

UNITED STATES PATENT OFFICE

2,269,415

ABRASIVE ARTICLE AND METHOD OF
MAKING THE SAME

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No Drawing. Application December 11, 1937,
Serial No. 179,338

15 Claims. (Cl. 51-295)

This invention relates, in general, to articles of manufacture of the type having a support and a layer of comminuted solid materials deposited and secured thereon; and more particularly to improvements in securing and maintaining a physical union of the comminuted material to its support.

The invention is particularly directed to the coating of supports such as strips or sheets of fabric, paper, or the like, with abrasive particles or granules and the application of their securing means for adherence thereto to make abrasive articles.

Composite structures of the abrasive type such as sandpaper or emery cloth comprise generally, (a) a base of sheet material, which may be felted as in the case of paper or woven as in the case of cloth, (b) a more or less finely comminuted resistant material having abrading properties, such as garnet, corundum, or the like, and (c) a binder generally in the form of a glue or resinous bond which serves to bind the abrasive to the base.

The manufactured abrasive articles known to us have at no time in the past ever been made so that all abrasive particles are coated and held in a durable matrix of solidified adhesives in such a manner that substantially all of the particles have an opportunity of rendering full utility.

The abrasive particles, to be firmly secured, require an additional bond or a plurality of bonds to anchor them to the adhesive on which they are coated. This additional bonding gives the finished abrasive article additional strength and utility, but in so doing, and in the methods of present use and their adaptation, a great percentage of the orientation and perpendicular erection of the abrasive particles is destroyed. Generally this destruction or changing of position of the particles may be described as due to the disturbing forces of a later applied bonding means, tending to pull the granule, loosened by a softening of the original binder, from its original position.

With the present type of application of oriented granular particles to an adhesive bond, a particular need is present of maintaining the granules in an oriented position for the purpose of producing maximum shearing effect of the work-

ing article. By orientation of an abrasive granule, we mean a disposition of the granular material coated on a bonding surface in such a manner that the longer dimensional configuration of the granular material is placed approximately perpendicular to the bond. Present methods of applying oriented particles are amply illustrated by electrostatic means as described in the patent to J. S. Snysen, No. 1,788,600.

Our invention is not concerned with the problems of applying the abrasive particles in a particular manner to the base material, but is concerned primarily with the provision of a combination of individually distinct and separate adhesive coatings co-operatively maintaining the particles in the original position obtained in their first application to the base. This position is preferably such that the particles are oriented so that a substantial proportion of their pointed abrasive surfaces are exposed, or at least such that particles are dispersed with the long dimensions thereof at a substantial angle to the base.

It is therefore a principal object of this invention to secure a maintenance of orientation of abrasive particles adhering to a primary or making adhesive coated on a base, during and after application of a second anchoring adhesive coating.

Another object of this invention is to provide an abrasive article having a better cutting edge due to coating of the particles in such a manner as to maintain them in an oriented position throughout the finishing process.

A further object is to provide for maintaining orientation of the abrasive particles on abrasive articles both as to those having a substantially rigid backing and those having a flexible backing; and the invention is applicable to preparing abrasive articles both for dry abrasive work and wet abrasive work.

In addition, we have further found that the application of the bonding materials in accordance with our invention results in an abrasive article having increased life and durability, as well as a strengthened granular bond.

In accordance with the present invention, the primary or making coat of adhesive (upon which the comminuted solid material is deposited as a layer or coating), and the second anchoring or sizing coating of adhesive (applied after the

comminuted solid material), are of such nature with respect to each other as to prevent the application of the anchoring binder coating from loosening the bond between the primary adhesive and the comminuted material. However, after application of some of the type adhesives as hereinafter expressed, a slight softening effect may be produced by heat treatments or the like, tending to fuse the bonds. Such slight softening effect does not destroy the oriented position of the granule, but tends to provide a more stable bond between dual binding means.

The nature of the invention will be apparent in more detail from the following examples and descriptions by which it is illustrated:

1. A glue-resin adhesive is made up consisting of:

	Parts
Glue.....	74
Phenol aldehyde resin.....	82
Water.....	66
Urea.....	13
Concentrated ammonia.....	24
Cellosolve (ethylene glycol monoethyl ether).....	16

This adhesive composition is coated on a backing material such as cloth, paper, or the like, as the primary or making coat. Abrasive granules are then oriented or coated on this adhesive and left to dry at room temperature for approximately 20 minutes. The sheet so dried is then coated with a phenol aldehyde resin solution which consists of:

	Parts
Phenol aldehyde resin.....	60
Cellosolve.....	40

again dried as above. The solvent "Cellosolve" used in this second anchoring adhesive has no effect on the primary bond to the extent of causing the abrasive mineral to lose its oriented position, the primary bond having been insolubilized to any mono-constituent solvent by evaporation of the solvents water and Cellosolve.

2. Another example of the use of this principle of coating is to insolubilize a coating of adhesive through direct chemical reactions, such as by a tanning reaction, or by heating. In this case, for example, a coating of glue of the usual type is applied to the abrasive backing and then the abrasive material is coated to the adhesive. The glue coated backing with abrasive thereon is then passed into a formaldehyde gas filled chamber wherein the glue is converted from a film soluble in water to one insoluble in water. A second coating of glue is then applied as an anchoring means for securing the abrasive material over the original glue film. In place of the specific formaldehyde gas there may be substituted para formaldehyde, furfural, acetaldehyde, or the like; or if this type of treatment is not desirable, the adhesive may be mixed with or treated after application in a bath of tannic acid or its salts, picric acid or its salts, chrome alum, sodium dichromate, dichromic acid or its salts, titanium oxide, stannous chloride, hexamethylenetetramine, or the like, any and all of which will render the adhesive substantially water insoluble and weather resistant. The anchoring bond subsequently added has no effect on the original position of the mineral particles because the solvent of the second coating does not affect the primary securing means. To render the anchoring bond water insoluble, the article may again be passed into the formaldehyde chamber or be otherwise treated as heretofore mentioned.

3. Similar results are obtained where a resin, for example a phenol aldehyde or heat advancing resin soluble in the alcohols as methyl and the like or ketones as acetone or organic esters as ethyl acetate, etc., is used as a primary coat on a backing. The mineral is coated directly on the adhesive phenol aldehyde surface. Sufficient heat is then directed on the mineral coated backing to volatilize the solvent and polymerize the resin. The temperature employed generally will run from 150° F. to 225° F. or higher as applicable to the materials used. The time varies from 20 minutes to several hours depending upon the amount of resin coated and the temperature used. Having accomplished a partial polymerization of the resin, we are then able to add additional resin in the form of an anchoring adhesive without affecting orientation because the resin once properly set up will not be further affected by the solvents in the anchoring coat, with a like treatment to set up this anchoring means. The subsequent heating may slightly interfuse the interfacial surfaces of this type bond without a destruction of the granular positioning.

4. Another example of the type bonding materials which we propose using is a primary adhesive coating applied as a base or binder for disposition of abrasive granular mineral, for example glue and resin soluble, e. g. in alcohol and water, which can be, by heat treatment as is commonly known to the trade, hardened sufficiently to hold the granules in place, and then a coating of a resin such as Bakelite, or other phenol-aldehydes or heat advancing resins, or styrene, vinylite resins and the like, which contains no solvent and is normally liquid at room temperature, is applied over the granules and the coated article is then subjected to a temperature which will polymerize or set up the resin beginning at approximately 110° F. and not exceeding the limit at which carbonization takes place.

5. Other methods of accomplishing a maintenance of orientation include use of a hydrophylic primary casein binder adhesive and an anchoring adhesive of a phenol aldehyde resin inorganic solvents which do not dissolve the casein binder; a sodium silicate primary binder adhesive soluble in water and a resin anchoring size as chloroprene, vinyl derivative, or the like applied in a liquid state and polymerized, for example, by heat and pressure, light, or a catalyst such as oxygen or a peroxide. An additional illustration is the application of a phenol aldehyde resin soluble in ethylene glycol monoethyl ether which serves as a good primary coating and maintains orientation well when employed in conjunction with N-propyl methacrylate polymer solution in benzene used as an anchoring adhesive.

In addition to the above enumerated examples, use may be made of an anchoring adhesive (such as a resin) in an organic solvent, which may be any ketone, poly ether, ester, ethyl alcohol, methyl alcohol, furfuran derivative, any chlorinated solvent or any other organic solvent or mixture of organic solvents in conjunction with a primary binder adhesive or bond dissolved in water, but not soluble in the particular solvent used in the anchoring adhesive. Conversely, we may make use of an anchoring adhesive dissolved in water and a water insoluble primary binding bond dissolved in an organic solvent as of the above character. These possibilities are illus-

trated by the use of a blood albumin anchoring adhesive in water and a primary resin binder adhesive soluble in a hydrocarbon of the above character; by a primary casein glue binder adhesive in water and a resin anchoring adhesive in an organic solvent, such as ether alcohols, esters, and the like, in which the glue is insoluble; and by water soluble soybean protein glue as the primary binder adhesive and a resin anchoring means in an organic solvent, such as benzene, ether, alcohol and the like, in which the soy protein is insoluble; any and all of which coatings may be used in vice versa or interchangeable form as contemplated by this improved combination of bonding means.

Further, by way of illustration, we may use an anchoring adhesive dissolved in an organic solvent and a primary binder bond dissolved in another organic solvent, but not soluble in the particular solvent used in the anchoring adhesive. As an example of this type of bonding means, in addition to those already given, we may use a primary binder coating of a proteid type, such as zein or the like, in alcohol, and a resin anchoring coating having an organic solvent in which the primary binder is insoluble such as benzene, ether, chlorinated methane, and the like.

As an alternative method of applying coatings dissolved in the same solvent, we have found that we may apply the granules to a primary adhesive coating and then by the use of a thin interposed covering of material such as a sulphonated rubber (for example an "acid seal primer" which is a commercial preparation of sulphonated rubber made by Goodrich), with or without a modifier, applying a sizing coat dissolved in the same solvent as the binder coat to secure a finished product with the granules in an oriented position. With the addition of this thin coating and sealing material, we have in reality applied three films for securing the abrasive granules and find that it is possible, by the use of the intermediate sealing layer (such as that previously mentioned or any equivalent layer which will meet the requirements of preventing the anchoring coating from attacking the primary or making coat and of securing a good intermediate cohesion between the making and the sizing bonds), to interchangeably use the bonding means in any form or combination desired, whether dissolved in a like solvent or not.

By the methods as herein disclosed, the primary binder and anchoring coats are co-operatively distinct in the product, although adhering or bonded together at the interface without destroying the granular position.

In general, it is our desire to use the examples illustrated in any combination which will accomplish the purpose of our invention, or any substitutes thereof which by nature have characteristics for accomplishing the results herein described; and while we have described more or less specifically the application of certain coatings, it will be readily understood that other combinations of adhesives may be applied for the purpose of securing maintenance of orientation.

Having thus described our invention and illustrated its use, what we claim is new and desire to secure by Letters Patent, is:

1. An abrasive article comprising abrasive grains secured to a backing by a plurality of coatings of bonding materials including a primary bonding coating and a sizing coating, said

abrasive grains being positioned in said bonding coating in predetermined oriented relation to said backing and reinforced and substantially maintained in said predetermined position by said sizing coating, said bonding coating being of a material selected with respect to the material of said sizing coating such as to be substantially unsoftened and undissolved by the material of said sizing coating in fluid form.

2. A coated abrasive article comprising abrasive grains secured to a backing by a plurality of coatings of bonding materials including a primary bonding or binder coating and a sizing coating, said abrasive grains being positioned in said bonding coating in predetermined oriented relation to said backing and reinforced and substantially maintained in said predetermined position by said sizing coating, said bonding coating being of a material selected with respect to the material of said sizing coating such as to be substantially unsoftened and undissolved by the material of said sizing coating in fluid form, said binder coating comprising glue and said sizing coating comprising a phenol-aldehyde synthetic resin.

3. A coated abrasive article comprising abrasive grains secured to a backing by a plurality of coatings of bonding materials including a primary bonding or binder coating and a sizing coating, said abrasive grains being positioned in said bonding coating in predetermined oriented relation to said backing and reinforced and substantially maintained in said predetermined position by said sizing coating, said bonding coating being of a material selected with respect to the material of said sizing coating such as to be substantially unsoftened and undissolved by the material of said sizing coating in fluid form, said binder coating comprising a hydrophilic organic material and said sizing coating comprising a heat convertible synthetic resin.

4. A coated abrasive article comprising abrasive grains secured to a backing by a plurality of coatings of bonding materials including a primary bonding or binder coating and a sizing coating, said abrasive grains being positioned in said bonding coating in predetermined oriented relation to said backing and reinforced and substantially maintained in said predetermined position by said sizing coating, said bonding coating being of a material selected with respect to the material of said sizing coating such as to be substantially unsoftened and undissolved by the material of said sizing coating in fluid form, said primary bonding or binder coating being water-soluble but substantially insoluble in organic solvents from the group consisting of cellosolve, methyl alcohol, acetone and ethyl acetate, and said sizing coating being an organic material soluble in at least one of the organic solvents aforesaid.

5. A coated abrasive article comprising abrasive grains secured to a backing by a plurality of coatings of bonding materials including a primary bonding or binder coating and a sizing coating, said abrasive grains being positioned in said bonding coating in predetermined oriented relation to said backing and reinforced and substantially maintained in said predetermined position by said sizing coating, said bonding coating being of a material selected with respect to the material of said sizing coating such as to be substantially unsoftened and undissolved by the material of said sizing coating in fluid form, said

primary bonding or binder coating being substantially insoluble in hydrocarbon solvents but soluble in at least one organic solvent from the group consisting of ethylene glycol monoethyl ether (i. e. cellosolve), methyl alcohol, acetone and ethyl acetate and the said sizing coating being an organic material soluble in a hydrocarbon solvent.

6. An abrasive article comprising abrasive grains secured to a backing by a plurality of coatings of bonding materials including a primary bonding coating and a sizing coating, said abrasive grains being positioned in said bonding coating in a predetermined oriented relation to said backing and reinforced and maintained in said predetermined position by said sizing coating, and an intermediate coating interposed between said bonding coating and said sizing coating serving to join said bonding coating and said sizing coating and to maintain said bonding coating unaffected by the material of said sizing coating to a degree to cause alteration of said predetermined position of said grains.

7. The method of manufacturing coated abrasives comprising adhesively coating a backing sheet with a viscous grit-bonding coat, depositing abrasive particles in oriented position on said adhesively coated backing sheet and adhering the particles to said sheet with said grit-bonding coat, solidifying said grit-bonding coat, then applying thereon an organic grit-sizing in the form of a liquid layer, said grit-sizing being of such character that it does not soften or dissolve said grit-bonding coat to any substantial extent, thereby to produce a sized flexible abrasive article in which the orientation of the abrasive particles is not substantially impaired by the application of the said grit-sizing coat.

8. The method of manufacturing coated abrasives comprising depositing abrasive particles in oriented position on a layer of plastic organic material, then solidifying said layer of organic material to preserve the orientation of said abrasive particles and insolubilizing the same with respect to a sizing coat to be employed, and then applying over the aforesaid layer of solidified organic material and over said abrasive grits the sizing coat aforesaid, thereby to produce a sized flexible abrasive article in which the initial orientation of the abrasive particles has been substantially preserved.

9. The method of manufacturing flexible coated abrasive articles as defined in claim 7 further characterized in that the said grit-sizing is applied as a single coat in the production of the finished flexible abrasive article.

10. The method of manufacturing coated abrasives comprising depositing abrasive particles in oriented position on an adhesively coated backing sheet and adhering the particles to the sheet, the adhesive coating on said backing sheet comprising a synthetic organic resinous material, then insolubilizing said adhesive coating, and then applying over said adhesive coating a synthetic organic resinous sizing coat, thereby to produce a sized flexible abrasive article in which the initial orientation of the abrasive particles is not substantially impaired by the application of the said grit-sizing coat.

11. The method of manufacturing coated flexible abrasive articles comprising adhesively coating a backing sheet with a grit-bonding layer or coating, said grit-bonding layer comprising a plastic mixture of a phenol-aldehyde resin, glue and a solvent and of such character that the

phenol-aldehyde resin and glue are mutually miscible in water, depositing abrasive grits in said grit-bonding coat in oriented position and adhering the grits or abrasive particles to the said backing sheet, then drying the resulting article substantially completely to eliminate the aforesaid solvent from said grit-bonding coat and to solidify the latter, and then applying to said abrasive coated sheet, over the layer of abrasive particles and over said grit-bonding coat, a grit-sizing coating comprising a phenol-aldehyde resin dispersed in an organic solvent.

12. The method of manufacturing coated abrasives which comprises adhesively coating a backing sheet with a grit-bonding layer or coating, said grit-bonding layer comprising a plastic protein composition, depositing abrasive particles or grits in oriented position in said grit-bonding layer or coat and adhering the particles to the said backing sheet, subjecting said grit-bonding coat to a tanning reaction whereby the same is substantially insolubilized, and then applying thereon, over the layer of abrasive particles and over the said grit-bonding coat, a coating of a grit-sizing material comprising a protein plastic composition and water.

13. The method of manufacturing coated abrasives which comprises adhesively coating a backing sheet with a plastic grit-bonding layer or coating of a partially reacted, resinous phenolic-aldehyde condensation product dispersed in an organic solvent, depositing abrasive particles or grits in oriented position in said grit-bonding layer or coat and adhering the particles to the backing sheet, then subjecting the resulting article to sufficient heat to volatilize the aforesaid solvent from said grit-bonding coat at such rate that the plastic grit-bonding coat will solidify without permitting disorientation of said abrasive grits and also so as to further polymerize the aforesaid resinous phenolic-aldehyde material, and then applying thereon, over the layer of abrasive particles and over said grit-bonding coat, a sandsizing coat containing a phenol-aldehyde resin dispersed in an organic solvent.

14. The method of manufacturing coated abrasives comprising coating a backing sheet with a grit-bonding layer or coating containing a water solution of a protein composition and a heat-advancing, i. e., heat-hardenable, resin in solution to form a plastic composition, depositing abrasive particles or grits in said grit-bonding layer or coat in oriented position and adhering the particles to the backing sheet, heating the resultant article to a temperature upwards of approximately 100° F. quickly to stiffen and solidify said grit-bonding coat, and then applying to said adhesive coated sheet, over the layer of abrasive particles and over the said grit-bonding coat, a coating of a grit-sizing material composed primarily of a fluid, heat-hardenable resin, thus maintaining the initial orientation of the aforesaid abrasive particles substantially undisturbed.

15. The method of manufacturing coated abrasives comprising adhesively coating a backing sheet with a grit-bonding layer or coating, said grit-bonding layer comprising a hydrophylic casein composition dissolved in water to render the same plastic, depositing abrasive particles or grits in oriented position in said grit-bonding layer or coat and adhering the particles to the said backing sheet, subjecting the resulting article to a heat treatment quickly to vaporize the water from said grit-bonding coat and to solidify the latter, and then applying to said adhesive

coated sheet, over the layer of abrasive particles and over the said grit-bonding coat, a coating of a grit-sizing material comprising an organophylic phenolic-aldehyde resin disseminated in an organic solvent, thereby to produce a finished commercial flexible abrasive article in which the

initial orientation of the aforesaid abrasive particles is preserved substantially undiminished.

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