Oct. 25, 1949. N. E. OGLESBY 2,485,765

COATED ABRASIVE

Filed Aug. 10, 1942

Fig. 1.

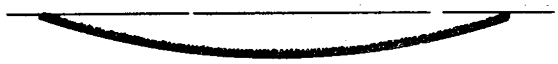


Fig. 2.

Fig. 3.

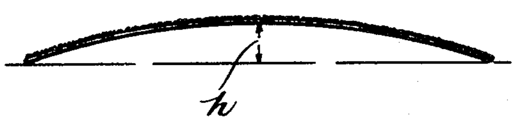


Fig. 4.

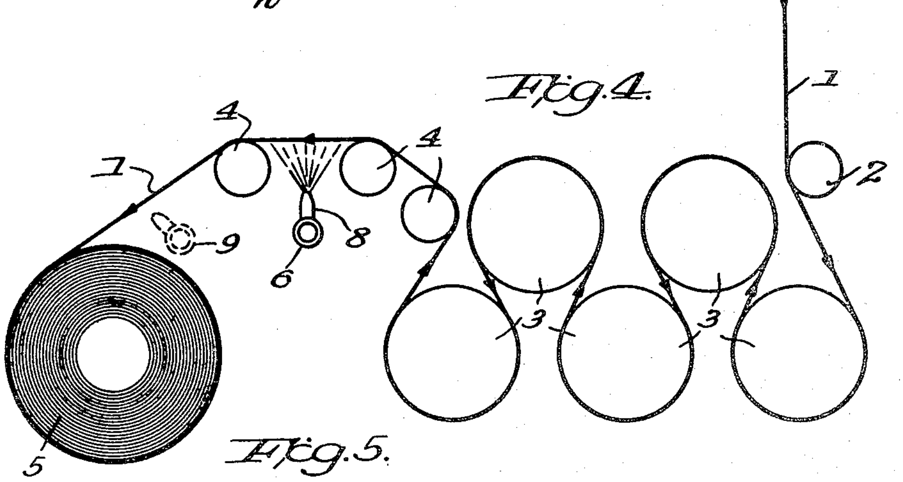
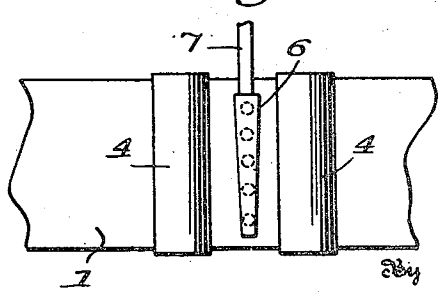


Fig. 5.



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UNITED STATES PATENT OFFICE

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COATED ABRASIVES

Nicholas E. Oglesby, Troy, N. Y.

Application August 10, 1942, Serial No. 454,316

5 Claims. (Cl. 51—195)

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This invention relates to the manufacture of coated abrasives and with regard to its more specific features to correcting the curling of coated abrasives during and subsequent to their manufacture.

This application is a continuation-in-part of Serial No. 124,508, filed February 6, 1937, now Patent No. 2,302,711, dated November 24, 1942.

It is an object of the present invention to control the curl of coated abrasives to provide a coated abrasive which is flat at some definite humidity. It is a further object of this invention to produce a coated abrasive, the abrasive surface of which exhibits convex curl instead of a concave curl; such an abrasive may be conveniently designated as having a "sand convex-curl." It is a further object of this invention to produce a coated abrasive which will be sufficiently flat for practical use at customary temperatures and humidities encountered in use. Still another object of this invention is the provision of a process for shrinking the reinforcing backing to dimensions which are approximately equal to or slightly less than those of the abrasive-adhesive coating. A further object of the present invention is to relieve the strains set up between the reinforcing backing and the abrasive-adhesive coating which ordinarily cause curling, warping and other such undesirable phenomena. A specific object of the present invention is the control of the curl of coated abrasives made with non-hydroscopic binders such as synthetic resins; e. g., the phenolic resins, the alkyd resins and urea-formaldehyde resins.

Another object of the invention is to provide a produce with one or more of the advantages cited. Another object of the invention is to provide a process by which one or more of the advantages indicated may be attained.

This invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts, and in the several steps and relation and order of each of said steps to one or more of the others thereof, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In carrying out the invention, I make use of any known machine for the production of coated abrasives and use any known method of applying the grits. In one form the present invention includes dispersion of the grits with orientation by means of an electrical field as described in the patents to Elmer C. Schacht, Patents Nos. 2,027,307 and 2,027,309 of January 7, 1936. A pre-

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ferred form of using the process of electrical dispersion comprises an operation wherein the adhesively coated backing, the adhesive face downward, is disposed above a belt carrying the abrasive grains and the two are passed simultaneously and in close proximity between electrodes constituting a field, preferably an electrostatic field. The effect of the field is to raise the grains against gravity and space them approximately equi-distant from each other with their long axes substantially perpendicular to the backing.

This orientation for many purposes gives the most effective performance of the final abrasive product. It is a feature of the present invention to control the curl of the abrasive so that the oriented abrasive grains may be more effectively presented to the work.

A feature of the present invention is the provision of a means of shrinking or otherwise controlling or adjusting the final dimensions of the backing to such an extent that under ordinary conditions of use, i. e., common relative humidities and temperatures, the said dimensions are equal to or slightly less than the dimensions of the abrasive adhesive coating under the same conditions, whereby the coated abrasive will either be relatively flat or show a controlled and desired amount of sand convex-curl. This control or adjustment is accomplished by subjecting the cellulosic backing to treatment with a volatile swelling agent for cellulose as will be hereinafter described.

A practical solution of the problem of controlling the curl of coated abrasives made with a non-hygroscopic binder and a cellulosic backing necessitates the production of a coated abrasive article which is free from a material degree of sand concave-curl and is either relatively flat or shows a moderate and controlled degree of sand convex-curl under common variations in atmospheric conditions that are encountered in practice. For most purposes, this result is attained when the coated abrasive is either substantially flat or shows a moderate degree of sand convex-curl between relative humidities of 15 and 60% and at working-room temperatures such as, for example, 70° F. Such limitations of humidity include common or average conditions in use, i. e., common or average variations of the atmospheric conditions or relative humidity. Where reference is made in the specification and claims to common or average conditions of use, or to common or average variations in relative humidity, is meant that the product exhibits the characteristics specified largely throughout the humidity range above set forth. In other words, the abrasive product is of a character which does not have a concave abrasive surface under ordinary working conditions. Such limits of humidity include common conditions in use, and the average of such conditions would be considered average variations of atmospheric conditions.

I have provided a means of shrinking the cellulosic backing such as a waterlaid sheet of paper, "vulcanized fibre" and the like or a woven fabric such as cotton cloth or a combination of a woven and waterlaid backing. The exact means by which my process is carried out varies somewhat according to the nature of the materials being used and the manufacturing process. By "cellulosic" or "paper" backing, I mean ordinary paper suitable for coating abrasives as well as suitably treated papers, for example, vulcanized fibre, also laminated backings containing one of the aforesaid paper materials combined with either cloth or another paper or cloth.

Referring to the drawings:

Figure 1 is a sectional view of a coated abrasive having a sand concave-curl.

Figure 2 is a sectional view of a coated abrasive which is devoid of curl.

Figure 3 is a sectional view of a coated abrasive having a sand convex-curl, in which h, the altitude, is used as a measure of the degree of convex curl.

Figure 4 is a diagrammatic view showing one method of carrying out the present invention, and

Figure 5 is a detail view of the spray device employed in connection with Figure 4.

Coated abrasive Example 1

In this case we may use by way of illustration, a binder which can be cured at a temperature below the boiling point of water. An example of such a binder may be prepared by cooking an oil soluble phenolic resin such as "Bakelite" resin No. 254 with China-wood oil as is well known in the varnish making art to produce a binder which for some uses may contain about 40% Bakelite resin and 60% China-wood oil. Suitable driers such as a manganese drier, as well known in the art, may be added.

I may also use a binder consisting of Bakelite resin #254, 35%, an alkyd resin 30% (such as "Rezyl" 408, obtainable from the American Cyanamid Company) and China-wood oil 35%. Rezyl 408 consists of about 50% oil acids and about 50% glycerine-phthalic anhydride condensation products and is prepared by methods known in the manufacture of such alkyd resins. To this binder I may add manganese resinate, or a mixture of cobalt and lead driers, in accordance with the known art.

Both of the foregoing binders may be conveniently dried at elevated temperatures but below the boiling point of water. I have found temperatures of from 160–190° F. effective, but lower temperatures or slightly higher temperatures may be used.

In the preparation of the foregoing resinous binders they are cooked to a viscous condition such as that represented by a Gardner-Holdt viscosity of Body O when thinned to 60% with high flash naphtha and tested at a temperature of 77° F.

By way of illustration, I may use either of these, or similar binders on a conventional sandpaper machine as illustrated in the patent to Nicholas E. Oglesby, No. 2,184,896, issued November 26, 1939 to coat No. 320—C silicon carbide paper.

A suitable paper backing is 70 lb. kraft paper which is prepared in accordance with the needs of the present sandpaper art, and a suitable treatment of the paper on the coat side before coating is heavy blown China-wood oil which is added to the extent of about 15% of the paper weight to seal the pores of the paper and prevent penetration of the binder applied to hold the abrasive grains. The oil may be used as such or thinned with a solvent such as "Varnolene," or high flash naphtha, and coated at a temperature of about 140° F. The paper treatment may be applied with conventional coating rolls and the paper is then preferably passed into a sandpaper drying room and dried in festoons at a temperature of about 130° F. for a period of from about 4½ to 24 hours, depending upon the nature of the China-wood oil used and the amount of drier used therein. Where heavy blown China-wood oil is used and the longer drying time can be allowed, I prefer to use no drier but where it becomes necessary to decrease the time of drying, about .3 to 1% of a manganese or cobalt drier may be added to the oil.

After the treated paper has been dried and cured it is removed from the racks in the form of rolls, and is then ready for application of the binder for the grits. Either of the binders given by way of illustration may be used and a suitable concentration for this grit number may be prepared by thinning the binder as prepared to a solids content of about 67%, with a solvent such as high flash naphtha. A suitable temperature for application of the binder is 160° F. and the binder may be applied with conventional sandpaper coating rolls. After the binder is applied, a layer of the grit, in this case #320 silicon carbide, is applied to the binder in any of the conventional ways but I prefer to use the new electrostatic methods disclosed in the before-mentioned patents to Elmer C. Schacht.

After the grit has been applied, the coated web is carried into a conventional drying room and dried for a period of about 24 hours at a temperature of 160° F. to a temperature of 190° F. After the binder coat has been cured, a second or sizing coat of adhesive is applied which may be the same binder as used for the making coat or a somewhat different binder. In any case, however, the sizing adhesive should be thinned to a lower viscosity than the making coat of binder. A suitable sizing adhesive for grit 320 may be prepared by thinning either of the binders given by way of illustration to a solids content of about 52%, with high flash naphtha. The sand sizing coat is applied with conventional sandpaper coating rolls, and a suitable temperature for the application of the sand sizing coat is about 140° F. After the sand sizing operation, the coated web is moved into a conventional sandpaper drying room and cured in the form of festoons. Suitable curing times for the item given by way of illustration are 24 to 36 hours, and suitable curing temperatures are from 160–190° F.

After the sand size has been cured and the making coat has been further cured after sizing, as indicated, the goods are removed from the racks in the form of rolls. A product so made when cut up into conventional sheets, belts or discs will show a sand concave curl and this has been the customary result before by invention, which contemplates the shrinkage of the cellulosic backing to the approximate dimensions of the adhesive-abrasive coating or to slightly lower dimensions. I may materially decrease the sand concave-curl, or produce instead thereof, a flat sand surface or a sand convex curl by superimposing upon the process just described, my special treatment. One method of applying my treatment is to start with goods in the curing racks after the grits have been applied to the making coat of adhesive, that is to say, during the curing of the goods after sand application and before the sand sizing adhesive is added. From experience in the manufacture of this item by conventional methods or by a deliberate processing of a small quantity of goods by conventional methods, the approximate extent to which the backing swells and to which sand concave-curl results therefrom may be determined. Having determined the extent of curling of the paper subsequent to coating, I add to the drying racks and maintain during the drying period, a quantity of a swelling agent, e. g., moisture, such as water vapor in the form of steam or water vapor generated by atomizing or other suitable means, found necessary to expand, or swell the paper, or to keep the backing expanded to a point equal to or slightly greater than that to which it has been found to expand after heating through the curing cycle and later exposing to average atmospheric conditions. Usually it will be found satisfactory to measure the width of the uncoated paper when in equilibrium with average atmospheric conditions such as 50% R. H. and then maintain in the drying racks during the curing operation, enough water to prevent shrinkage of the paper, that is, enough water to maintain the width of the paper equal to or greater than its uncoated width when in equilibrium with a relative humidity of 50% and a temperature of 70° F.

After the sand size is applied and during the curing operation which takes place after sand sizing, water vapor should be added to the drying racks in sufficient quantity to prevent shrinkage of the paper. An indication that this is being accomplished will be the fact that the coated paper web is substantially flat and relatively free from curling in the racks, especially free from said convex-curling.

Where it is desired to produce a still greater degree of reversal of sand concave curl, a greater quantity of steam or water vapor should be introduced into the drying chambers where the goods are cured after grit application and after sand size application, and I regulate the quantity of water vapor in the drying racks according to the result that is desired. Greater quantities of water vapor or higher humidities give a greater swelling of the paper and a greater correction or reversal of the sand concave-curl of the finished product to produce a relatively flat sheet or a sand convex-curl, whichever is preferred for the particular product in question.

When the coated abrasive used by way of illustration is removed from the racks and allowed to come to equilibrium with average atmospheric conditions such as about 70° F. and 40% to 50% relative humidity, there will be little change in moisture content of the backing, or a loss in moisture rather than a gain, with the result that the coated abrasive will be flat or have a mild sand convex-curl.

While the foregoing procedure is simple and often serves my purpose well, it is not universally applicable. For instance, certain types of binders require oxygen for the best conditions of cure and a more or less complete replacement of air with water vapor results in a deficiency of oxygen. This condition occurs at the higher curing temperatures which approach the boiling point of water.

I have also discovered that at the high temperatures required to cure certain binders such as the phenol-formaldehyde binders, substantially complete replacement of the air with superheated steam, does not result in a material expansion of the paper. In other words, paper and similar cellulosic backings are not materially swelled by dry steam (or superheated steam) at temperatures of around 110° C. or higher.

A more generally applicable variation of my process of controlling the curl of coated abrasives made with a cellulosic backing and a non-hygroscopic adhesive consists in shrinking the cellulosic backing after the coated abrasive has been made in the usual way or according to the methods disclosed in the patent to Nicholas E. Oglesby, No. 2,184,896, issued November 26, 1939.

I may also correct the curl of the coated abrasive used by way of illustration in the foregoing Example 1 by shrinking the backing after the coated abrasive has been fabricated. Where this variation of my method of controlling curl is employed, the coated abrasive is made or cured as previously described except that it is not necessary to control the dimensions of the web during curing after grit application and after sand size application by the introduction of relatively large quantities of water vapor into the curing racks. After the final curing operation the coated abrasive web is taken down in the form of rolls. Just prior to taking down in the form of rolls, or conveniently during the taking down process, or subsequent to the taking down in rolls, I apply a controlled amount of a swelling agent such as water or other cellulose swelling liquid to the back of the abrasively coated web, that is, to the side opposite to that coated with sand. A convenient method of applying water to the back of the web is by a set of spray nozzles spraying into the crotch of the roll at the takedown where the roll is being wound up. I may also use a felt roll which runs in a water trough and touches the back of the coated abrasive web as it is rolled up. Other methods of wetting the backing will occur to those skilled in the art.

A very satisfactory method of carrying out this variation of my invention is shown in Figures 4 and 5. In both figures, the same numbers refer to identical parts. 1 is a coated abrasive web being drawn from the curing room, not shown, in the direction of the arrows. 2 are idler rolls used to guide the web. The numeral 3 represents friction drums used to regulate the tension on the web. Numeral 4 represents additional idler rolls used to guide the web and 5 represents a roll of coated abrasive being wound up in the usual way. 6 represents a manifold connected by a pipe 7 to a water line, not shown, and having a multiplicity of spray nozzles 8 which are directed upwardly against the backing of the coated abrasive web. The water is under any suitable line pressure which may vary according to the type of spray nozzle used. Many commercial spray nozzles will be found satisfactory. Instead of having the manifold 6 positioned between the rolls 4, in some cases, I position it so as to spray into the crotch formed between the web 1 and the roll 5, as shown in dotted lines at 9. Generally, I prefer to apply the spray in close proximity to the crotch as this prevents evaporation of the water prior to rolling up and soaking in. If the water is applied in such positions it will also usually be found easier to roll up the web.

I may also first take the roll of coated abrasives down and in a subsequent re-rolling operation, apply water to the back of the coated web, or I may add water to the back of the coated web by any convenient means prior to the taking down operation, after which the web may be dried and rolled up or rolled up and subsequently dried. The water should be uniformly applied to the backing and allowed to soak in. After the water has soaked into the web; e. g., after about two hours, the web may be dried as by rehanging in festoons or any convenient method, or the coated abrasive may be cut into sheets, discs, or other forms, and these final forms of the coated abrasive may be allowed to dry.

I vary the water added to the backing according to the product being made and according to the extent to which I wish to reverse the normal sand concave curl. Usually water to the extent of 10% to 30% of the weight of the cellulosic backing will be found effective. Within limits, the correction of curl will vary with the amount of water added to the backing, but once 25 to 35% of water, based upon the weight of the cellulosic backing, has been added to the coated web, the use of additional quantities of water will usually serve no useful purpose in increasing the correction or reversal of curl but may be a disadvantage, as a greater quantity of water will have to be removed in the subsequent drying operation, thus increasing the difficulties and the expense of the drying operation. Furthermore, the use of excessive quantities of water may result in undue softening of the backing; e. g., paper, making it difficult to handle without tearing or other injury.

Coated abrasive Example 2

Mix phenol 100 parts by weight, Formalin 187 parts by weight, and barium hydroxide 6 parts by weight, and heat for four hours at 60–65° C. Apply 25–28" vacuum and heat to 110° C. Hold under vacuum at this temperature until a drop in ice water is brittle. Then add alcohol (denatured) 40 parts by weight to dissolve the condensation product and cool the mass.

If a lower viscosity is desired, more solvent may be added or conversely less solvent may be used for higher viscosities.

The resin itself when made in accordance with Coated abrasive Example 2 if substantially completely dehydrated is a solid at ordinary temperatures. The resin of Coated abrasive Example 2 is remarkably free of penetration into the base at coating concentrations and, therefore, when this resin is used, there is no objectionable brittlizing due to impregnation.

The foregoing resinous adhesive may be used in the manufacture of grit 0–90 fused aluminum oxide paper as described in the patent to Nicholas E. Oglesby, No. 2,184,896, issued November 26, 1939. For this purpose, the resin is prepared to contain approximately 75% solids and 25% solvent such as alcohol.

The adhesive is applied to a backing such as 130 lb. rope cylinder paper at a temperature of about 120–130° F. and the grits previously heated to about 158° F. are applied to the adhesively coated web by electro-static means, all as shown in detail in the said co-pending application. The coated abrasive web, while traveling, is then, if necessary, treated as for example by evaporation to increase the viscosity of or rigidify the resin bond, after which it passes into a coated abrasive drying room where a critical curing cycle is applied. A suitable cycle for this particular grit and adhesive is one hour at about 75° F. and then 18 hours at 160° F. followed by an intermediate heating step for one-half hour at 140° C., as described in the patent to Oglesby, No. 2,184,896, issued November 26, 1939.

After the heating cycle is completed, a second or sizing coat of resin is applied as by spraying or as by adhesive coating rolls. A suitable resin for the sizing operation is prepared from the resin described under Example 2, by diluting to a solids content of about 55% with ethyl alcohol. The sizing coat may be satisfactorily applied at a temperature of around 70-80° F.

After the sand sizing operation, the coated web is again passed to a sandpaper drying room and festooned. A satisfactory drying cycle for this particular product after the sizing operation is one hour at room temperature, about 75° F., then eighteen hours at 160° F., followed by one and three-quarter hours at 140° C.

The initial low temperature curing conditions insure the maintenance of the grits in substantially their initially applied positions and the final high temperature develops toughness and the tensile strength of the binder.

It will be appreciated that many variations can be made in the process, provided the essential and critical conditions are maintained. The viscosity of the adhesive during and immediately after sand application, as well as the temperature provided for drying and curing the resin subsequent to the cooling operation which takes place after the sand application, are all critically controlled as described in the patent to Nicholas E. Oglesby, No. 2,184,896, issued November 26, 1939.

The goods made and cured as described may now be rolled up while hot in the form of a roll with conventional takedown equipment. The web may now be passed between coating rolls and a thin coating of water may be applied to the back, that is, the side opposite to that to which the abrasive grain is applied. Instead of using coating rolls I may use sprays to apply the required quantity of water or other cellulose-swelling liquids, or I may pass the web into an atmosphere of condensing steam or otherwise add the required quantity of water. After wetting the back the web is again rolled up and the water is allowed to penetrate evenly throughout the cellulosic backing. The quantity of water coated to the backing is governed by the result that it is desired to obtain and must be varied according to the nature of the cellulosic backing used, and cold or hot water may be used. Hot water is normally more rapid in penetrating and swelling the paper. In the present example where a normal or usual 130 lb. Cylinder sandpaper, as used in the coated abrasive industry, is employed as a backing, water may be added so that the total water in the cellulosic backing varies from about 10% to about 35% according to the result that it is desired to obtain.

After the water or other suitable liquid has been allowed to thoroughly penetrate into the paper, the web may be rehung and dried or it may be cut into sheets, discs, narrow strips or rolls or other forms desired for final use and these final forms may be allowed to dry or be dried.

According to the amount of water added and the treatment of the web after adding water, there will be a greater or less correction or reversal of curl. Everything else being equal the reversal of curl will be greater the greater the quantity of water added up to about a total moisture content of 30%. The addition of greater quantities of water will normally serve little or no useful purpose in changing curl but will increase the difficulty of handling the web and of the drying operation.

Furthermore, if the coated abrasive is dried under tension, as for instance while held flat with weights, or when rolled up into a roll so that it cannot curl on an axis parallel to the machine direction, the reversal of curl will be less than if the coated abrasive is allowed to dry free without tension. As typical of one set of results obtained in the corrections or reversal of curl, 0–80 aluminous oxide coated abrasive made on 130 lb. cylinder paper backing as described in this example was treated with varying quantities of water and was then dried while wrapped up in a roll. The width of the web was 10″. After the web was dried, short pieces were cut and exposed to an atmosphere of 25% relative humidity at a temperature of about 70° F. and tested for curl characteristics. In all cases the normal sand concave curl had been corrected. Where the paper backing was treated so as to contain about 10% moisture, the strips came to equilibrium and produced a slight sand convex-curl, the segment of a circle formed by a cross section of the 10″ strip in the cross direction of the paper and a line drawn from one edge of the curled paper to the other (dotted line in Figure 3) having an altitude (h in Figure 3) of about 1″; where the paper was treated to have a moisture content of about 15% the altitude of the segment was about 2½″; where the paper was treated to have about 26% water, the altitude of the segment was about 3″. All of these are slight but not objectionable sand convex-curls. At higher humidities than 25% the sand convex curl is less, the foregoing mild sand convex curls at low humidities being considered typical of a product desirable for many purposes.

Coated abrasive Example 3

Suitable adhesives for coated abrasive Example 3 may be made as follows:

Resin Example A.—Heat together to 100–110° C. while stirring, phenol, 100 parts by weight, and sodium hydroxide (solid) .86 parts by weight, and hold at 100–110° C. for 15 minutes to dissolve the sodium hydroxide. Then cool to 50° C. and add slowly while stirring, paraformaldehyde, 30 parts by weight.

While stirring raise the temperature slowly over about 70 to 75 minutes to about 120° C. and hold at 100–120° C. for about half an hour or until cooled sample is of desired viscosity. The mass is not allowed to boil so that the reaction will not become violent and uncontrollable.

Instead of using paraformaldehyde as illustrated in Example 1, I may also use formaldehyde and secure equivalent results. In still another variation, a part or all of the formaldehyde may be replaced with hexamethylene tetramine.

Resin Example B.—A satisfactory method of preparing a resin with a lower viscosity than Example A is as follows:

Heat together to 100–110° C. while stirring phenol, 100 parts by weight, and sodium hydroxide (solid) .86 parts by weight, and hold at 100–110° C. for 15 minutes to dissolve the sodium hydroxide. Then cool to 50° C. and add slowly while stirring, paraformaldehyde, 30 parts by weight.

Apply a slight vacuum (about ½″ to 1″) and raise the temperature slowly over one to one and one-quarter hours to 100° C. Raise vacuum to 10–15″ until temperature is about 70° C. Hold at this temperature under vacuum until cooled sample shows desired viscosity. Then cool to 35° C.

The foregoing resin examples consist of Example A, a very viscous resin, and of Example B, a less viscous resin. These two resins may be blended to give a variety of viscosities useful for coating a number of coated abrasive products.

These resins may for example be used in coating #24 fused aluminous oxide abrasive. A fabric backing may be selected from various types of paper and combinations of cloth and of paper and of cloth and "vulcanized" fibre. For the manufacture of #24 fibre backed discs with a resinous binder, a preferred backing is described in a co-pending application of Oglesby, Reilly and Gilbert, Serial No. 124,506, filed February 6, 1937, which issued as Patent No. 2,333,034, dated October 26, 1943.

The preferred backing consist of one lamina of vulcanized fibre of about 10 mils in thickness and weighing about 200 lbs. per paper ream to which is adhesively united a de-sized drill's cloth under conditions which prevent blisters and separations of the laminae. A suitable adhesive for the laminating operation is Resin Example A or resin Example A thinned with Resin Example B. After laminating, the web is preferably partially cured to a highly adhesive but relatively flexible condition.

Vulcanized fibre is a term applied to a hard, horny paper-like material which is generally produced by manufacturing paper from cotton rag stock and then subjecting the rag paper to an action known as vulcanizing which consists of an appropriate treatment with sulphuric acid or more commonly with a solution of zinc chloride, whereby the cellulose is more or less gelatinized but generally without complete disintegration of the individual fibres. After the gelatinizing action, the web is washed thoroughly to remove all traces of sulphuric acid or zinc chloride as the case may be, as the presence of even minute quantities of these materials will result in a rapid deterioration of the product as, for example, loss of strength.

The combination web prepared as described and as given in further detail in the said copending application is removed from the curing racks and is ready for coating. While either side of the resin may be coated, I generally prefer to coat the cloth side of the combination.

A suitable adhesive for the manufacture of #24 aluminous oxide is illustrated by Resin Example A or by a mixture of Resin Example A and Resin Example B. A diagrammatic illustration of equipment suitable for processing this item with these resins is shown in the patent to Nicholas E. Oglesby, No. 2,184,896, issued November 26, 1939.

The adhesive used for anchoring the grits to the backing (the making coat) may be Resin Example A or Resin Example A thinned with a small quantity of Resin Example B. The adhesive is applied with coating rolls, as for instance, at a temperature of 150–160° F. A suitable weight of adhesive for this particular case is about 22 lbs. per sandpaper ream. The adhesively coated web passes under a sandfall where an excess of grits is applied at a temperature of about 150° F. After the sand is applied in excess of that required for the coating, the adhesively coated web carrying some excess sand passes into nip rolls where the sand is pushed into the adhesive. The coated web may then pass around a sand drum where there is a further pushing in of the abrasive grains. The coated web then passes over a suction drum which is used to pull the web through the machine and from the suction drum the web is conveyed by conventional means to a sandpaper drying room where it is festooned and heat is applied through a critically controlled curing cycle.

For the adhesive and method used by way of illustration, a satisfactory drying cycle is found to be 105° F. for 2 hours; 110° F. for 1¾ hours; 115° F. for 2 hours; 120° F. for 2 hours; 125° F. for 2 hours and 130° F. for 4 hours. The goods may then be cooled to a temperature of around 70° to 80° F. to render the adhesive less tacky and then taken down in roll form or other conventional ways or if desired the web may be moved directly to the sizing apparatus and sized. A preferred method is to take down in the form of rolls and mount the rolls on a suitable bundle stand or other means in front of a coated abrasive sand sizing machine, where the sizing adhesive is applied by coating rolls. A satisfactory temperature for application of a sizing adhesive used in this case is 140–150° F.

A satisfactory adhesive for the sizing operation may be prepared by taking 60 parts by weight of Resin Example A and mixing with 40 parts by weight of the less viscous resin illustrated in Example B. For many applications, a satisfactory weight of the sizing material to be applied is 27 lbs. per sandpaper ream. After the sizing coat has been applied, as described on conventional sandpaper equipment, the sand sized web is then delivered by the usual means to a sandpaper drying room where it is festooned and where a heat cycle is applied. This cycle is critical to preserve orientation, the sized goods, as explained, being subject to flow with consequent dislocation of the adhesive and the abrasive grains. In the present illustration, a satisfactory drying cycle within the drying room is as follows: 100° F.—six and one-quarter hours; 105° F.—five hours; 110° F.—five and one-quarter hours; 115° F.—four and one-half hours; 120° F.—five hours; 125° F.—five and one-quarter hours and 130° F.—ten and one-half hours. After this drying cycle has been completed the goods should be cooled to a temperature of around 95° F. to reduce the tackiness of the adhesive so that the goods can be taken down in the form of rolls. Excessive cooling should be avoided as otherwise the goods will become too brittle for satisfactory taking down and winding up in rolls.

The goods, taken from the sandpaper drying room in the form of rolls, are then cut into satisfactory lengths or strips for a subsequent drying operation to finally cure the resin binder and develop high tensile strength of about 8000 to 14,000 lbs. per square inch or more. It has been found that a drying cycle of any commercially economical duration at relatively low temperatures will not produce the final cure of this resin which is required for maximum cutting efficiency and that the cut of the coated material is greatly increased by a high temperature drying cycle now to be described.

The strips cut from the rolls of coated goods are conveniently cured to the final condition by placing them on suitably arranged shelves within a baking oven which can be regulated within critical limits to obtain the desired temperatures and temperature control. A satisfactory final drying cycle for the strips is as follows: eight hours—70° C.; eight hours—80° C.; then gradually raise the temperature to 100° C. so that a temperature of 100° C. is reached within one hour; hold at 100° C. for one hour; raise during the next hour to a temperature of 120° C. and hold at 120° C. for one hour; during the next hour raise gradually to 140° C. and then hold at 140° C. for one hour; during the next hour raise gradually to 150° C. and then hold for three and one-half hours. Turn off the heat, open the oven and allow the strips to cool. The strips are then removed and are subsequently cut into conventional disc shapes or any other form that it is desired to produce as an abrasive article.

The strips as removed from the final high temperature bake are dry and relatively brittle. Prior to cutting into the form of discs they should be stored under light pressure to prevent excessive curling until they have taken up enough moisture from the atmosphere to reduce the brittleness of the dry backing, or a small quantity of water should be applied to the backing if it is desired to cut the strips before they have had time to pick up sufficient moisture from the atmosphere. In this case it is only necessary to apply water to the extent of about 7 or 8% of the weight of the vulcanized fibre in the backing, since in the process of combining and coating the cloth has become substantially impregnated with the resinous adhesive and is no longer subject to rapid changes in moisture content when exposed to variable humidities. Water to the extent of about 7 or 8% of the weight of the vulcanized fibre may be applied to the backing of the strips in any convenient way as by sponging, painting, spraying or passing through soft coating rolls as for instance, felt rolls, one of which turns in a trough of water. After the application of this water the strips should be stacked for a period of time to allow the water to soak into the vulcanized fibre; usually a period of time of two hours or more will suffice.

The strips are then cut into discs in the conventional way, and the backs of the discs are treated with a further quantity of water to bring the moisture content of the vulcanized fibre to from 10–25% of its weight. This water may be applied by means of a spray, by sponging, by painting, or by coating rolls or by other suitable means. The quantity of water added to the backs of the discs is regulated in accordance with the result that it is desired to obtain. The greater the quantity of water applied, the greater will be the correction or reversal of the sand concave curl, to produce a disc which is relatively flat at average temperatures and humidities or a disc which under these conditions will show a desired and limited degree of sand convex-curl.

Immediately after the backs of the discs have been wetted, the discs should be stacked one on top of the other and baled, as for instance, by applying end boards to each end of a stack of discs, placing in a baling press, pressing and fastening wire around the end boards. The pressure applied in the baling operation should not be enough to damage the discs to any material extent due to pushing the grains into the vulcanized fibre where the abrasively coated side of one disc comes in contact with the vulcanized fibre side of the other disc. The pressure should, however, be great enough to keep the discs substantially flat. The bales of discs preferably should not be wrapped or made impervious to circulation of air until after storage at ordinary atmospheric conditions for about one week. During this time a substantial part of the excess water in the backs of the discs will evaporate. Allowing the discs to dry while held under light pressure prevents warpage during drying and in fact materially reduces any warpage that may have occurred previously during the processing of the coated abrasive. Furthermore, if the discs are dried under light pressure and if by error excess water has been applied to the backing, the chance of excessive sand convex-curl in the final coated abrasive discs as used will be minimized. It should be appreciated that where the cellulosic backing such as paper or vulcanized fibre has been treated with a given substantial quantity of water, the reversal of curl will be less if the water-treated coated abrasive is allowed to dry flat under pressure than will be the case if the same or similar coated abrasive is allowed to dry without restraint and is therefore able to curl at will during the drying.

After the water-treated discs have been allowed to stand at normal atmospheric conditions for about one week, they may be wrapped in any way desired for shipment or storage. Where the discs are to be used for a dry sanding operation, no further treatment is required.

If, however, it is desired to use discs of the type described in an abrading operation where water is used as a lubricant or where the work is otherwise wet or under conditions whereby the disc might become wet, the backs of the discs should be given a waterproofing treatment to render them suitable for wet operations. I have found that a coating of paraffin emulsion will render the discs suitable for most wet abrading operations, but I may also waterproof the backing with various flexible varnishes, lacquers, e. g., nitrocellulose or cellulose acetate with suitable plasticizers, or resins, e. g. a resin consisting of about 50% oil acids and about 50% glycerine-phthalic anhydride condensation product, as above mentioned, all of which are commercially available. For some purposes, a coating of tung oil or linseed oil will be effective.

Where it is desired to waterproof the discs with a paraffin emulsion, I may add a paraffin emulsion in water to the backing of the discs in lieu of the pure water treatment used to correct the curl of the discs, thereby combining the control-of-curl step with the waterproofing step.

In the examples given by way of illustration, details have been given for the control or correction of curl by the use of a swelling agent for cellulose, e. g., water either in the form of vapor or as liquid. I may use other agents which are capable of shrinking cellulosic backings to the dimensions of the adhesive-abrasive coat or to dimensions which are slightly smaller than the abrasive-adhesive coating to produce a relatively flat coated abrasive or a coated abrasive with a controlled degree of sand convex-curl instead of the normal sand concave-curl obtained with coated abrasives made with a non-hygroscopic binder.

The rate at which a liquid penetrates into a cellulosic backing is governed to some extent by the surface tension of the liquid. The organic compound methyl alcohol readily penetrates cellulosic backings and has been found to function in a manner analogous to the behavior of water. Furthermore, methyl alcohol is quite volatile and is more readily removed from the backing than water. A suitable grade of methyl alcohol is 95% methyl alcohol, the remainder being mainly water.

Mixed liquids such as a mixture of ethyl alcohol and water or a mixture of acetone and water may also be used to control or reverse the curl of coated abrasives made with a water resistant or non-hygroscopic binder by applying these liquids to the backings of the previously fabricated coated abrasives. A suitable mixture of ethyl alcohol and water may be prepared by taking one volume of ethyl alcohol and one volume of water. Similarly, a mixture consisting of one volume of acetone and one volume of water may be used. These mixed solutions of alcohol and water or of acetone and water have been found in some instances to penetrate into and swell cellulosic backings more rapidly than pure water. Furthermore, volatile solvents such as acetone and alcohol are more quickly and readily evaporated from the backing than pure water.

The use of mixed liquids such as alcohol and water or of acetone and water in some cases makes it easier to control the extent of the reversal of curl in that a larger volume of the liquid as compared with pure water, may be applied to the cellulosic backing without a corresponding increase in the sand convex-curl obtained in the subsequently dried product.

It is believed that liquids which are suitable for the control of the curling of coated abrasives function by softening and swelling the cellulosic fibres and loosening the natural cementing cellulosic adhesive to an extent that some realignment of the fibres to relieve stresses and strains is possible. Regardless of the mechanim by which the correction takes place, the net result is a shrinkage of the cellulosic backing whereby sand concave curl is corrected and there is produced instead thereof, a relatively flat coated abrasive or a coated abrasive with a controlled and desired degree of sand convex curl about an axis parallel to the machine direction in the case of paper, vulcanized fibre backings or similar water-laid sheet.

As explained before, open coated abrasives made with a glutinous or similar hygroscopic binder and conventional paper, curl sand concave. Ordinarily it is not advisable to correct this curl by wetting the backing with water since wetting and subsequent drying results in some damage to the bond between the glutinous adhesive and the abrasive grains. Where correction of curl of open coat abrasives made with a glutinous binder is required, I may treat the backing with methyl alcohol, thereby doing less damage to the bond between the glutinous binder and the abrasive grains than is obtained where water is used for a similar purpose.

While I have referred herein to binders of the synthetic resin type and these are preferred, it is to be understood in some cases, we may use a varnish prepared from China-wood oil, rosin, suitable thinners, and dryers as is well known in the varnish making art. In like manner, in some cases, I may use a solution of shellac and alcohol and subsequently heat the shellac to harden and toughen it, and I may also add to the shellac suitable plasticizers. Natural resins have heretofore been used as components of binders in the coated abrasive art. The term binder as used in this application is intended to cover the various adhesives mentioned which are non-hygroscopic, as well as other binders which exhibit this characteristic.

In accordance with the present invention, there is obtained a coated abrasive in which the grit is adhered by a synthetic resinous bond and the backing may consist of paper, vulcanized fibre or cloth or be constituted by a combination of these materials united by a suitable binder preferably one of the synthetic resin type. It is an important characteristic of the preferred adhesive for the grit that the tensile strength thereof is above 6,000 lbs. per square inch and usually between 8,000 and 14,000 lbs. about per square inch. Further, the preferred synthetic resin bond for the grits is resistant to temperatures up to substantially 500° F. and is not affected by water or organic solvents. It is another important characteristic of the invention that the product has a substantial volume of the individual grits exposed above the average level of the adhesive layer which is free to engage the work, usually about ⅓ to ½ or more of the total volume of the grits will be above the average level of the adhesive layer. Also, it is preferred that between the base of the grit layer and the adjacent surface of the backing there is a definite continuous layer of the synthetic resin adhesive. These characteristics impart to products made in accordance with this invention a very high efficiency.

While the invention has been illustrated by cases in which the making and sizing coats of adhesive are both of similar material, e. g., glue or resin, it should be understood that I may also use, for example, a resin making coat and a glue sizing coat or a glue making coat and a resin sizing coat in binding the abrasive grits to the backing. In such instances I prefer to use for one of the coats a composition which is immiscible with the composition of the other coat, so that a making coat, for example, of either glue or resin, as the case may be, will not be softened by the sizing coat to an extent that would permit the movement of the abrasive grains from the positions in which they are deposited in the making coat during or as a result of the sizing operation.

As an illustration of this form of the invention I will describe by way of illustration, the manufacture of a #240 "E" tannery paper. As a backing I may use 130 lb. cylinder paper. To the backing I apply a coating of a resinous binder as, for example, a solution of an alkyd resin dissolved in high flash naphtha, a cyclic hydrocarbon solvent. The alkyd resin may consist of a condensation product of phthalic anhyride, linseed oil acids, China-wood oil acids and glycerine. Such a binder is described in Example II of U. S. Patent No. 2,004,466 issued June 11, 1935 to Joseph B. Dietz and Henry L. Plummer.

The binder is applied to the paper by conventional means and subsequently a coating of grit as, for example, No. 240 silicon carbide is applied by a known grain orienting method as, for example, a method involving the use of an electrostatic field aided by mechanical orientation. After the grains have been applied to the making coat of adhesive in oriented relation as just described, the web is passed to a drying room and the binder is cured, for example, for 24 hours at a temperature of about 160° F. The web is then removed from the drying room and passed through a set of conventional sandpaper sizing rolls where a sizing adhesive of hide glue dissolved in water is applied in the conventional manner. The web is then again moved to drying racks and dried at a low temperature to evaporate the water from the glue solution used as a sizing coat. The making coat of alkyd adhesive is insoluble in and unsoftenable by the sizing coat of glue dissolved in water and the orientation of the grits is well preserved.

The resinous adhesive solution dissolved in high flash naphtha used as a making coat readily forms a smooth film which is more level and freer from brush marks and similar imperfections than the glue films normally prepared for the reception of the abrasive grains in the manufacture of coated abrasives. With such smoother films, more level and perfect coatings, especially of the fine grits of coated abrasives are obtained. Where smooth coatings are desired, as is often the case in order to obtain a superior finish, the use of such a resin making coat in conjunction with a glue sizing coat is advantageous. If, on the other hand, as is sometimes the case, somewhat rougher coatings, which are more readily formed with glue, are desired, it is advantageous to use a glue making coat. It is to be understood that in either case the grains are oriented with their long axes substantially perpendicular to the backing. The greater smoothness with the alkyd resin coatings is attributed to the fact that the bottom ends of the grains, and therefore the top ends of the grains, are more nearly in the same plane in these coatings than in the case of the somewhat rougher coatings made with a glue making coat.

Where a resinous sand sizing coat is used in connection with a resinous making coat the making coat is preferably cured as in Coated Abrasive Examples 1 and 2 to render the same insoluble in the sizing coat before applying the latter in order to preserve the orientation of the abrasive grains.

I claim:

1. In the manufacture of coated abrasives having a cellulosic backing, a coat of abrasive grit held thereto by a making coat of animal glue in the form of a layer adjacent the backing and a sizing coat of synthetic resin in the form of a layer applied over the grains, the step, after the coats have been applied, the said glue making coat has been dried and the said resinous sizing coat has been at least partially cured, of swelling the backing by application thereto of an aqueous medium and thereafter drying to shrink the backing sufficiently to produce a backing the outer surface of which is of such dimensions in relation to the outer surface adhesive-abrasive coating dimensions that it will not under average conditions of use absorb sufficient moisture from the atmosphere to curl the article and present a concave abrasive surface, thereby forming a coated abrasive having a grit surface character substantially flat to convex curl under average conditions of use, whereby a concave grit surface is avoided.

2. In the manufacture of coated abrasives having a cellulosic backing, a coat of abrasive grit held thereto by a making coat of animal glue in the form of a layer adjacent the backing and a sizing coat of synthetic resin in the form of a layer applied over the grains, the step, after the coats have been applied, of curing the synthetic resinous sizing coat in the presence of an aqueous medium for the backing sufficient to maintain the width dimension of the backing during curing of the resinous sizing coat at least equal to the width dimension of the backing before coating

under average conditions, and thereafter drying to shrink the backing and to produce an outer surface of the backing of such final dimensions in relation to the dimensions of the outer surface of the adhesive-abrasive coating that under average conditions of use the backing will not absorb sufficient moisture from the atmosphere to curl the article to form a concave abrasive surface, whereby a concave grit surface is avoided.

3. In the manufacture of coated abrasives having a cellulosic backing, a coat of abrasive grit held thereto by a making coat of animal glue in the form of a layer adjacent the backing and a sizing coat of synthetic resin in the form of a layer applied over the grains, the step, after the coats have been applied, the glue coat has been dried and the synthetic resin sizing coat has been cured, of swelling the backing by application thereto of an aqueous medium and thereafter drying to shrink the backing sufficiently to produce a backing the outer surface of which is of such dimensions in relation to the dimensions of the outer surface of the adhesive-abrasive coating, that under average conditions of use it will not absorb sufficient moisture to curl the abrasive to present a concave abrasive surface, thereby producing a coated abrasive having a grit surface character substantially flat to convex curl under average conditions of use.

4. In the manufacture of coated abrasives having a cellulosic backing, a coat of abrasive grit held thereto by a making coat of animal glue in the form of a layer adjacent the backing and a sizing coat of synthetic resin in the form of a layer applied over the grains, the step, after the coats have been applied, the glue has been dried and the synthetic resin has been cured, of swelling the backing by application thereto of an aqueous solution selected from the group consisting of alcohols and acetone and thereafter drying to shrink the backing sufficiently to produce a backing the outer surface of which is of such dimensions in relation to the dimensions of the outer surface of the adhesive-abrasive coating that under average conditions of use it will not absorb sufficient moisture to curl the abrasive to present a concave abrasive surface, thereby producing a coated abrasive having a grit surface character substantially flat to convex curl under average conditions of use.

5. In the manufacture of coated abrasives having a cellulosic backing, a coat of abrasive grit held thereto by a making coat of animal glue in the form of a layer adjacent the backing and a sizing coat of synthetic resin in the form of a layer applied over the grains, the step, after the coats have been applied, the glue has been dried and the synthetic resin has been at least partially cured, of swelling the backing by application thereto of a volatile aqueous medium and thereafter drying to shrink the backing sufficiently to produce a backing the outside surface of which is of such dimensions in relation to the dimensions of the outside surface of the adhesive-abrasive coating that under average conditions of use it will not absorb sufficient moisture to curl the abrasive to present a concave abrasive surface, thereby producing a coated abrasive having a grit surface character substantially flat to convex curl under average conditions of use.

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The following references are of record in the file of this patent:

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Certificate of Correction

Patent No. 2,485,765 October 25, 1949

NICHOLAS E. OGLESBY

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 1, line 36, for the word "produce" read *product*; column 4, line 71, for "by" read *my*; column 5, line 45, for "said" read *sand*; column 7, line 62, for "grit 0–90" read *grit 0–80*;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 14th day of March, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.