a mixture of polychloroprene and a phenolic resin, the proportion of phenolic resin being 1-30% based on the polychloroprene.

4. A method of securing a rigid supporting plate to a bonded abrasive body, steps of which comprise inserting a sheet of unvulcanized tie bond material consisting essentially of polychloroprene and phenolic resin between the bonded abrasive body and the supporting plate therefor and in direct contact therewith, the proportion of phenolic resin being 1-30% based on the polychloroprene, and subjecting the assembly to heat and pressure to vulcanize the tie bond layer and

cause it to adhere with tenacity to the bonded abrasive body and the supporting plate.

5. A method of securing a rigid supporting plate to a bonded abrasive body, steps of which comprise inserting a sheet of unvulcanized tie bond material consisting essentially of polychloroprene and a liquid phenolic resin between the bonded abrasive body and the supporting plate therefor and in direct contact therewith, the proportion of phenolic resin being 1-30% based on the polychloroprene and subjecting the assembly to heat and pressure to vulcanize the tie bond layer and cause it to adhere with tenacity to the bonded abrasive body and the supporting plate.

6. A composite article of manufacture components of which are united by means of a solid combining layer containing as an essential ingredient a substantial proportion of a mixture of polychloroprene and a phenolic resin, the proportion of phenolic resin being 1-30% based on the polychloroprene.

JAMES A. PRENTICE.

Certificate of Correction

Patent No. 2,394,478.

February 5, 1946.

JAMES A. PRENTICE

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, lines 23-24, for the word "Vacuum" read *Varcum*; page 4, first column, line 6, claim 2, after "resin" strike out the period and insert instead, *the proportion of phenolic resin being 1-30% based on the polychloroprene.*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of October, A. D. 1946.

[SEAL]

LESLIE FRAZER,

First Assistant Commissioner of Patents.

2. In an abrasive article having a rigid supporting means secured thereto, a resilient tie bond between the supporting means and the abrasive body containing as an essential ingredient a substantial proportion of a mixture of polychloroprene and a phenol aldehyde resin.

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