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COMPOSITE ARTICLES AND ABRASIVE
BELTS OR SHEETS

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The present invention relates to new articles of manufacture and to method of producing the same. It more particularly concerns novel articles comprising a composite flexible material or an article involving a plurality of different layers of material in integral, adhering or contiguous relation.

While the present invention has other embodiments, as will be understood from the application taken as a whole, one important adaptation is a sheet abrasive article, which may be in the form of an abrasive belt or in other form, in which a grit-bonding or binder coat is joined in integral and/or contiguous relation with or is adhesively joined to a backing coat or an impregnated backing material. Where the sheet abrasive article includes a fibrous material, e. g. a fabric backing, one coat may serve to impregnate the fibrous or like material and then the binder or grit-bonding coat may be adjacent to and joined in integral relation with the impregnated fibrous backing.

The present application is a continuation-in-part of my copending application Serial No. 558,872, filed August 24, 1931, and also is a continuation-in-part of my applications Serial Nos. 222,490 and 228,188, filed respectively on August 1, 1938, and on September 2, 1938. This application is also a continuation-in-part of the application of Joseph H. Kugler and myself, Serial No. 237,760 filed October 29, 1938.

It is an object of this invention to produce an abrasive or other article which is resistant to deterioration, as, for example, when it comes into contact with aqueous or other fluids. Another object is to provide an article which will resist disintegration when subjected to flexing and/or stresses. Another object is to produce a sheet abrasive article having good heat resistance. A further object, where cloth, paper or other fibrous material is employed, is to avoid weakening, rotting, disintegration or other deterioration of such fibrous material. A further and salient object is to provide an article comprising two or more layers of material which are joined together with a strong bond, for example to form a flexible abrasive article or abrasive belt which can be used wet in the "sanding," abrading or smoothing of glass, "Carrara," "Vitrolite," marble, plastics, steel, etc. A still further object is to improve the bond between a fibrous sheet and a grit-bonding or other coating, as the case may be, by first giving the fibrous sheet an impregnating treatment or applying thereto a backing coat of a different material. Another object is to provide abrasive

belts and like articles of improved quality. These and other objects and advantages will appear from this application taken as a whole.

Illustrative of articles within the scope of this invention are abrasive belts of an improved type and construction. Abrasive belts known to me, which were in use prior to this invention, had various defects. When some of them were exposed to conditions encountered during use, the grit-bonding or binder coat would loosen from or shell off of the fibrous backing. This condition might be due to poor adhesion between the binder coat and the backing and/or to a tendency of the fibrous backing to become "raggy" and to stretch out or otherwise undergo change from its original dimensions, for example, due to fluids encountered during use or because of poor adhesion between the binder coat and impregnated fibrous backing in the first instance. Various other defects existed in abrasive belts heretofore employed, which it is an object of this invention to overcome. For example, abrasive belts were employed prior to this invention, of a type which have been known for upwards of twenty five years, in the polishing or smoothing of glass "Vitrolite" and the like, but such belts could only be used dry, which occasioned a serious dust and silicosis hazard. Such prior art belts, which were frequently made with a glue bond, had the further disadvantage that the glue grit-bonding coat would soften with heat and hence such articles were subject to rapid "loss of cut" under the high heats often developed in dry "sanding." This grave disadvantage has been overcome by the wet abrasive belts herein described and illustrated.

In the making of abrasive belts, according to a preferred aspect of this invention, the woven fabric or other fibrous material may be coated on either or both sides, as by immersion, or otherwise coated or impregnated with a thermoplastic and/or polymeric or resinous material of the type herein illustrated which, in its solidified condition, is of good or sufficient elasticity. Thermoplastic materials which contain neutral or synthetic polymers and which are not brittle under ordinary temperatures of use are especially contemplated. Illustrative of this class of materials are: polymerization products of ethylene linkage compounds, and of certain other multi-bond carbon to carbon linkage compounds, for example various polymeric vinyl compounds of the water-proof or water-dispersible types: sulphur-olefin resins, e. g. polyalkylene polysulphide resins produced, for example, by the reaction of ethylene dichloride on sodium polysulphide ($\text{Na}_2\text{S}_{2.2}$).

calcium hydroxide and ethyl alcohol first being added to the sodium polysulphide in known manner and the final product being rendered strong and rubber-like, for example, by heating with sulphur or equivalent, or by the interaction of ethylene dichloride on a soluble polysulphide such as sodium tetrasulphide, Na_2S_4 ; and/or certain particular heat hardenable resinous materials such as those employed in making materials such as the commercial product "Revolite," though the latter is less advantageous than, for example, various vinyl resins and polyalkylene polysulphide resins in the making of wet sanding belts for glass and the like according to this invention. Materials of the types indicated above may be used alone as a backing treatment or impregnating coat for fibrous belts or the like or may be employed in admixtures. Admixtures containing materials of each of the above types have been employed and also admixtures of materials of the above types with other materials not thus far mentioned, including other resinous or polymeric materials and/or solvents, plasticizers, modifiers and stabilizers, have been used for the purposes indicated.

Where materials of the above type are used as a backing coat or as an impregnating coat, a phenolic resin such as a condensation product of phenol and formaldehyde, or cresol (or other substituted phenolic material) and an aldehyde, or alkyl modifications of phenol-aldehydes may be used to advantage as the grit-bonding or binder coat, although other materials such as alkyls, urea-aldehydes, etc., may, if desired, be used in combination with or in lieu of phenol-aldehyde resins.

The invention will be further illustrated by the following specific compositions adapted for use as an impregnating or backing coat or sizing for fibrous materials, e. g. for woven backing materials such as commercial "drills" or other suitably woven fabric, such as "jeans," where cloth backing is employed. Drills or other fabrics, woven so as to reduce stretching thereof to a minimum, i. e. so as to make the same stretch-resistant, are especially desirable in making abrasive belts.

Example 1

	Parts by weight
Vinyl chloride-acetate copolymer	14
Litharge (stabilizer)	27
Methyl-amyl ketone (solvent)	42
Carbon black	2

The vinyl copolymer mentioned in the above table was made from a mixture containing 75-85% vinyl chloride, the balance being made up primarily of vinyl acetate. However other proportions of vinyl chloride and vinyl acetate can be employed. Increased quantities of the acetate would further soften the copolymer.

Other specific vinyl resin compositions contemplated by me for use as an impregnating or backing coat or sizing coat for fibrous material include polymerization products of vinyl chloride $\text{CH}_2=\text{CHCl}$, vinyl acetate $\text{CH}_2=\text{CH}(\text{C}_2\text{H}_3\text{O}_2)$, β -chlor-propylene $\text{CH}_2=\text{CClCH}_3$, vinyl alcohol $\text{CH}_2=\text{CHOH}$ and vinyl benzene, etc.

The above compounds have the general formula $\text{RCH}=\text{CH}-\text{R}'$, where R may be hydrogen and R' may be a hydroxyl, carboxyl, chloride, acetate, bromide, etc., or various other organic radicals. Where one R in the above indicated formula, for example R', is an hydroxyl group, or where a substantial or high proportion of com-

pounds contained in such a resinified or polymerized product contains hydroxyl groups, this resulting polymerized material is self-dispersible or soluble in water. Water solubility or dispersibility is also promoted by groups other than the hydroxyl groups, for example, by the carboxyl (COOH) group or the amine (NH_2) group. Where a water-soluble resin is employed, it may be treated with physical and/or chemical insolubilizing agents to improve the finished abrasive article or render the same water-resistant.

Another specific polymerized or resinified product suitable for my purpose may be made from the following:

Example 2

	Parts by weight
Vinyl chloride	80
Vinyl acetate	20

The mixture of Example 2 is properly polymerized, i. e. polymerized sufficiently so that the resulting product will be a solid of desired flexibility. Such a polymerized product, which is a flexible solid at room temperatures, may be utilized with or without thinners for the purposes of this invention. Preferably however controlled, desired plasticity, flexibility and other properties may be aided or improved by the addition of softeners or plasticizers or other modifiers including such materials as linseed oil, tung oil, castor oil, high boiling esters, such as diethyl phthalate, dibutyl phthalate, diamyl phthalate, and p-toluene sulfonamide. The phthalates mentioned are in many instances very good modifiers and plasticizers for my purposes.

Another specific example of a vinyl resin contemplated by me is as follows:

Example 3

5-15 parts to a mixture of polymerized vinyl chloride and vinyl acetate made in accordance with example 2.
1-10 parts of modifier or plasticizer, e. g. dibutyl phthalate.

The composition of Example 3, when plastic or while still warm, may be directly applied to a backing material such as cloth or the like, as herein otherwise illustrated, for a sizing, filler, sealing or impregnating coat, for example. The composition of Example 3 may, however, advantageously be thinned with volatile organic solvents or vehicles in which such polymerized or resinified mass may be considered a dispersion or solution.

A polymerized or resinified compound, such as the vinyl resin just indicated, may be dissolved in a solvent or thinner mixture as illustrated by the following:

	Parts
Butyl acetate	40
Ethyl alcohol	20
Toluene	40

Higher boiling solvents may also be used where desired, examples being mono butyl, ether of ethylene glycol, commonly known as butyl cellosolve, with which xylene may be used, etc. Also, low boiling solvents may be substituted for those above enumerated, such for example as ethylene dichloride.

Polymerized styrol, polymerized crotonylene, such as crotonyl chloride, etc., may be used as a substitute for or in combination with the polymerized vinyl chloride and/or acetate, polyvinyl alcohol and the like, where desired.

An example of another contemplated composition is as follows:

Example 4

Polymerized vinyl chloride and/or vinyl acetate	Parts 5-25
Plasticizer and/or softener (preferably dibutyl phthalate, although vegetable oils, such as linseed oil, tung oil, castor oil, high boiling esters, such as diethyl phthalate, diamyl phthalate, p-toluene sulfonamide, aromatic phosphates, such as tricresol phosphate, triphenyl phosphate, may be used)	1-10
Inert pulverulent product, such as carbon black, bone black, zinc oxide, etc.	2-10

The solvent used with the above and the quantities thereof may be as indicated in connection with Example 3 hereof, though vehicles altered to produce a dispersion of the polymerized or resinified products are also contemplated. Vegetable oils, especially those of a drying nature are preferably not used where a woven, cloth backing is employed and where the finished article is to be employed for severe duty, such as the sanding of glass, etc.

Where aqueous mixtures of water-dispersible or soluble vinyl resins, e. g. polyvinyl alcohol etc., as heretofore indicated, are employed in impregnating a cloth or other fibrous or cellulosic backing, to which impregnated backing a layer of a phenol-aldehyde resin or other suitable or heat convertible resinous or grit-bonding coat is joined in integral relation, the waterproofness of such product may be improved by the employment of suitable modifying agents in conjunction with polyvinyl alcohol, e. g. by employing modifying agents such as various vegetable oils including linseed oil, tung oil, etc., as well as other materials, including paint pigment such as litharge, preferably in combination with linseed oil, tung oil or the like. The flexible abrasive articles may be treated with such modifying agents after the grit-bonding coat has been applied or the abrasive belts or other abrasive articles may be given a backsize treatment with such modifiers before or after the grit-bonding coat, such as phenol-aldehyde, or other heat-convertible or thermoplastic material is applied. The phenol-aldehyde or like grit-bonding coat, together with a suitable sandsizing coat, such as a vinyl resin, phenol-aldehyde resin, etc., serves to provide a substantial measure of waterproofness to a polyvinyl alcohol or like water-dispersible impregnating or presizing coat by keeping water out of contact therewith. Also water-dispersible vinyl resins, such as polyvinyl alcohol and the like can be rendered insoluble or resistant to attack by water, in respect to uses to which the article is to be put, by treating the polyvinyl alcohol or the like (after the same has been applied to the cloth or like backing material) with other physical insolubilizing agents alone or with mixtures hereinabove presented and/or with chemical insolubilizing agents such as diethyl sulphate, dimethyl sulphate, etc. in admixture with alkaline material such as caustic alkali; various ethers, ketones such as diethyl ketone, etc. Diethyl sulphate is preferred over dimethyl sulphate from the angle of safety in use.

Also such modifiers as linseed oil, tung oil, with or without addition agents such as paint pigments, e. g. zinc oxide, litharge, etc., may also be used, either alone or in admixtures with them-

selves and/or with other physical and/or chemical insolubilizing agents, herein illustrated, to improve the water-resistance or waterproofness of abrasive articles made with polyvinyl alcohol, or other water-dispersible resins, where the latter are used, for example, as a binder or grit-bonding coat and/or as a sandsizing coat. Such modifiers, for example in oxidized and/or polymerized state provide waterproof films which, of course, improve the water-resistance of the abrasive.

Another composition which may be used as an impregnating or sizing or backing coat follows.

Example 5

	Parts by weight
Olefine-polysulphide resin (i. e. polyalkylene polysulphide resin)	10
Crepe rubber	5
Zinc oxide	1
Carbon black	2
Tetra-methyl thiuram disulphide (softener)	.03

Illustrative of specific polyalkylene-polysulphide resins mentioned in Example 5 are reaction products of ethylene dihalide with sodium polysulphide, to yield resins such as one having the empirical formula, $(C_2H_4S_n)_n$ or so-called "Thiokol B," which latter is a product of commerce. This type of material is ordinarily not applied to fabrics in the manner in which vinyl resins may be employed. That is, most olefine-polysulphide resins, i. e. polyalkylene polysulphine resins, cannot satisfactorily be dissolved. The usual practice is to soften the composition, such as above illustrated, usually on a rubber mill, and then friction it into the cloth or fabric on calender rolls, which at one and the same time stretch the fabric longitudinally and iron down the fibers thereof while coating or impregnating the fabric with a composition such as illustrated in Example 5. Thus the stretch of the fabric is set, the impregnating or backing coat is applied and the sheet of fabric is calendered all in the one operation. This type of composition and coating operation sets the stretch of the fabric very satisfactorily. Where a bonding or abrasive-binder coat of the nature of insolubilized glue, bonds made with casein, and certain other natural and synthetic resins, or the like, are used, which adhere with great tenacity to a cloth backing, it is often preferred to apply the composition of Example 5 only to one surface of the cloth or fibrous backing material, so as to leave a "starved" side to which the abrasive binder coat may be applied. Tension on the backing material is preferably released prior to the application of the binder coat and the abrasive grits. Any desired sand-size or grit-size coat may then be applied to the composite abrasive article and the latter subjected to curing temperatures of the order of 150° F. to 300° F., for a relatively short time sufficient to effect the curing, without decomposing or embrittling the thermoplastic composition or appreciably deteriorating the fabric. However temperatures above about 325° or 350° F. are preferably avoided in many if not most instances.

Where grit-bonding coats are employed which will adhere more firmly to a fabric covered with the composition of Example 5 or that of any of the preceding examples, according to primarily contemplated aspects of this invention, rather than to a starved side of the fabric, it will be understood that the above fabric may be and preferably is thoroughly impregnated with the

above composition, or that such composition may be applied to both sides of the fabric in the manner above described or in any other suitable manner.

While insolubilized glue, etc. are mentioned above as a possible grit-bonding coat, it will, of course, be understood that phenol-aldehyde resins and other materials mentioned hereinabove, particularly those of the heat-convertible type, are especially contemplated for this purpose where a composition as given in Example 5 is employed as an impregnating or backing coat.

Another method of producing an impregnated backing sheet, to which a suitable phenol-aldehyde, urea-aldehyde, etc., resinous grit-bonding coat may be joined in the making of "wet belts" for glass "sanding," or the like, is as follows:

Take straight phenol and formaldehyde and react the mixture, at superatmospheric temperatures (e. g. 180° to 210° F. more or less) and in the presence of phosphoric acid as catalyst, until a viscous liquid, i. e. a partly reacted resin, is produced. Then add this viscous liquid to China-wood oil, intimately admix the same, and heat to gelation. This gelled material is then milled on a heated rubber mill to further increase the body thereof, or to stiffen the same, and pigments (which may be quite inert) such as zinc oxide, carbon black, litharge, etc. or mixtures containing one or more of the same, are added and the milling and heating is continued until the desired plasticity is attained, e. g. until the finished product resembles crepe rubber. This plastic product may then be applied to a cloth or fibrous backing, such as "drills" or "jeans," for example by frictioning the same into the cloth. A suitable grit-bonding coat (or presize and grit-bonding coat) such as a suitable phenolaldehyde resinous grit-bonding coat may then be applied to such an impregnated back, and the abrasive grits and sand-sizing coat added thereto, to make a finished article.

While such article is useful and advantageous in making abrasive or like articles, as illustrated, vinyl resins and/or polyalkylene polysulphide resins, or the like, as hereinabove exemplified, are preferred to impregnate the backing in making "wet belts" for glass sanding and the like.

In making articles such as abrasive belts, which are often subjected to heavy service requirements and severe stresses, as in the wet "sanding" of glass, there are relatively few materials which can be satisfactorily employed in impregnating the cloth or fibrous backing material in the making of a good, serviceable and commercially advantageous article. Vinyl resins, such as those hereinabove set forth, are excellent materials for this purpose, particularly when a coating of a phenol-aldehyde resin or a modified phenolic aldehyde resin is applied in contiguous relation with the polymeric vinyl compound or with the fabric impregnated therewith. This situation exists where the fabric is impregnated or saturated with a vinyl resin and then is given a presize coating of the same or another vinyl resin, the phenol-aldehyde condensation product or resin being applied over the vinyl presize coating. Likewise, a good bonding between a vinyl resin and a phenol-aldehyde resin occurs where, for example, both the presize and grit-bonding coat are of the phenol-aldehyde resin type and the fibrous backing is first coated or impregnated with a vinyl resin. Among the vinyl resins preferred are mixtures or copolymers comprising polyvinyl chloride

which are not too high in polyvinyl chloride. Where the latter is employed, a polyvinyl ester of an organic acid, e. g. polyvinyl acetate, or equivalent, is preferably employed to substantial extent. But it is to be understood that polyvinyl chloride is not required and vinyl resins containing no polyvinyl chloride and no polyvinyl acetate are, of course, contemplated, as will be seen from description given hereinabove.

However, as will be clear from the description herein taken as a whole, a good final product is also obtained where other types of backing treatments or impregnating agents of the type hereinabove described, e. g. various polyalkylene polysulphide type resins, are employed. A phenol-aldehyde type bonding coat may be employed with satisfaction with any of the impregnating coats above mentioned. Also, other bonding coats such as alkyds or modified alkyds may be employed, although bonding agents containing or comprising phenol-aldehyde type resins or similar heat-convertible resins are in most cases preferred by me in the making of abrasive articles. This is especially true in the making of "wet belts" for the "sanding" of glass or the like. Likewise while the present invention is of high utility in connection with articles comprising woven fabric backings, it has utility in connection with other fibrous bodies such as paper, where the fibers are felted rather than woven, although it has very important utility in connection with woven fibrous material.

While various phenol-aldehyde resins and other heat-convertible resins may be employed as the grit bonding coat (and/or as a presize or as the sandsize coat), as will be understood, the following is illustrative of an advantageous resin and a method of making the same.

Mix together the following:

	Pounds
98% phenol (2% water)-----	248
37% formaldehyde (61% water)-----	214
Barium oxide-----	2

Heat the mixture between about 125° and 150° F. until the formaldehyde percentage has been lowered to approximately 5 per cent. This may take about 24 hours, more or less. Then neutralize the mixture with an acid, e. g. HCl. Next boil off the water by heating to about 215° F. and hold at this temperature until the viscosity of the resin is about 500 centipoises at 70° C. (150° F.). Now cool to about 200° F. and then add 2.5% by weight of 28% aqueous ammonium hydroxide. Hold the temperature of the mixture at substantially 200° F. until the viscosity thereof becomes about 1000 centipoises at 70° C. Then add solvent, e. g. Cellosolve, and cool to about 120° F. The amount of Cellosolve, or the like, may be about 10%, more or less. The resulting resinous material may be used as a grit-bonding coat or, upon further dilution, as a sandsizing or grit-sizing coat. Where grit sizes Nos. 24, 30 or 36 are employed, the dilution of the resin provided by 10% Cellosolve usually will make the same satisfactory for a grit-bonding coat, but greater dilution will customarily be desired for a sandsizing coat, or as a grit-bonding coat where smaller abrasive grits are used. On the other hand, less dilution is needed where the resin is used as a grit-bonding coat with larger grits.

A modified resin of highly advantageous qualities, e. g. as a grit-bonding coat over an impregnated backing, is secured by replacing am-

monium hydroxide with sodium hydroxide in the above procedure.

Another advantageous modification of the above procedure, e. g. in producing a sandsize resin which may be used in making "wet belts" for glass sanding, involves increasing the amount of formaldehyde in relation to the phenol so that the mol ratio is about 2:1. This may be accomplished by using some paraformaldehyde to avoid excessive water in the mix. Also, instead of eliminating water by heating up to about 215° F., as indicated in the above procedure, the water may be removed by vacuum dehydration at relatively low temperatures. In this modification also, sodium hydroxide may be employed instead of ammonium hydroxide. The result is a resin which, when employed, for example, as a sandsize coat in making an abrasive belt (such as herein illustrated for the wet "sanding" of glass, etc.), produces an abrasive article having greater heat resistance and increased tensile strength and one which will cut considerably more before it is exhausted.

The above are only exemplary of various grit-bonding and/or sand-sizing coats which may be employed. Other resinous materials of suitable character, including urea-aldehydes, alkyd modified phenolics, etc., are, of course, also contemplated.

Where phenolic materials other than phenol are employed as reactants for aldehydes to produce resin grit-bonding coats, it is to be observed that some are better than others. For example, various cresols or cresylic acids may be used and, of these, metacresol, paracresol and especially meta-paracresols are among the more advantageous reactants for aldehydes such as formaldehyde.

While the invention has been illustrated hereinabove in considerable detail in connection with the making of abrasive sheet goods, particularly such as abrasive belts, e. g. those used in the wet abrading of glass, metal, it will be understood that the invention is not to be limited by the illustrations. For example it will be recognized that a composite article of this process would have utility even though the solid particles embedded in the grit-bonding coat were not intended for abrading operations. Furthermore it will be recognized that sheet goods can be made up in accordance with the teaching herein presented where no granules or like hard particles, whether of a decorative or other nature, are embedded in the surface coating, and whether or not the latter comprises a phenol-aldehyde resin or other modified or equivalent material.

Fibrous backing described herein, while ordinarily desired, particularly in abrasive articles such as abrasive belts, is usually employed primarily for the purpose of adding strength and endurance to the finished article. Where the finished article has sufficient strength for purposes desired in the absence of the fibrous or cloth backing, it will be understood that the same may be dispensed with while still following the teaching of this invention, for example in regard to the matter of securing good adhesion or a good bond between a base or backing coat or layer and a contiguous overlying sheet or binder coat, as the case may be.

While hereinabove an abrasive article has been discussed comprising a fibrous backing material, an impregnating or backing coat therefor, a pre-size coat, a back-size coat, a grit-bonding or binder coat adapted to be applied over the pre-size

coat, a layer of granules or abrasive particles of the like embedded in said binding coat and a sandsize or abrasive-size coat over the layer of granules or particles, yet nevertheless it will be understood that this invention is by no means limited to such a specific illustration and comprehends composite articles comprising a plurality of layers of material joined together in accordance with the teaching of this invention whether they have such a number or variety of layers or coatings, or not. For example the back-size coat, the pre-size coat, and/or the sandsize coat might be absent, while still making a composite article comprising an impregnated fibrous backing to which a grit binder coat was joined in integral or contiguous relation. These and other variations within the scope of the appended claims are contemplated.

What I claim is:

1. A flexible abrasive article adapted to be used wet for abrading or polishing glass, marble and the like which comprises a strong woven fibrous material; an impregnating or sizing coat for said fibrous material which consists of a film-forming, elastic waterproof adhesive material comprising a thermoplastic synthetic resin; a waterproof organic grit-bonding coat comprising a heat-convertible phenolic-aldehyde resin, joined to the impregnated fibrous backing aforesaid; and a multiplicity of abrasive particles embedded in said grit-bonding coat; said grit-bonding coat being less flexible and very substantially harder than said impregnating or sizing coat.

2. A flexible abrasive article comprising a sheet of fibrous material and at least two layers or coatings of material, all joined in integral relation, one of said coatings being an abrasive-bonding coat and another of said coatings intervening to substantial extent between said abrasive-bonding coat and said fibrous material and being composed of a substance comprising a polyalkylene poly-sulphide resin of a rubbery nature, said abrasive-bonding coat comprising a heat-convertible synthetic resin, and a layer of abrasive grits embedded in said grit-bonding coat.

3. A flexible abrasive article of the coated abrasive type, adapted for use wet in the abrading or polishing of glass, comprising a fibrous sheet, an impregnating or sizing coat for said fibrous sheet comprising a thermoplastic polyvinyl compound, an organic binder coat joined in integral relation with the impregnated fibrous sheet aforesaid, and a multiplicity of abrasive particles anchored by said binder coat, said organic binder coat being of composition different from said impregnating or sizing coat and comprising a heat-advancing synthetic resin, said binder coat being substantially harder than said impregnating or sizing coat.

4. An abrasive article comprising a fibrous sheet, an impregnating or sizing coat for said fibrous sheet comprising a thermoplastic polyvinyl compound, an organic binder coat joined in integral relation with the impregnated fibrous sheet aforesaid, and a multiplicity of abrasive particles anchored by said binder coat, said organic binder coat being of composition different from said impregnating or sizing coat.

5. An abrasive article comprising a fibrous sheet, an impregnating coat for said fibrous sheet comprising an elastic waterproof thermoplastic copolymer of a vinyl halide and a vinyl ester of an organic acid; an organic binder coat, which is harder and less flexible than said impregnating coat, joined to the impregnated fibrous sheet

aforesaid; and a multiplicity of abrasive particles embedded in said binder coat.

6. An abrasive article comprising a fibrous sheet, an impregnating or sizing coat for said fibrous sheet comprising a thermoplastic polyvinyl compound, an organic binder coat joined in integral relation with the impregnated fibrous sheet aforesaid, and a multiplicity of abrasive particles anchored by said binder coat, said organic binder coat being of a composition different from said impregnating or sizing coat and comprising a heat-convertible phenolic resin, said binder coat being harder and less flexible than said impregnating or sizing coat.

7. An abrasive article comprising a fibrous sheet, an impregnating or sizing coat for said fibrous sheet comprising a thermoplastic polyvinyl compound, an organic binder coat joined in integral relation with the impregnated fibrous sheet aforesaid, and a multiplicity of abrasive particles anchored by said binder coat, said binder coat being of composition different from said impregnating or sizing coat and comprising a heat-advancing phenol aldehyde resin, said binder coat being harder than said impregnating or sizing coat.

8. A flexible abrasive article of the coated abrasive type, adapted to be used wet in the sanding of glass, marble and the like, comprising a fibrous sheet backing material, an impregnating or sizing coat for said fibrous sheet comprising a thermoplastic polyvinyl ester of an organic acid, an organic binder coat joined in integral relation with the impregnated fibrous sheet aforesaid, and a multiplicity of abrasive particles anchored by said binder coat, said organic binder coat being of composition different from said impregnating or sizing coat and comprising a heat-convertible phenolic resin.

9. A flexible abrasive belt adapted to be

used wet for abrading and smoothing glass, steel and like heavy abrading operations which comprises a strong woven, stretch-resistant fibrous material; an impregnating or sizing coat for said fibrous material which comprises a waterproof, thermoplastic resinous organic material containing a vinyl resin and a polyalkylene polysulphide resin of a rubbery character; a grit-bonding or binder coat which is harder and less flexible than said impregnating coat and comprises a heat-advancing synthetic resin, overlying and joined in integral relation with the impregnated fibrous backing aforesaid; and a multiplicity of abrasive particles embedded in said grit-bonding coat.

10. A flexible abrasive article comprising a sheet of fibrous material and at least two layers or coatings of material, all joined in integral relation, one of said coatings being an abrasive-bonding or binder coat comprising a heat convertible phenolic resin and another of said coatings intervening to substantial extent between said abrasive-bonding coat and said fibrous material and being composed of a substance comprising a polyalkylene polysulphide resin of a rubbery nature.

11. A flexible waterproof abrasive article comprising a sheet of woven fibrous material and at least two layers or coatings of different material, all joined in integral relation, one of said coatings being an impregnating coat for said woven fibrous backing and comprising an ethylene dichloride sodium polysulphide resinous substance and another of said coatings comprising a heat-convertible phenolic-aldehyde resin joined to the impregnated fibrous backing material and a layer of abrasive grits embedded in said phenolic-aldehyde layer or grit-bonding coat.

BYRON J. OAKES.

CERTIFICATE OF CORRECTION.

Patent No. 2,357,350.

September 5, 1944.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, second column, line 44, for "nautral" read --natural--; page 2, second column, line 13, for the word "purpose" read --purposes--; line 40, for "5-15 parts" read --5-25 parts--; page 3, second column, line 33, for "polysulphine" read --polysulphide--; page 5, second column, line 1, for "of" after "particles" read --or--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 26th day of December, A. D. 1944.

Leslie Frazer

(Seal)

Acting Commissioner of Patents.