

Sept. 3, 1957

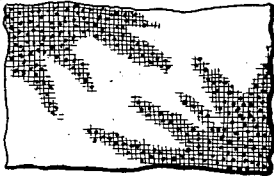
J. R. O'NEIL, JR., ET AL

2,805,136

ABRASIVE CLOTH AND METHOD OF MANUFACTURING

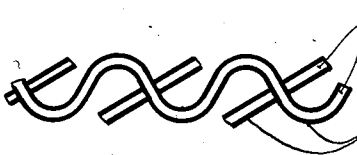
Original Filed March 24, 1952

**Fig. 1**



ABRASIVE CLOTH COMPRISING ABRASIVE GRAINS BONDED TO A RESIN-IMPREGNATED CLOTH FILLED WITH A STARCH-BASE FILLING MATERIAL.

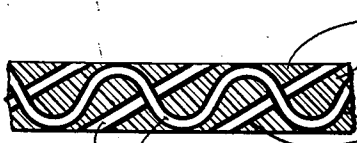
**Fig. 2**



CLOTH THREADS CONTAINING STARCH-BASE FILLING MATERIAL.

STARCH-BASE FILLING MATERIAL.

**Fig. 3**



HEAT-HARDENABLE SYNTHETIC RESIN FILLING MATERIAL.

STARCH-BASE FILLING MATERIAL.

CLOTH THREADS CONTAINING STARCH-BASE FILLING MATERIAL.

INVENTORS:

JOSEPH R. O'NEIL, JR.

HALSEY W. BUELL.

BY

*W. J. Dole*  
ATTORNEY

1

2,805,136

## ABRASIVE CLOTH AND METHOD OF MANUFACTURING

Joseph R. O'Neil, Jr., Youngstown, and Halsey W. Buell, Niagara Falls, N. Y., assignors to The Carborundum Company, Niagara Falls, N. Y., a corporation of Delaware

Continuation of abandoned application Serial No. 278,302, March 24, 1952. This application November 18, 1955, Serial No. 562,369

10 Claims. (Cl. 51—298)

This invention relates to abrasive cloth and method of manufacturing the same. More specifically, the invention is concerned with abrasive cloth wherein the cloth is partially filled with starch base material and has the abrasive grains attached by a synthetic resin bond.

This application is a continuation of our copending application Serial No. 278,302, filed March 24, 1952, now abandoned.

Abrasive cloth, of which the product commonly known as "emery cloth" is an example, has been made for a great many years using animal glue as the bond for attaching the grains to the cloth. The cloth is commonly a very high grade cotton drill, jeans, or similar weave which is made by first shrinking and dyeing a woven material known as "grey goods" and then treating the cloth with aqueous dispersions of various kinds of filling material such as starch, glue, or clay, and drying the cloth under tension. The cloth thus prepared is then coated with a hot aqueous dispersion of animal glue and abrasive grains are applied to this glue "making" coat. The glue is dried enough to gel it to the point where it holds the grains to the backing and a second or "sandsize" coat of glue is then applied over the abrasive grains to anchor them more firmly to the cloth. The product is then dried and cut up into rolls, sheets, discs, belts or other suitable shapes.

More recently abrasive cloth has been made with a synthetic resin bond such as a phenol-formaldehyde condensation product for attaching the abrasive grains to the cloth. These resins do not adhere to the starch and glue-filled cloth commonly used for making the glue bond abrasive cloth and it has therefore been necessary to fill the grey goods with other materials to which the resin bond would adhere. Numerous patents on special treatments for cloth to be used in making resin bonded abrasive cloth have been issued in which various synthetic resins and elastomers are described. Typical of such patents are Kugler et al. Patents 2,357,335 and Oakes 2,357,350.

The abrasive cloth made with the synthetic resin or elastomer filling materials and with the synthetic resin bonds is waterproof and has been made in substantial quantities in the past few years. Although it was originally made with the idea of using it in the presence of water as a coolant it has been found that such products have uses where coolants are unnecessary and there has consequently been a demand for a resin bonded abrasive cloth which would have the improved life and efficiency which come from the use of a heat-hardened resin bond but which would not necessarily have to be waterproof. The synthetic resin bonds do not soften in use as glue does and consequently they do not load up with the detritus formed in an abrading operation. However, products made with such bonds have been more expensive than glue bond material not only because of the cost of resin bond and treatment needed to heat-harden it but, additionally, because of the more expensive treatments

2

applied to the cloth. Furthermore, unless a cloth is treated with a relatively inelastic material it will stretch when made into a belt and be unsatisfactory for that reason. On the other hand, if inelastic filling materials are added to the cloth the cloth is necessarily stiffened to a considerable extent and this is also undesirable.

It is accordingly an object of the invention to make abrasive cloth in which the cloth backing is filled with starch base materials similar to those used in making glue bond abrasive cloth but having the grains bonded to the cloth by a synthetic resin. Another object of the invention is to provide a method for making such a product. Still another object of the invention is to provide a synthetic resin bonded abrasive cloth in which the cloth is preliminarily filled with starch or similar materials and then pretreated with a particular type of resin to an extent sufficient to provide an anchorage for the resin bond without substantially affecting the flexibility of the product.

We have discovered that if cloth prepared in a conventional way for use in making glue bond abrasive cloth is preliminarily treated with a very thin and "green" synthetic resin and the thus-treated cloth is given a preliminary heat-treatment to solidify and slightly advance this treatment resin a backing is obtained which can be subsequently coated with synthetic resin bond and abrasive grains according to practices common in the manufacture of resin bonded abrasive cloth.

In the accompanying drawings:

Figure 1 represents in plan view a portion of our abrasive cloth comprising a cloth base having a layer of abrasive grains attached by a heat-hardened resin to a cloth backing which has been filled with a starch-base filling material and then impregnated with a heat-hardenable synthetic resin;

Figure 2 represents in enlarged cross-section the cloth backing filled with the starch-base filling material; and

Figure 3 represents in enlarged cross-section the cloth backing of Figure 2 after it has been impregnated with a heat-hardenable synthetic resin.

The invention will be illustrated by reference to specific examples but it is to be understood that the scope of the invention is not to be limited thereto.

### Example 1

A cloth backing suitable for making resin bond abrasive cloth was prepared by first dyeing and drying a drill cloth 42 inches wide having a thread count of 76 x 48 with 14's warp threads and 12's fill threads and of such weight that 1.97 yards of cloth 42 inches wide weighed 1 pound. This cloth is one which has been used for a great many years in the manufacture of both glue bond and resin bond abrasive cloth.

The dyed cloth was then dip sized by immersing in an aqueous dispersion containing 22% solids by weight, the solids being of the following composition:

	Percent
Borated dextrine.....	5
Thin boiling starch.....	10
Pearl corn starch.....	60
Hide glue.....	25

This wet cloth was then dried under tension and again dip sized and dried, the tension being sufficient to reduce the width of the cloth after the second dry from 42 inches to 36½ inches. These treatments resulted in adding 5 pounds of solids per sandpapermaker's ream of 480 sheets 9 inches x 11 inches. The original cloth weighed 16 pounds per ream and the thus-treated cloth 21 pounds per ream.

The cloth thus prepared was roll sized on the coat side (the side on which the abrasive grain is to be applied)

with a very thin "green" phenol-formaldehyde resin, 4.5 pounds per ream of the liquid resin being applied at a temperature of 110° F. It was then dried for 2½ hours at 175° F. at which time the material was tack-free but the resin was still heat-fusible and water-sensitive.

The resin was a liquid phenol-formaldehyde condensation product to which had been added 0.5% of a wetting agent sold as "Aerosol OT," which is said to be the dioctyl ester of sodium sulfosuccinic acid. The resin contained 67% solids and had a viscosity of 100 centipoises at 25° C. and infinite water tolerance. It contained substantial amounts of phenyl alcohols and was prepared according to the following procedure:

A vessel equipped with a reflux condenser, agitator and thermometer was charged with the following materials, all parts being by weight:

Liquid USP phenol (90%) .....	1254
36.8% aqueous formaldehyde .....	1168
Ba(OH) <sub>2</sub> ·8H <sub>2</sub> O .....	56.4
Diethylene glycol .....	112.8

The mass was heated at a substantially uniform rate of increase in temperature up to a temperature of 60° C. over a period of 2 hours and 13 minutes. When that temperature was reached vacuum was applied to dehydrate the mass, the reaction temperature being held at 60° C. throughout the dehydration. Dehydration was continued for 5 hours whereupon the resin was removed from the vessel and stored under refrigeration to prevent further reaction.

The cloth which had been prepared as described above was then coated with abrasive grain according to the following procedure. A making coat was prepared from a phenol-formaldehyde resin obtained by further advancing the resin used to presize the cloth to the point where it had a solids content of 72% and a viscosity of 6000 centipoises at 25° C. and mixing with ground calcium carbonate in the proportions of 55% by weight of the liquid resin and 45% by weight of calcium carbonate. The calcium carbonate filler had an average surface diameter of 14.7 microns and was of the character described and claimed in United States Patent No. 2,322,156. In addition, the making coat contained 15% by weight of ethylene glycol and 0.5% by weight of the Aerosol wetting agent described above, the percentage being based on the weight of the liquid resin. The mixture was then cut with water to a viscosity of 2000 centipoises at 90° F.

This making coat was applied to the coat side of the cloth in the amount of 12 pounds per ream (sandpaper-maker's), wet weight, and while the making coat was still liquid 60 grit fused aluminum oxide abrasive grain was applied to the extent of 33 pounds per ream. The product was dried at this stage for 1½ hours at 175° F. at the end of which time the making coat had set up sufficiently to hold the abrasive grain so that the sandsize coat could be applied.

A sandsize was then prepared having the following composition:

	Percent
Liquid resin of the making coat.....	38
Calcium carbonate filler.....	62

This mixture was then diluted with ethylene glycol and Aerosol in the proportions described in connection with the preparation of the making coat and the whole mixture was then cut with water to a viscosity of 1000 centipoises at 90° F.

The sandsize coat was applied in the amount of 17 pounds per sandpapermaker's ream, wet weight, and the product was then dried for 7 hours at 175° F. It was thereupon taken down from the racks where it had been dried in festoons according to conventional practice and was wound into so-called "jumbo" rolls on a 6-inch core to a total outside diameter of 36 inches. The material thus rolled was then given an oven cure of 36 hours at

200° F. and 28 hours at 250° F. After this treatment the completed web material was cut into conventional belts, bands, and sheets according to standard practices in the industry.

The improvement resulting from the use of the thin liquid resin presize material is very striking. Prior to the development of our invention products had been made by dip sizing a backing containing glue and starches and prepared exactly as described above in hide glue to provide 3.5 pounds of dry glue to the cloth, bringing the weight of the cloth up to about 24 pounds. This cloth was then coated with resin bond and abrasive grains exactly as described above in connection with the invention and bands for use on a contact wheel were cut from it. A test of that material showed that after 7½ minutes the abrasive cloth had lost 42 grams and had removed 480 grams of steel. The loss of abrasive grain was so great at this time that the material was of no further value.

By way of comparison, products made in accordance with this invention and the specific example described above when tested in an identical manner showed a loss of only 16 grams and a cut of 4230 grams in 1 hour grinding time.

In our attempts to make a satisfactory backing of the character of this invention we experimented with a great number of treatment materials for application to the starch filled cloth and from our work it appears that it is necessary to use a hydrophilic resin in which a large part of the reaction product is in the form of molecules of relatively low molecular weight. An example of such resin is a phenol-formaldehyde resin which contains a large proportion of phenol alcohols or methylol phenols.

The hydrophilic character of the resin appears to be required in order to get a satisfactory wetting of the starch or other hydrophilic filling material in the cloth. One convenient way of measuring the hydrophilic character of the resin is to determine its water tolerance, which is done by adding water to the liquid resin until a precipitate is formed which does not redissolve upon agitation. When water is first added to the liquid the resin may become cloudy, but upon stirring the cloudiness disappears. Eventually there comes a time when the precipitate cannot be redissolved by agitating for a period of two minutes and the amount of water which is required to reach this stage is referred to as the water tolerance. It is commonly expressed as a percentage of the original liquid resin used.

The resin described in Example I had an infinite water tolerance but it is not necessary to use a resin quite so green as this. The following example describes the preparation of a slightly less hydrophilic resin which was found to be satisfactory for use in filling a cloth in the manner described in Example I.

#### Example II

The resin was prepared from the materials and according to the procedure described in Example I except that the mass was raised to a temperature of 70° C. in 1 hour and 40 minutes and evacuated while holding at that temperature for a period of 5 hours and 20 minutes. The completed resin had a viscosity of 200 centipoises, a water tolerance of 520% and contained 71.3% solids.

Instead of raising the temperature to which the reactants are brought, as was done in Example II, a further advancement of the resin may be brought about by holding the reactive mixture at a lower temperature. For example, a resin made as described in Example I but differing therefrom in being held at the reaction temperature of 60° C. for 2 hours was found to have a solids content of 69.2% but to be otherwise much like the resin of Example I. In this particular instance the time of raising to the reaction temperature of 60° C. was 2½ hours and a total of 7 hours and 7 minutes was required to evacuate at the 60° C. temperature.

In making the resins of the examples we employed barium hydroxide as the catalyst. Other catalysts which may be employed are ammonium hydroxide, amines and sodium or potassium carbonate or hydroxide. Where the more strongly basic catalysts are used the amount of catalyst is reduced to keep the pH of the resin down to the order of about 8.0. If the pH is raised it is more difficult to control the reaction and stop it at the desired point.

As is well known in the resin art, other procedures and other reactants as well as other catalysts may be employed to make the hydrophilic resins of low molecular weight which we use in our invention. For example, paraformaldehyde may be substituted for the aqueous formaldehyde or, for that matter, other aldehydes such as benzaldehyde or furfural and other phenols such as certain of the cresols may be substituted provided the materials and procedures employed are selected to result in the hydrophilic resins of low molecular weight, such procedures and materials being well known in the resin art. We may also use synthetic resins of other types such as dimethylol urea, a very slightly reacted urea-aldehyde or melamine aldehyde resin, or even a dilute solution of resorcinol and formaldehyde always provided that the reaction products are hydrophilic and of low molecular weight.

Although the making and sandsizing resin used in the specific example were identical with the treatment resin applied to the cloth except that they were further advanced, it is not essential that the same resin be employed for this purpose so long as a resin is used which is compatible with the treatment resin. Consequently other variations of the making and sizing resins including resins of other types such as the urea and melamine formaldehyde resins may be made without departing from the invention.

In our example we described the use of the making and sandsizing bonds which contained a substantial amount of inert filling material. While the use of such filler is advantageous it is not essential in the invention and thoroughly satisfactory products can be made with the use of other fillers or without any fillers at all.

In describing the preparation of the completed product we referred to particular heat treatments and specifically to a final cure in the form of a roll. Other methods of curing and other heat treatment cycles may be employed without departing from the invention so long as they result in a final cure of the resin treatment and bond coats to substantially the well-known "C" stage.

Other kinds of cloth may be employed and of course a wide variety of kinds and sizes of abrasive grains may be used in making products under our invention in accordance with practices well known in the art without departing from the spirit of the invention the scope of which is defined in the appended claims.

We claim:

1. A coated abrasive article comprising a cloth backing having a layer of abrasive grains attached to a surface thereof by a heat-hardened synthetic resin bond, said cloth containing a hydrophilic filling material comprising essentially a major proportion of starch  $(C_6H_{10}O_5)_n$  in and around the threads which make up the cloth and a heat-hardened synthetic resin filling material, which in its

uncured condition was hydrophilic and of low molecular weight, and which is compatible with the resin bond and which surrounds the filled threads and at least partially fills the interstices therebetween.

2. A coated abrasive article as claimed in claim 1 wherein the synthetic resin filling material is a one-stage phenol-formaldehyde condensation product.

3. A coated abrasive article as claimed in claim 2 wherein the synthetic resin bond is a heat-hardened phenol-formaldehyde condensation product.

4. A coated abrasive article as claimed in claim 3 wherein the hydrophilic filling material constitutes about 28-32% by weight based on the weight of the unfilled cloth.

5. A coated abrasive article as claimed in claim 4 wherein the synthetic resin filling material constitutes about 16-20% by weight based on the weight of the unfilled cloth.

6. A coated abrasive article as claimed in claim 5 wherein the hydrophilic filling material comprises approximately 60% pearl corn starch and 25% hide glue by weight.

7. Method of making a coated abrasive article which comprises preliminarily filling a cloth backing with a starch base filling material dispersed in water, drying the cloth under tension to reduce the width by approximately 12-15%, presizing the thus filled cloth with a liquid heat-hardenable hydrophilic synthetic resin filling material of low molecular weight, heat-treating to solidify the resinous filling material, coating the thus treated cloth on the pre-sized side with a heat-hardenable synthetic resin bond which is compatible with the resin filling material and with abrasive grains, and heat-treating the article thus formed to heat-harden the synthetic resin filling material and the synthetic resin bond.

8. Method as claimed in claim 7 wherein the synthetic resin filling material is a hydrophilic one-stage phenol-formaldehyde condensation product containing a substantial amount of phenyl alcohols and having a solids content of about 60-75% by weight and a viscosity of about 100 centipoises at 25° C.

9. Method as claimed in claim 8 wherein the aqueous dispersion of the starch base filling material contains about 20-25% solids by weight and is added in an amount sufficient to leave about 28-32% solids by weight based on the weight of the unfilled cloth.

10. Method as claimed in claim 9 wherein the synthetic resin filling material is added in a quantity sufficient to leave about 16-20% resin solids by weight based on the weight of the unfilled cloth.

#### References Cited in the file of this patent

##### UNITED STATES PATENTS

1,954,805	Drew	Apr. 17, 1934
2,128,905	Benner et al.	Sept. 6, 1938
2,354,350	Oakes	Sept. 5, 1944
2,398,224	Hackett	Apr. 9, 1946
2,414,474	March	Jan. 21, 1947
2,477,407	Grant et al.	July 26, 1949
2,534,805	Waterfield	Dec. 19, 1950
2,534,806	Webber et al.	Dec. 19, 1950