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A. W. WALKER

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ABRASIVE ARTICLE AND METHOD OF MAKING THE SAME

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Fig. 1.

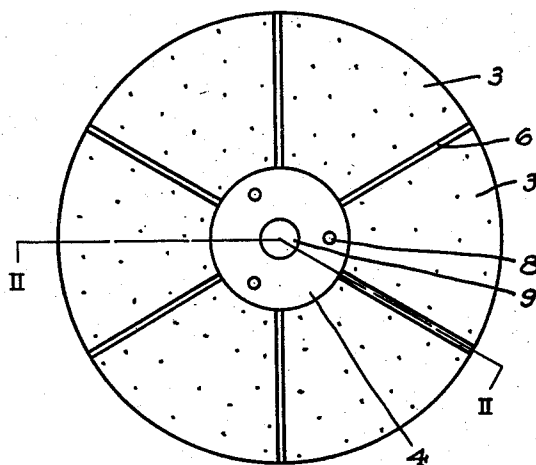
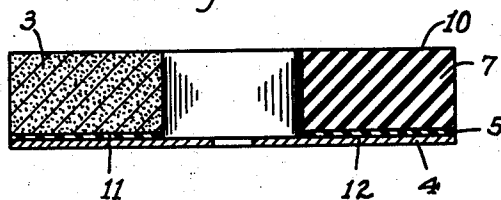


Fig. 2.



BY

INVENTOR.
AVERY W. WALKER

Al Binnus

ATTORNEY.

UNITED STATES PATENT OFFICE

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ABRASIVE ARTICLE AND METHOD OF
MAKING THE SAMEAvery W. Walker, Niagara Falls, N. Y., assignor
to The Carborundum Company, Niagara Falls,
N. Y., a corporation of Delaware

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9 Claims. (Cl. 51-209)

This invention relates to bonded abrasive articles, and more particularly it relates to a disc type of abrasive wheel made of a plurality of abrasive sections supported by a rigid backing plate and which presents an extensive flat abra-

sive area for grinding. The invention also pertains to a method of making such wheels. It has been found in the past that many heavy duty grinding operations can be performed most efficiently by presenting the work to the flat face of a disc-shaped grinding wheel. In grinding operations where disc wheels have been mounted and used for side grinding, however, it has been found that the large contact area between the wheel and the work causes sufficient heat to be developed to cause considerable damage, and in some cases destruction of the wheel. This is especially true with the use of disc wheels in which the abrasive member is mounted on the backing plate as a monolith. Monolithic disc wheels have the further disadvantage that any localized thermal shocks due to the heat of grinding are transmitted to the entire wheel in a manner which sets up stresses within the wheel which are greater than the wheel can withstand and as a result, the wheels often fall early in service.

For this and related reasons, efforts have been directed towards making disc wheels from a plurality of segments mounted upon a backing plate with sufficient strength to stand up under the rigorous conditions to which such wheels are put in service. Various methods of mounting and assembling segments have been developed in an attempt to meet the requirements of heavy duty grinding but have proven to be to a large degree unsatisfactory because of their unreliability and consequent lack of safeness or because of the relatively high cost involved in their manufacture. Discs made with the abrasive segments fastened to the backing plate by nuts and bolts, or other mechanical assemblies, have proven unsatisfactory because of their tendency to loosen during the grinding operation. Such wheels have the additional disadvantage that they prevent utilization of the lower portion of the abrasive segment and are thereby wasteful.

Other wheels in which the backings are attached to the abrasive sections by means of layers of vulcanized rubber are also subject to failure before the useful life of the abrasive has been obtained because of the deterioration of the rubber under the heat of grinding. Further failures of wheels, in which vulcanized rubber is used, are caused in wet grinding by attack on the rub-

ber layer by cooling agents such as kerosene, oils and other hydrocarbons. Segmented disc wheels are often preferred to wheels having monolithic abrasive portions because a segmented construction allows for the expansion and contraction of the upper or surface portions of the abrasive that are in contact with the work and are directly exposed to the heat of grinding. This expansion and contraction sets up stresses which the use of segmented wheels is intended to avoid. Segmented wheels have been made in which the segments are separated by clearance spaces so that the individual segments might be left free to expand and contract without straining the wheel. However, the problem has not been solved in this manner since the individual segments have not shown the rigidity and strength of support necessary to hold up under severe grinding operations. Likewise, rubber, while effective to a limited degree in portions of the wheel more remote from the abrading surfaces, when used in joints between the segments to strengthen the wheel, rapidly deteriorates in proximity to the grinding surfaces where in dry grinding considerable heat is developed, and in wet grinding, from deterioration by the cooling agents used.

In accordance with the present invention, a segmented abrasive disc wheel is provided in which the individual segments are adhesively secured to a rigid backing plate by means of an intermediate bonding layer (herein referred to as a tie bond) which is strongly adherent to both the metal backing plate and to the bonded abrasive sections, and which retains the greater part of its strength in the presence of cooling agents such as kerosene, oils and hydrocarbons, as well as the extreme temperatures involved in heavy duty grinding operations. This tie bond is a vulcanizable, synthetic elastic material which has been properly compounded with the necessary fillers, vulcanizing agents, and so forth. A tie bond material which is highly effective is polychloroprene which has been suitably compounded. Among other materials which are satisfactory are polyvinylchloride, divinyl polymers, and polymers of ethylene sulphide. The wheels of the present invention are further characterized by having the joints between the adjacent abrasive segments additionally strengthened by being filled with a cold-setting resin which is likewise highly resistant to the heat of grinding and to the various cooling agents used in wet grinding. Resins of the phenolformaldehyde type have been found highly suitable for this purpose.

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

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

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

The segmented disc-shaped grinding wheel illustrated in Figures 1 and 2 consists of a plurality of bonded abrasive segments 3 of any desired thickness. In the wheel illustrated there are six of these segments which together in the wheel form a flat grinding face 10 and an opposing supporting face 11. The abrasive sections 3 are composed of abrasive grain such as crystalline aluminum oxide or silicon carbide suitably bonded. The bond may be a vitrified ceramic material, or it may be a silicate, a resin or a rubber compound. As a support to provide added strength during grinding and to provide a means for mounting, the abrasive sections 3 are mounted upon a steel backing plate 4 which is rigidly and adhesively attached to the supporting faces 11 of the abrasive sections 3 by means of an intermediate layer of tie bond 5. To assist in the adherence of the tie bond 5 to the abrasive sections 3 and metal plate 4, the supporting faces 11 of the abrasive sections and the inner face 12 of the steel plate are properly treated prior to assembly. The backing plate 4, as illustrated, is provided with a center arbor hole 9 and three equally spaced bolt holes 8 for fastening the backed wheel to a face plate on the grinding machine. (The machine face plate is not shown.) The abrasive sections 3 are mounted on the backing plate so as to be separated one from the other by narrow dividing or clearance spaces 6. After the abrasive sections have been firmly secured to the backing plate, the clearance spaces are filled with a cold-setting resin 7.

As the above description and drawing show, the grinding wheel assembly is composed of a plurality of abrasive segments equally spaced apart by relatively narrow joints but held together by a cementing compound filling the joints between the segments, a rigid backing plate supporting the segments and a tie bond adhesively uniting the abrasive segments and the backing plate. Before assembling the components of the wheel the various parts are prepared for use. In making an abrasive wheel according to the present invention the following procedure is taken.

In preparing the bonded abrasive sections for combination with the metal backing, the supporting faces of the sections are cleaned with a wire brush and any loose dust or dirt removed by an air blast. On the clean, dry supporting faces of the abrasive sections, one or more thin coatings of cement are applied and the segments dried after each application of cement. After the last coating of cement has been applied and dried, the segments are heated in an oven to cure the cement. A cement for this purpose can be made from vulcanizable compounded polychloroprene broken down to cement form in a solvent such as benzol or toluol. Two cements which have been found highly satisfactory are ones sold on the market as Bostik M-117 and Bostik M-162, which are cured satisfactorily at 250° F.

In the wheel illustrated, the mild steel backing plate is cut the same diameter as the finished wheel. It may have other means of machine mounting than the centrally-located bolt holes of the depicted embodiment. The steel backing plate is first cleaned to remove all oil

and dirt. The plate is then subjected to an ordinary commercial pickling procedure followed by washing and drying, which, when used with the present tie bonds, gives an entirely satisfactory surface for adhesion. After the above preparation, the plate is given one or more coatings of a cement similar to that used on the supporting face of the abrasive sections, dried and held ready for use.

The intermediate layer referred to herein as the tie bond consists of a layer of soft, pliable material in the form of a thin sheet approximately $\frac{3}{16}$ "- $\frac{1}{8}$ " in thickness, although the thickness may vary somewhat from these figures. Before use, the sheets of tie bond material are wiped clean and dry on both sides and a coating of cement such as that used on the backing plate and the abrasive sections is applied to each side and allowed to dry.

As a tie bond material, polychloroprene, especially when properly compounded, has been found to be highly effective in bonding the backing plate to the abrasive sections. By the addition of a filler such as soft carbon black in sufficient quantities, a bond of extremely high strength has been obtained. Other fillers may be used to replace part or all of the soft carbon black, as, 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 rubber or a reclaimed rubber.

A tie bond material which is highly satisfactory for the present use is made of the following ingredients compounded and sheeted to the desired thickness on a roll mill.

		Parts by weight
Polychloroprene	-----	100
40 Extra light calcined magnesite	-----	4
Zinc oxide	-----	5
Soft carbon black	-----	200
Cottonseed oil	-----	5
Sulphur	-----	1
45 Phenyl-beta-naphthylamine	-----	2

Polychloroprene, when it is properly compounded, is the preferred fundamental or basic substance for the tie bonds and has been found to give the most satisfactory results. It is a polymer of chloroprene, otherwise known as 2-chloro-1, 3-butadiene having the formula



and may be classified as being a halogen-substituted butadiene. Other compounds which can be used instead of polychloroprene include polymers of divinyl, polyethylene sulphide, and polymers of vinyl chloride and vinyl acetate. These are all synthetic vulcanizable elastic substances having physical properties somewhat similar to polychloroprene. They are materials of high molecular weight and form tough, resilient, pliable solids. In vulcanized form they withstand the heat evolved in dry grinding and are also resistant to water and hydrocarbon cooling agents used in wet grinding. They also are highly resistant to aging accompanied by the usual loss of strength that is characteristic of tie bonds of rubber such as have been used in attempts to build disc wheels for long life and safe operation.

After the tie bond has been prepared in sheet form and has been cut to the desired size for use with the backing plate and the abrasive sections, the parts are assembled. The bond sheeting of the size and shape of the assembled supporting

faces of the abrasive sections is placed on the metal backing plate and smoothed down by running a roller over the surface of the sheet to insure complete contact with the metal plate and to remove any air bubbles which may be trapped between the sheet and the metal. The abrasive sections which have been kept in an oven are then removed, and while still hot are placed on the tie bond sheets and metal plate. The assembly is centered on a mandrel, a center block, encircling ring, and spacing inserts between the adjacent segments used to hold the parts in place during the cure, and the whole placed in a hot press to 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. It has been found satisfactory to cure the tie bond in a hot press under pressures of 100-600 pounds per square inch at a temperature of 290°-300° F. Thirty minutes is usually sufficient to adequately cure the wheel.

After the abrasive sections have been adhesively secured to the backing plate by means of the tie bond and the tie bond cured, the wheel is removed from the hot press, the positioning blocks removed, and the wheel allowed to cool. The joints between the adjacent abrasive sections are then filled with cement. A cold-setting phenol-formaldehyde resin has been found very effective for this purpose. The resin can be applied in the form of a paste in which case it is forced into the joints by means of an extrusion gun, after which the wheel is set aside and the cement allowed to harden. Any other manner of filling the joints with cement may be used, depending upon the form in which the cement is applied, without departing from the spirit of the invention. Likewise, the abrasive segments may be cemented together at their side faces to form a disc and then mounted upon the backing plate, although the method arrangement of steps previously outlined is the one found to yield the best results.

In addition to accomplishing the objects previously set forth, the present invention offers numerous advantages which become apparent in its use. For example, in cementing a monolithic abrasive disc to a backing plate, the pressures necessary to bring about good adhesion cannot be applied without frequently damaging the abrasive disc, whereas in mounting a plurality of segments upon a backing plate the individual segments not only stand up under the extreme pressures and temperatures desired for vulcanizing without damage, but also readjust and align themselves with elimination of strains and stresses which are otherwise developed in the assembly of a steel backed disc wheel. The use of a cold-setting resin cement to fill the joints between adjacent segments in conjunction with the described type of tie bond is an important part of the present invention. By making segmental disc wheels having the joints filled with a cold-setting resin in the manner just described, an assembled disc wheel is produced in which there are no high stresses as the segments have adjusted themselves during vulcanization. This eliminates the major cause of cracked disc wheels and makes this new assembly a superior product, particularly for such severe operations as spring grinding which are of a heavy duty character and in which considerable heat is developed.

Disc wheels assembled as described when

speeded to destruction are found to burst at approximately $2\frac{1}{2}$ times the normal operating speed. Inasmuch as the resin cement adhesion between the segments is considerably lower than the tensile strength of the abrasive in the segments, any slight adjustment that may be required due to the surface heating of the abrasive on the working face can be obtained without developing strains that will show up within the abrasive segments. Stresses so developed will be relieved by the resin joint cement between the adjacent segments. The heat of grinding is generated on the abrasive surface of the disc wheel, and causes greater expansion in the layers near the grinding surface than in the layers of abrasive that are adjacent to the steel mounting plate. The cement filler in the joints softens perceptibly so that it can be compressed by the thermally expanding abrasive without building up destructive stresses at any point.

Having described the invention in detail, it is desired to claim:

1. An abrasive grinding disc comprising a rigid backing plate and a plurality of bonded abrasive segments adhesively attached thereto by means of an intermediate layer comprising polychloroprene, the joints between the opposing side faces of adjacent abrasive segments being filled with a cold-setting resin cement.

2. An abrasive grinding disc comprising a rigid backing plate and a plurality of bonded abrasive segments adhesively attached thereto by means of an intermediate layer comprising a vulcanizable synthetic elastic material, the joints between the opposing side faces of adjacent abrasive segments being filled with a cold-setting resin cement.

3. An abrasive grinding disc comprising a rigid backing plate and a plurality of bonded abrasive segments adhesively attached thereto by means of an intermediate layer comprising a polymerized halogen-substituted butadiene, the joints between the opposing side faces of adjacent abrasive segments being filled with a cold-setting resin cement.

4. An abrasive grinding disc comprising a rigid backing plate and a plurality of bonded abrasive segments adhesively attached thereto by means of an intermediate layer comprising a vulcanizable synthetic elastic material, the joints between the opposing side faces of adjacent abrasive segments being filled with a cold-setting, non-resilient resin, said abrasive disc being further characterized by having a bursting speed approximating that of a monolithic abrasive disc of similar size and character.

5. An abrasive grinding disc comprising a rigid backing plate and a plurality of bonded abrasive segments adhesively attached thereto by means of an intermediate layer comprising a vulcanizable synthetic elastic material, the joints between the opposing side faces of adjacent abrasive segments being filled with a cold-setting phenol-formaldehyde resin.

6. In the process of making segmented abrasive discs the steps which comprise forming a plurality of bonded abrasive segments, adhesively attaching said segments to a rigid backing plate by means of an intermediate layer comprising a vulcanizable synthetic elastic compound, vulcanizing said intermediate layer to firmly secure the abrasive segments to the backing plate, and filling the joints between the opposing side faces of the adjacent segments with a cold-setting resin cement.

7. In the process of making segmental abrasive discs the steps which comprise forming a plurality of bonded abrasive segments, adhesively attaching said segments to a rigid backing plate by means of an intermediate layer comprising a vulcanizable synthetic elastic compound, vulcanizing said intermediate layer to firmly secure the abrasive segments to the backing plate, cooling the assembled disc after vulcanization substantially to room temperature, and after the assembled disc has been cooled filling the joints between the opposing side faces of the adjacent segments with a cold-setting resin cement.

8. In a process of making segmental abrasive discs the steps which comprise forming a plurality of bonded abrasive segments, adhesively attaching said segments to a rigid backing plate by means of an intermediate layer comprising a vulcanizable synthetic elastic compound, vulcanizing said intermediate layer to firmly secure the

5 adhesive segments to the backing plate, cooling the assembled disc after vulcanization substantially to room temperature, and after the assembled disc has been cooled filling the joints between the opposing side faces of the adjacent segments with a cold-setting resin cement whereby the resulting abrasive disc is substantially free from stresses.

10 9. In the process of making segmented abrasive discs the steps which comprise forming a plurality of bonded abrasive segments, adhesively attaching said segments to a rigid backing plate by means of an intermediate layer comprising polychloroprene, vulcanizing said intermediate layer under high pressure to firmly secure the abrasive segments to the backing plate, and filling the joints between the adjoining side faces of the adjacent segments with a cold-setting phenol-formaldehyde resin.

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AVERY W. WALKER.