May 15, 1945. N. E. OGLESBY 2,375,813

METHOD OF MAKING COATED ABRASIVES

Filed June 9, 1941 2 Sheets-Sheet 1

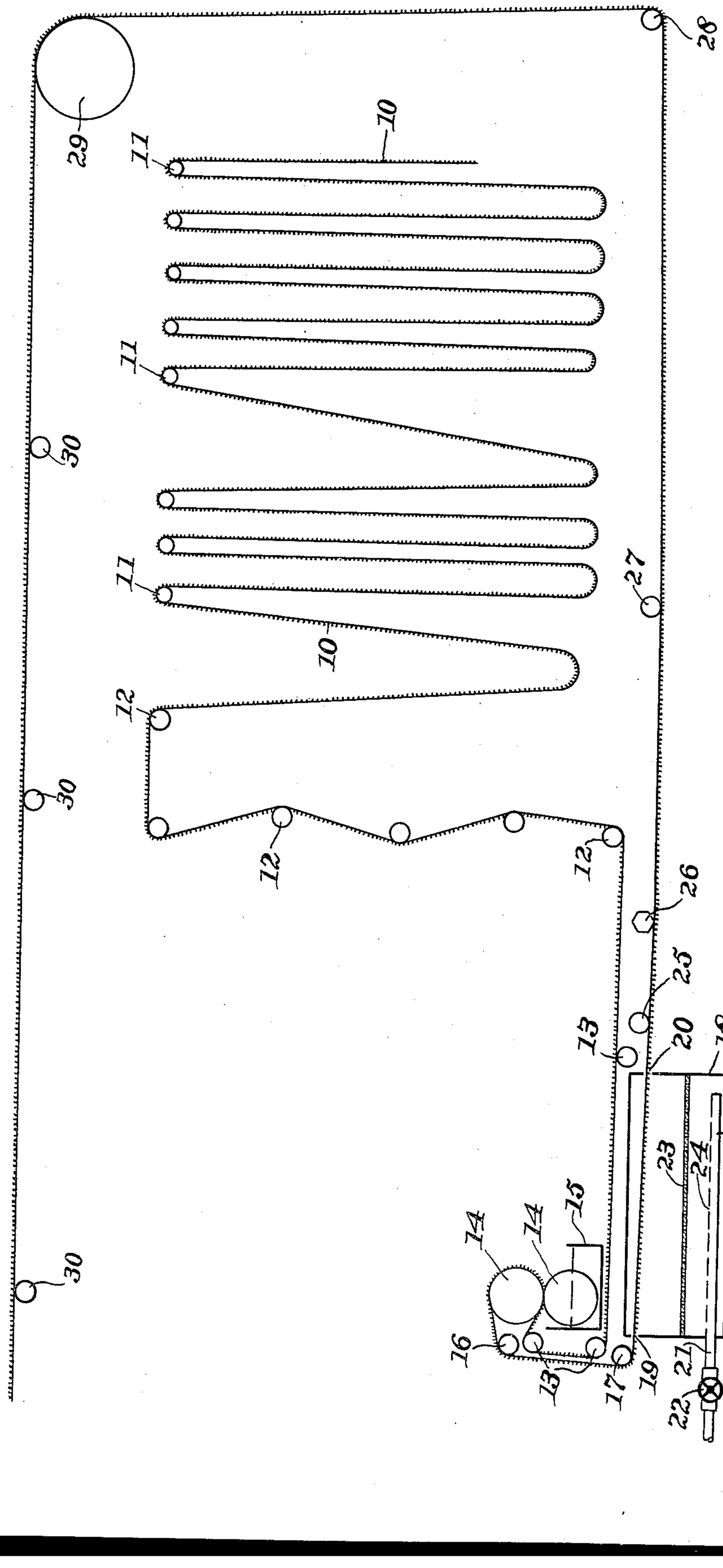


Fig. 1

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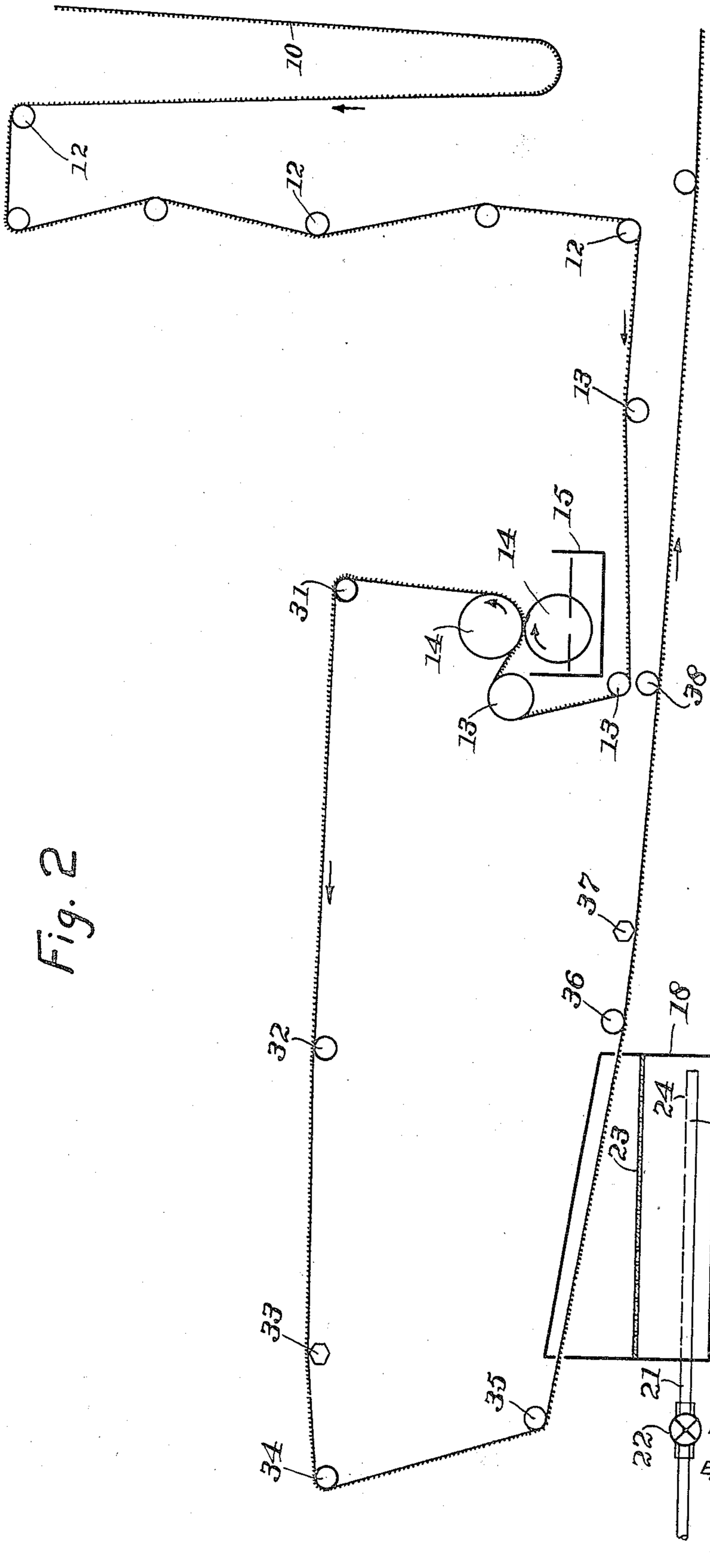


Fig. 2

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METHOD OF MAKING COATED ABRASIVES

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Application June 9, 1941, Serial No. 397,299

11 Claims. (Cl. 51—295)

This invention relates to improvements in the art of making coated abrasives and particularly to the step of sizing coated abrasives. The invention relates among other things, to a method of treating a sized coated abrasive with an atmosphere containing a vapor of a solvent for the adhesive subsequent to the sizing operation.

The present method is particularly adapted to sizing on the abrasively coated side, webs of paper, cloth, combinations of cloth and paper or vulcanized fibre and the like to which have been adhesively attached, coats of abrasive grains preferably suitably oriented and to maintaining the desirable orientation brought about in the step of depositing the abrasive grains. The present invention not only makes it possible to maintain the grains in substantially their initially applied positions but also may be operated to improve the orientation or location of grains sometimes brought about in the coating operation, particularly where the coating method is not one that gives the optimum orientation, sharpness or roughness desired. Furthermore, the method is not only applicable to the finer grits but is highly desirable in the case of very coarse grits where the problem of imparting the desired orientation to the grits at the time of the deposition in the coating step, and the retaining of this orientation has been a problem.

It is an important object of this invention to retain during the sizing operation the orientation of abrasive grains brought about in the so-called electrostatic coating methods. It is a further object of this invention to produce high grade coated abrasives with optimum roughness and sharpness. It is a further object of this invention to produce coated abrasives in which the sizing adhesive has been removed from the edges and points of the abrasive grains that engage the work in a commercial abrading operation. It is a still further object of this invention to produce oriented coatings of coarse abrasive grains which are of such a coarseness that they are not readily oriented and deposited by electrostatic means and subsequently retained in their deposited positions. It is still another object of this invention to produce a superior bond between the abrasive grains and the sizing coat of adhesive as well as between the sizing coat of adhesive and the previously applied making coat of adhesive. It is a further object of this invention to drop, i. e., move the sizing coat of adhesive well below the tops of the abrasive grains and to eliminate a large part of the entrapped air bubbles and films incident to the application of the sizing coat of adhesive by conventional means.

I am aware of the fact that attempts have been made to make sharp coated abrasives with upstanding grains, the outermost edges and points of which are free from excessive adhesive, by spray sizing methods, in which the sizing adhesive is blown into and among the grains with a propelling charge comprising a warm solvent vapor-laden gas. I am furthermore aware that attempts have been made to solve this problem by first applying the sizing coat of adhesive in the conventional manner and then blowing the same down into the grains with a jet of high velocity solvent-laden gas. I am also aware that it has been proposed to apply an excess of a thin sizing coat of adhesive and then immediately, while the same is fluid, blow off the excess of adhesive, clear the edges of the grain of adhesive and drop the sizing coat well down among the grains by means of a high velocity jet of solvent-laden gas. I find, however, that none of these methods serve my purpose in that a jet of solvent vapor or warm gas laden with solvent vapor moves the grains from their initially applied positions and produces a relatively flat and dull coat as compared with the product of this invention. This is particularly true where the making coat of adhesive, as for instance glue or incompletely cured synthetic resin, is softenable by the sizing coat. In my process I, therefore, avoid the use of a jet of solvent or solvent-laden gas impinging against the abrasive coat and thereby avoid the dulling of the sheet and upsetting of grains incident to such operations.

I also find that if the newly sized coated abrasive as made by conventional methods, as for instance glue bonded coated abrasives or coated abrasives made with a synthetic resin bond, the making coat of which has not been rendered completely insoluble in the sizing coat, is subjected for a considerable period of time, i. e., a time sufficient to fully accomplish my purpose, to a warm solvent vapor or a warm atmosphere containing solvent vapor even without any jet effect, there is loss of orientation of the grains and consequent dulling of the final product if these operations are carried out with the coated abrasive facing upwardly while the web is traveling in a horizontal position or if the coated abrasive is inclined at any substantial angle to the horizontal as is the case in the conventional methods, as for instance, where the web is passed from the sizing machine to the drying racks. I avoid the loss of orientation and dulling of the final prod-

uct so brought about by subjecting the sized web to an atmosphere consisting of warm solvent vapor or containing a substantial amount thereof, while the coated abrasive web is traveling horizontally with the abrasive surface facing downwardly or while the abrasive surface is facing downwardly and the direction of travel of the web is at a relatively small angle to the horizontal, as for instance, an angle of about 30° or less. Substantially the horizontal position during the time of treatment is generally preferred. I therefore size my abrasively coated web previously made by any known method, by any conventional sizing method such as, for instance, calender rolls or suitable spray means and then quickly, i. e., before serious loss of grain orientation occurs, turn the web so that it is traveling with the abrasively coated side facing downwardly and horizontally or, at a small angle to the horizontal and complete my process with the web traveling in this position. This is a preferred method. Another method will be described later.

After the sized web has been turned so that it travels with the abrasive side down in a direction parallel to the horizontal or at a small angle to the horizontal, I apply to the web a fluidizing treatment of warm solvent vapor or a treatment with a warm atmosphere containing a substantial amount of solvent vapor such as suffices to prevent hardening of the sizing adhesive by the heat during this part of the treatment. Subsequent to this treatment of the web, the web continues in substantially a horizontal direction after emerging from the treating zone until the adhesive has set up sufficiently to prevent loss of orientation of the abrasize grains, referring of course to orientation brought about in the deposition of the grains and also to such favorable orientation as is further imparted by my special treatment, such favorable orientation as is imparted in my treatment being aided in some cases by a beater or vibrator as hereinafter described.

It is a new and unexpected result of my invention that even though a fluidizing treatment is applied to maintain the fluidity of and even increase the fluidity of the sizing adhesive with the abrasive coat facing downwardly, nevertheless. the sizing adhesive is cleared off of the abrasive edges and points and travels upwardly to sink deeper into the abrasive grains counter to the force of gravity. I believe that this phenomenon is a resultant of the actions of capillary and surface tension forces. Furthermore, even with a glue bond sandpaper product in which the glue is readily softenable by the sizing adhesive. in my treatment the grains do not drop out of the adhesive coating or move away from the backing to any undesirable extent. Furthermore, since the abrasive is facing downwardly the action of gravity is to maintain the grains in their upright positions or to bring them into upright positions rather than to bring about loss of orientation.

Furthermore, with the adhesive coats in a softened condition, there is a random displacement of the ends adjacent the backing, conducive to the formation of a close coat abrasive having certain advantages heretofore enjoyed by open coatings in that the exposed ends of the grains with the greatest displacement from the backing protrude above those of equal size having a smaller displacement and engage the work first, the effect of which is a greater pressure on the smaller number of grains until their points have been worn or broken away, so that the points of grains at a slightly lower level then engage the work.

It is characteristic of the products produced by the preferred methods of my invention that the exposed points and edges of the abrasive grains are relatively free from any deleterious quantity of the sizing adhesive; that the coatings are of great depth for the quantity, shape and size of abrasive grains used and that the exposed ends of the grains in the top of the coating are spaced far apart and open as compared with conventional coatings carrying the same weight of the same size and shape of abrasize grains. Electrostatic methods of applying abrasive grains are known in the art which orient substantially all of the abrasive grains with their long axes at right angles to the plane of the backing in the grain-applying step. Such electrostatic methods conveniently apply a single layer of grains, one grain deep, with substantially all of the grains as initially applied being oriented with their long axes substantially at right angles to the plane of the backing. In a preferred method of carrying out the present invention I apply a sizing coat of adhesive which will soften the making coat of adhesive over the abrasive grains so oriented and immediately further treat the coated abrasive so sized while the abrasive grains are facing downwardly to further soften the making coat and render highly fluid the sizing coat and with the coated abrasive in such condition I vibrate it, as, for instance, as illustrated in Figure 1, so as to create a random displacement of the ends of the abrasive grains adjacent the backing from their initially applied positions and away from the backing but within the making coat of adhesive. After this treatment the adhesives are set at least sufficiently to support the grains while the abrasive grains are still facing downwardly. In the resulting product the abrasive grains are still oriented with their long axes substantially perpendicular to the backing but as a result of my special treatment have their exposed ends extending a correspondingly variable distance above the average level of the sizing adhesive, the exposed points and edges of the grains being free from any deleterious quantity of sizing adhesive and the coating being of great depth for the quantity, shape and size of abrasive grains used and the exposed ends of the grains in the top of the coating being spaced far apart and open as compared with conventional coatings carrying the same weight and the same size and shape of abrasive grains.

In connection with the treatment just described, I find a beater or vibrator applied to the back of the web before, concurrently with, or subsequent to the previously described treatment, an aid to maintaining favorable orientation of the abrasive grains and in many instances and under certain conditions of operation a method and device that can further impart to the abrasive grains in the coating more favorable orientation even than that which is present after the deposition of the abrasive grains but before sizing. This is particularly true where the preferred electrostatic methods have not been used or have been used with such abrasive grains that the maximum orienting effect cannot be obtained. Furthermore, this use of a beater or vibrator as a part of my process greatly improves abrasive coats made by other than the orienting methods.

It is to be understood that I treat my webs in such a position that the torques on the individual grains brought about by gravity serve to hold

grains oriented substantially perpendicularly to the backing in position, or to pull inclined grains into a position perpendicular to the backing at a time that the adhesive coats are relatively soft and would not maintain the grains in fixed positions against the forces of gravity, and thus avoid loss of orientation that has heretofore occurred. When in the specification and claims it is stated that abrasive grains are oriented, it is meant that the grains have their long axes substantially at right angles to the plane of the backing. By stating that the grains have their long axes substantially at right angles to the plane of the backing, substantially perpendicular to the backing or substantially normal to the backing, it is meant that the long axes of the grains approach the right angle, perpendicular or normal relation to the plane of the backing sufficiently close to give the sharpness of coating and abrading efficiency associated with oriented coated abrasives.

Otherwise stated, I treat the web with the abrasive coat facing downwardly whereby the grains are lightly held at their bases by the making coat of adhesive and are pendant from the reinforcing backing.

Referring to the drawings,

Figure 1 is a diagrammatic view of a preferred form of this invention showing an apparatus and a method that have been found highly satisfactory.

Figure 2 is a diagrammatic view of still another form of my invention which is sometimes more readily adapted to existing sandpaper machines, wherein the apparatus shown in Figure 1 can be less readily installed.

Referring to Figure 1, 10 is an abrasively coated web which may be delivered as shown from any commercial sandpaper making machine in the form of conventional festoons supported by travelling slats 11 and made to pass over idler rolls 12 to take the web out of festoon form and deliver it as a traveling web to pass over additional idler rolls 13 and through conventional calender rolls 14, the bottom roll of which dips into a glue box 15 filled with a suitable adhesive according to the nature of the web 10 and which may often be animal glue or synthetic resin. In passing through the calender rolls the abrasively coated side of the web 10 has applied thereto a suitable quantity of the sizing adhesive such as glue; the web then passes quickly and through a short space as shown over idler rolls 16 and 17 so that the abrasively coated side of the web is faced downwardly quickly after sizing whereby to prevent loss of orientation of the abrasive grains which otherwise accompanies softening of the bottom or make coat of adhesive by the sizing coat of adhesive. Idler roll 17 also serves as one damper roll for certain locations of the whipper, beater or vibrator hereafter referred to. After the web has been faced downwardly and beyond idler roll 17, I provide a fluidizing chamber 18 with slots 19 and 20 through which the web enters and leaves the chamber. In this chamber the sizing coat is maintained fluid or its fluidity is increased and the making coat is softened. I also supply an atmosphere-controlling means 21 which may be a pipe of suitable size with a valve 22 which may be opened to any desired degree to admit a controlled quantity of warm solvent vapor or a gas laden with solvent vapor. The chamber is preferably provided with a perforated plate 23 which further insures uniform distribution of the conditioning atmosphere and the avoidance of a substantial jet effect which as previously explained is objectionable. In the present construction, the conditioning atmosphere is discharged through a plurality of openings 24 in the pipe 21 and then passes through the perforated plate so that objectionable jetting action is eliminated. I may also provide within the chamber, though I usually do not find it necessary, an independent heating means whereby the temperature within the chamber may be subject to control independently of the temperature of the aforementioned atmosphere-controlling vapors or vapors and gases introduced through the supply line 21 into the chamber 18. However, I usually find it preferable to control the temperature and partial pressure of the atmosphere within the chamber 18 by controlling the quantity and the temperature of vapor or vapor-laden gases that are introduced through the supply line 21. In this connection I frequently find a conventional super-heater (not shown) desirable since such a superheater can be used to control the temperature of the material added through supply line 21 independently of the quantity added which is subject to control by the setting of valve 22. After the web leaves the chamber 18, it passes over a damper roll 25 and then over a power driven beater, or other type of vibrator 26. To bring about the vibrating or beating action that I desire, I find a power driven hexagonal bar with dimensions of 1½" between the opposite parallel faces highly satisfactory. This beater or vibrator is driven at speeds which among other things depend upon the weight of the backing and the size of the abrasive grains. The web 10 then passes from the power driven beater or vibrator 26 to a damper roll 27 and thence over an idler roll 28 to a suction drum 29 and over additional idler rolls 30 to a conventional suction drum and rattler (not shown) where it is picked up by suitable slats to form the customary festoons that are passed to conventional sandpaper drying rooms. The location of the beater or vibrator has been shown between idler rolls 25 and 27 outside of the treating chamber 18. However, the power driven beater or vibrator 26 may be placed at other locations, as for instance, within the chamber 18 and between damper rolls 17 and 25.

Referring to Figure 2, 10 is the web of unsized abrasively coated coated abrasive which may be delivered to the apparatus from any commercial sandpaper making machine in the form of conventional festoons as illustrated in Figure 1 wherein the traveling festoons are supported by slats 11 and made to pass over idler rolls 12 to take the web out of festoon form and deliver it as a traveling web to pass over idler rolls such as the idler rolls 13 of Figure 2. It will be appreciated that in the case of the festoons shown in front of the machine in Figure 1 the festoons may be moved around a 90° turn to come inside of the vertical portion of the web 10 between idler roll 28 and suction drum 29 in Figure 1. The same or similar means may, of course, be employed in the case of Figure 2.

The unsized abrasively coated web of Figure 2 is delivered as shown to pass over idler rolls 13 and between calender rolls 14, the bottom roll of which dips into adhesive in a glue box 15, whereby a suitable sizing coat is applied over the coat of abrasive grains after which the sized web 10 passes over idler rolls 31, damper roll 32, vibrator or beater 33, damper roll 34, idler roll 35, thence through a fluidizing chamber 18 with

the abrasively coated side facing downwardly and the web making an angle, preferably less than 30°, with the horizontal. The chamber 18 is similar to that described in connection with Figure 1, i. e., is equipped with a supply line 21 by which warm solvent vapor or warm solvent-laden gas may be introduced into the chamber 18 through ports 24 to maintain or improve fluidity of the sizing coat and soften the making coat. Also, I provide a valve 22 which may be used to control the quantity of conditioning vapor or conditioning vapor-laden gases admitted to the chamber 18, the perforated plate 23 in the chamber and slots 19 and 20 by which the web 10 may enter and leave the chamber. After leaving the chamber the web 10 passes over damper roll 36, past a driven beater or vibrator 37 over a damper roll 38, thence along a substantially horizontal direction or at a predetermined angle to the horizontal, as indicated, for a distance or time sufficient for the adhesive to set up and firmly anchor the grains in place before the sized web is changed in direction as indicated at 28 in Figure 1, and moved to a commercial sandpaper drying room where the adhesive is completely dried or cured, as the case may be, depending upon the nature of the adhesive used.

By using apparatus such as that illustrated in Figure 2, in which the sized web may not always be faced downwardly before the sizing coat of adhesive has time to substantially soften the bottom coat of adhesive, I find that a beater or vibrator may be used to advantage to minimize the turning over of the grains, agglomeration of the grains and general loss of orientation before the abrasively coated web is turned over and faced downwardly in which position, as explained before, such loss of orientation is substantially minimized or substantially prevented. I furthermore find that a vibrator in any of the positions shown serves an added function of helping to remove entrapped air films or bubbles and thereby is conducive to the formation of a superior bond.

Where a beater or vibrator has been shown in Figures 1 and 2, as for instance, beater or vibrator 26 of Figure 1, whipper or vibrator 33 of Figure 2 or whipper or vibrator 37 of Figure 2 the whipper or vibrator in question is shown operating between two damper rolls as for instance, damper rolls 25 and 27 of Figure 1, damper rolls 32 and 34 of Figure 2 or damper rolls 36 and 38 of Figure 2. The ideal distance between these various pairs of damper rolls varies somewhat with the weight of the backing, the weight of adhesive used, and the weight and even the size of the abrasive grains. The spacings of these damper rolls for ideal operating conditions may be varied in accordance with the natural frequency of vibration of the web upon which the vibrator or whipper is used. However, 130 lb. cylinder paper is a common backing for many important coated abrasives and using this backing and hide glues, as is customary in the coated abrasive art, to anchor grits to the backing, for many coated abrasive articles I find a suitable spacing between the damper rolls to be 37 inches. Furthermore, I find that the frequency of vibration preferably should also be varied in accordance with the nature and weight of the backing, the weight of adhesive, and the weight and size of abrasive grains used. However, for a large class of products just described made with 130 lb. cylinder paper as a backing, I find that my preferred hexagonal bar vibrator heretofore described gives good results if rotated against the backing at a speed within the range of 2185 to 4300 revolutions per minute. Specific illustrations of preferred speeds within this range will be given in detailed examples later herein described. Referring to both Figures 1 and 2 it will be noted that the beaters or vibrators 26 of Figure 1 and 33 and 37 of Figure 2 have not been located in the center of the span between the damper rolls adjacent the beater or vibrator in question. The spacings illustrated in Figures 1 and 2 are such that the point of contact of the vibrator or beater with the back of the coated abrasive web is 9'' from one adjacent damper roll and 28'' from the other adjacent damper roll. This spacing has been found to give good results. It should, however, be appreciated that many spacings and locations of the damper rolls and beaters or vibrators will serve my purpose, including spacings in which the vibrator is midway between the adjacent damper rolls.

In the operation of the beaters or vibrators, they are made to press against the back of the coated abrasive webs with different forces and different displacements of the web from a straight line between the adjacent damper roll according to the nature of the coated abrasive being made. In general, the heavier the backing and/or the coarser the grit being coated the more firmly should the vibrator or beater press against the backing. As a result of this pressure of the vibrator or beater there is a slight deflection in the web so that at the point of contact of the beater with the backing the web may, for example, be deflected from the straight line drawn between the tops of the adjacent damper rolls within the range of about one-eighth to about five-eighths of an inch, the smaller deflection normally being used for the lighter backings and finer grits and the larger deflection for the heavier backings and coarser grits. It will, therefore, be seen that the damper rolls, or the beater or vibrator, or both the damper rolls and the beater or vibrator are adjustable, whereby the pressure of the vibrator or beater against the back side of the web may be varied according to the product being made.

In operating the treating chamber 18 of Figure 1 and similarly the treating chamber 18 of Figure 2, which, since the operation of the two chambers is similar, I will generally explain by reference to the chamber 18 of Figure 1, conditions are created within the chamber, as for instance, chamber 18 of Figure 1 in which there is sufficient solvent vapor to prevent substantial or rapid evaporation of residual solvent in the sizing coat of adhesive where such is present, or in any event to aid in maintaining a fluid condition of the sizing adhesive within the chamber 18. Furthermore, the temperature within the chamber 18 is controlled to produce and maintain a highly fluid condition in the sizing coat of adhesive without fluidifying the bottom or making coat of adhesive to an extent that the abrasive grains would drop therefrom. This is readily accomplished even in the case of standpaper made with a hide glue, and I believe that this is true for several reasons. In the first place, the heat within the treating chamber contacts the surface of the sizing coat of adhesive but requires some time to penetrate to the bottom or the making coat of adhesive. Furthermore, the making coat of adhesive usually contains a higher percentage of glue, for instance, than the sizing coat of adhesive and experience shows that a glue laid down from a high concentration of solution ab-

sorbs water more slowly than a glue film laid down from a lower concentration of solution. There is thus a pronounced delay in the equilibrium distribution of the water applied in the sizing coat of adhesive between the sizing coat and the making coat. At any rate, I have found it a practical matter to create in the chamber **18**, sizing glues not only fully as fluid as the sizing glue at the time of application but, where desired, sizing glues of much greater fluidity than the fluidity at the time of application whereby the sizing glue actually travels upwardly among the grains to produce a sharp coated abrasive in which the edges and points of the grains are remarkably free from adhesive, while at the same time avoiding any objectionable movement of the abrasive grains downwardly and away from the backing. By using the treating apparatus and process shown in Figure 1 without the driven beater or vibrator, such as the beater or vibrator **26**, I am able to obtain highly desirable results. However, a preferred method of operation is the conjoint use of the treating chamber and beater or vibrator, especially since the beater or vibrator straightens up grains which may not have been previously well oriented or which may have lost some of their orientation, and also serves to separate grains that may have become agglomerated or bunched.

Similarly, referring to Figure 2, the treating chamber, in the absence of either beaters or vibrators **33** or **37**, gives desirable results but maximum sharpness is obtained by the use of either beater or vibrator **33** or beater or vibrator **37** and a preferred method with the apparatus of Figure 2 is one in which beater or vibrator **33**, the treating chamber **18**, and beater or vibrator **37** are used. Even with the web in a substantially horizontal position and facing upwardly as between damper rolls **32** and **34** in Figure 2, driven beaters or vibrators such as illustrated by **33** materially retards loss of orientation which might otherwise occur where it is impracticable to avoid very substantial travel of the web before the abrasive side is faced downwardly.

The various beaters or vibrators shown in Figures 1 and 2 have a desirable effect in most instances (depending upon the degree of softening of the making coat of glue by the sizing coat) even in the absence of the treatment carried out in chamber **18**, but the optimum effect from the vibrators will be obtained where it is used with the sizing coat of adhesive in a condition of optimum fluidity such as the condition brought about by the treatment in chamber **18** of Figures 1 and 2 with the abrasive facing downwardly.

In some cases, the reversal of the position of the abrasively coated web to face the abrasive side downwardly takes place before there has been any opportunity for the sizing coat to set, while in other cases the setting or jelling has already been initiated. Where initiation of set of the sizing coat has occurred, the sizing coat may, of course, be fluidified in my treating chamber. In any event, it is to be observed that quickly after sizing the web is disposed so that the oriented grains project downwardly.

From the foregoing, it will be appreciated that where the grains are inclined with respect to the perpendicular, they may be caused to assume a desired perpendicularity and, at the same time, the perpendicularity of abrasive grains existing at that time is maintained. Generally, i. e., for most purposes, it is desired that the grains on a coated abrasive product be oriented with their long axes perpendicular to the backing. However, in cases where a uniform inclination of the abrasive grains is desired, this inclination may readily be brought about and controlled by adjusting the angle of inclination of my web to the horizontal during the time of treatment and for a period thereafter sufficient for the adhesive to set. Instead of the rotating hexagonal bar, the speed of rotation of which may be varied as desired, and which is a preferred form of vibrator, I may use other types of vibrators such as the well known electromagnetic vibrators to vibrate the web. The frequency and amplitude of vibration may, as in the case of the hexagonal bar or other form of vibrator, be adjusted in accordance with the nature of the material being coated.

Specific examples of the operation of my apparatus and method will now be described:

Coated abrasive, Example 1

This is what is generally known as a fine grit sandpaper. A suitable backing is 130 lb. rope cylinder paper. A suitable grit is #400 silicon carbide. A suitable making coat of adhesive is 29% 145 millipoise hide glue at a temperature of 155° F., while a suitable sizing solution is 16% of 86 millipoise hide glue at a temperature of 160° F. A suitable coating method is any one of the well known and established electrostatic methods such as those described in the Smyser and various Schacht Patents Nos. 1,788,600, Re. 20,660, and 2,027,309. Using a coating process, backing, adhesive and abrasive grain such as described, I may coat approximately 2.4 lbs. per sandpaper ream of abrasive grains onto the backing by methods well known in the art and pass the same to the usual festoons between the making and sizing machines where the making coat of adhesive is given at least appreciable drying to set up and solidify the making coat of adhesive and anchor the grains in place. From the festoons the abrasively coated web is passed over idler rolls **12**, preferably rubber covered, as illustrated by the web **10** in Figure 1 and thence by the idler rolls previously described between the calender rolls **14**, where the sizing coat of adhesive previously mentioned and held at a temperature of 160° F. in the glue box **15** is applied over the abrasive grains in substantially the usual quantity used in commercial practice. From the calender rolls **14**, the sized abrasive web **10** is quickly turned about idler rolls **16** and **17** to face the abrasive side downwardly, and with the abrasive facing downwardly the web is led through the treating chamber **18**, entering the chamber at slot **19** and leaving it at slot **20**. Within the chamber **18** the web is subjected to a steaming treatment, steam being the vapor of water and water also being the solvent used in making the hide glue solution. Steam is admitted through the supply line **21** in controlled quantities by adjusting the valve **22** and comes from a suitable source of steam which, in this case, may be steam at 15 lbs. pressure produced from steam in a line at 90 lbs. by a suitable reducing valve. Since the steam chamber is below the abrasive web, i. e., the steam is admitted beneath the web and since a jet effect is avoided in releasing the steam, wet steam will often serve my purpose and can be used without any objectionable condensation on the web. However, I sometimes prefer to use superheated steam, especially as an independent means of temperature control. Within the chamber **18**, the fluidity of the sizing glue is controlled and increased as desired, but in any event, a

highly fluid condition of the sizing glue is brought about and maintained within the chamber **18**. Upon emerging from slot **20** in the chamber **18**, the web may be passed over roll **25**, roll **27**, roll **28** and the suction drum **29**, thence to the drying racks. Between the emergence of the web from the slot **20** and its turn from the controlled direction of travel with the abrasive side facing downwardly into a vertical direction to approach the suction drum **29**, the adhesive sets to an extent that loss of orientation or dislocation of the grains after the web is turned from its controlled position of travel is avoided. In this variation of my process, the driven vibrator or whipper, such as that illustrated by **26**, has not been used but a superior result has been obtained as compared with the coated webs of the prior art. However, a preferred method of operation includes the driven whipper or beater **26** which, in this case, may be so set against the backing of the web that at the point of contact between the whipper and the web the web is displaced about one-eighth of an inch from the straight line drawn between the bottoms of damper rolls **25** and **27**. Furthermore, a suitable speed of the whipper in this case is about 3700 revolutions per minute. This is a case in which a relatively heavy backing is combined with a relatively fine grit.

The speed of the traveling web and the size of the chamber **18** in this case may be so adjusted that the web is within the chamber for a time of about two and one-half to three seconds. The temperature within the chamber may be approximately 140° F. and the quantity of steam added to the chamber is such as to prevent substantial evaporation of the solvent within the chamber. Furthermore, the time of travel with the abrasive facing downwardly after emergence from the chamber **18** is, in this case, not less than about eight seconds. It will be appreciated that larger chambers and greater distances of travel may be used and that the size of the treating chamber may be varied within wide limits. However, it is usually economical of space to use the smallest chamber which will give the desired effect and the shortest distance of travel which will permit sufficient setting up of the adhesive to prevent loss of orientation of the grains.

Coated abrasive, Example 2

This is what is generally known as a medium grit sandpaper. A suitable backing is 130 lbs. rope cylinder paper. A suitable grit is #80 fused aluminum oxide abrasive grains. A suitable making coat of adhesive is a 46% solution of 86 millipoise hide glue, and a suitable temperature for the application of this adhesive is 160° F. A suitable sizing solution is a 31% solution of 86 millipoise hide glue and a suitable temperature for the application of the sizing coat of adhesive is 155° F. A suitable coating method for applying the abrasive grains is any one of the well known and established electrostatic methods such as those described in the previously mentioned Smyser and Schacht patents. Using a coating process, backing, adhesive and abrasive grain such as described, I may coat approximately 21.6 lbs. per sandpaper ream of the abrasive grains onto the adhesively coated backing. As in the case of Coated abrasive, Example 1, I pass the abrasively coated web to the usual festoons between the making and sizing machines where the making coat of adhesive is given at least an appreciable drying to set up the making coat of adhesive and anchor the grains in place. The festoons are then taken down continuously as previously described and the abrasively coated web is passed through the sizing machine as in the case of Coated abrasive, Example 1, where substantially the usual commercial sizing coat of adhesive is applied over the abrasive grains. From the calender rolls **14**, the sized abrasive web **10** is quickly turned about idler rolls **16** and **17** to face the abrasive side downwardly, and with the abrasive facing downwardly, the web is led through the treating chamber **18**, entering the chamber through slot **19** and leaving it from slot **20**. Within the chamber **18** as in the case of Coated abrasive, Example 1, the web is subjected to a steaming treatment and in this case, the temperature within the chamber **18** may be about 160° F. A highly fluid condition of the sizing glue is brought about and/or maintained within the chamber **18**. Upon emerging from slot **20** of the chamber **18**, the web may be passed over roll **25**, roll **27**, roll **28** and the suction drum **29** and thence to the drying racks. Before the web turns upwardly at roll **28**, the adhesive is set to an extent that loss of orientation or dislocation of the grains after the web is turned from the controlled position of travel is substantially avoided. Alternately, I subject the web to the action of a driven vibrator or beater such as that illustrated by **26**, and preferably I subject the web to both the treatment in the chamber **18** before described, and the action of the driven vibrator or beater **26**. With this grit and this backing, a desirable speed of the preferred hexagonal vibrator shown is 3400 to 3600 revolutions per minute. The time of travel with the abrasive facing downwardly to permit the adhesive to set after the treatment in the chamber **18** is about eight seconds or more.

With this grit and this backing the hexagonal vibrator **26** may be set to press against the backing with a force which causes a three-eighths of an inch displacement of the backing at the point of contact with the vibrator from a straight line drawn between the two surfaces of the adjacent damper rolls at their points of contact with the backing.

Coated abrasive, Example 3

This is what is generally known as a relatively coarse grit. A suitable and generally useful backing is 130 lb. rope cylinder paper. A suitable grit is #30 silicon carbide abrasive grains. A suitable making coat of adhesive is a 51% solution of 86 millipoise hide glue and a suitable temperature for the application of this adhesive is 160° F. A suitable sizing solution of adhesive for this grit is a 38% solution of 86 millipoise hide glue which may be applied to the abrasively coated web at a temperature of 155° F.

As in former examples, a suitable weight of abrasive grains may be coated onto the backing with the making coat of adhesive described and by any of the established methods. In making this grit, I coat onto the adhesively coated backing about 58 lbs. per sandpaper ream of #30 silicon carbide abrasive grains after which the abrasively coated web is given substantial drying in festoon form between the making and sizing machine and then passed to the sizing machine as illustrated, for example, diagrammatically in Figure 2.

Referring to Figure 2, the sized abrasive web **10** then passes over idler roll **31**, damper roll **32**, the beater or vibrator **33**, idler rolls **34** and **35** after which, without any treatment in chamber

18, the web may be passed over rolls 36 and 38 and after the adhesive has been set with the abrasive facing downwardly, it may be passed over rolls and a suction drum (not shown) to deliver it to conventional sandpaper drying racks. An improvement will be noted in the abrasively coated web as compared with the web similarly made, but without the use of the vibrator 33. Alternately, I may pass the web from vibrator 33 over rolls 34, 35 and 36 to the action of vibrator 37 without applying a treatment in the chamber 18, and it will be found that there is a further improvement over the web made in which only the vibrator 33 was used. However, I preferably pass the web from the action of beater 33 over the rolls 34 and 35 into the treating chamber 18 and apply therein my softening process after which the web passes over roll 36, vibrator 37 and roll 38 and is subjected to a vibrating action by the vibrator 37. After this, the web is carried from roll 38 with the abrasive side facing downwardly until the adhesives set up to anchor the grains after which the web may be passed to conventional sandpaper drying rolls as previously described for Coated abrasives, Examples 1 and 2. This latter web in which the steaming or softening process has been combined with the vibrating action, will be found to be a remarkable improvement in regard to the sharpness of the points and edges of the grain and the tenacity with which the adhesive holds the grains as compared with the webs in which only one beater or the two beaters 33 and 37 were used without the treatment in chamber 18. Furthermore, in most cases, the web made by the combined treatments of the chamber 18, and the vibrators will have not only a rougher and sharper coating, but one in which the grains have definitely better orientation with their long axes parallel to the direction of the force of gravity at the time of treatment.

In the case of this grit and with the backing described, the beaters 33 and 37 where used, are set to press against the backing to an extent that will cause a one-half inch displacement of the backing at the point of contact with the beater from a straight line drawn between the two surfaces of the adjacent damper rolls at their points of contact with the backing. In this case, a suitable speed of the hexagonal vibrators 33 and 37 where used is 3100 revolutions per minute. A suitable temperature within the treating chamber 18 is 170° F. As in the previous examples, the quantity of steam admitted into the chamber 18 is adjusted to prevent substantial evaporation of the water solvent of the sizing glue. Wet steam may be used with good results. However, steam with a few degrees of super-heat may be used with equally good or superior results.

The three examples given by way of illustration are typical of a wide range of grit sizes. Sometimes, I employ very heavy backings such as laminations of 10 mil vulcanized fibre with drills cloth as a backing and coat the abrasive preferably on the cloth side. Such backings are more often used with relatively coarse grits. In this case, I normally set the beaters or vibrators to press against the backing with a greater force so that there is a displacement of about five-eighths of an inch in the backing at the points of contact with the vibrator from a straight line drawn between the surfaces of the damper rolls adjacent the backing. Furthermore, with such heavy backings and coatings, I find that it is advisable to use a higher temperature in the treating chamber 18 and usually employ temperatures of the order of 200° F.

This invention has been illustrated with particular reference to glue bond coated abrasives where it has always been a problem to prevent loss of orientation of the grains due to the softening of the making coat of adhesive by the sizing coat of adhesive. However, my process and apparatus are not limited to use with glutinous adhesives, but may be used with a wide variety of adhesives, where the making coat of adhesive is of a nature or in a condition in which it is substantially softened by the sizing coat of adhesive whereby the grains are not sufficiently anchored shortly after or during the sizing operation to prevent movement of the grains. For example, in the copending application of Nicholas E. Oglesby, Charles F. Reilly and Victor W. Gilbert, Serial No. 124,506, filed February 6, 1937, there is described a method of making resin bonded fibre combination discs in which the sizing coat of adhesive is applied over an incompletely cured and therefore softenable coat of making adhesive. Such a web after the sizing operation may be treated by the apparatus and process illustrated in Figures 1 and 2. That is, the web may be subjected to beaters, as illustrated, or to a softening treatment in the chamber 18 or to a combination of treatments in the chamber 18 and with the vibrators or beaters. In applying the treatment in chamber 18 to such webs, I introduce through the supply line 21 into the chamber 18 vapors of a solvent for the sizing coat of adhesive or such vapors associated with soluble inert gases such as air. The sizing coat of adhesive (phenol formaldehyde resin) described in the aforesaid application of Oglesby, Reilly and Gilbert, is softenable to a considerable extent with water, and I may, therefore, prevent case hardening of the resin by introducing steam into the chamber 18 which may be wet steam, but in this case is preferably steam with a few degrees of super-heat. Where phenol formaldehyde resins are used to size the coated abrasive webs and these resins have been advanced in cure before the sizing operation to a point where they are not softenable by water vapor, I may introduce instead of water vapor, vapors of alcohol which readily soften such phenol formaldehyde resins of advance cure.

However, in making certain types of flexible coated abrasives, a sizing adhesive of oil modified polyhydric alcohol polybasic acid resin is used, such resins being readily softenable by aromatic solvents such as toluene or high-flash naphtha, and where such adhesives are used in the sizing operation, I may introduce into the treating chamber 18 the vapors of such aromatic solvents.

In using the various types of adhesives, the principle of the operation of the chamber 18 is the same as has been previously described with specific reference to glutinous adhesives. In other words, the chamber 18 is controlled as to temperature and partial pressure of the softening vapors to bring about and/or maintain in the chamber a fluid and mobile condition of the sizing coat of adhesive without case hardening of the same whereby a superior bond is formed between the adhesive and the abrasive grains and whereby the edges and points of the abrasive grains are remarkably free from adhesive due to the movement of the adhesive away from the

points and edges of the grains, and its accumulation near the bases of the grains where it forms a firm union not only with the grains, but also with the making coat of adhesive.

As illustrative of a synthetic resin that may be used in carrying out my process I will describe in detail a suitable phenol-formaldehyde resin and its application and treatment in the process.

A suitable phenol-formaldehyde resin which may be used in making a number of coated abrasive articles may be prepared by reacting under reflux in a jacketed container fitted with thermostatic controls and a mechanical agitator, 100 parts of phenol to 82 parts 37% formalin in the presence of an alkaline catalyst, for example, 0.8 to 1.0 part of sodium hydroxide. The manufacture of the resin is carried out by the usual practice of the resin art. When the reaction has proceeded to the required point as determined by the usual control tests, the water content of the resin as determined by the Karl Fisher reagent is reduced under vacuum to approximately 10%. After this reduction in the water content, the density of the resin should be about 1.2 at 25° C. and the water tolerance of the resin should be approximately 40 ccs. per 10 grams of resin previously thinned with 10 grams of methanol. The viscosity of the resin should be about 18 poises at 25° C. The pH of the resin should be about 8.7 to 9. This resin may be thinned with water to produce lower viscosities where required or desirable in the coating and sizing operations that are carried out in the manufacture of the coated abrasives. Likewise, in instances where a higher viscosity is desirable, a greater amount of water may be removed in the vacuum treatment previously referred to.

Coated abrasive, Example 4

This is what is generally known as a relatively coarse grit coated upon a heavy backing. A suitable backing for this example is .30 mil vulcanized fibre. A suitable grit is No. 36 fused aluminum oxide abrasive such as is sold under the trade name "Alundum." A suitable making coat of adhesive is the phenol-formaldehyde resin containing 10% of water, the preparation of which has been described in detail. A suitable temperature for the application of the making coat of adhesive is 120° F. A suitable sizing solution of adhesive for this grit is the same phenol-formaldehyde resin previously described containing 10% water. While the resin in this condition serves my purpose well, I may also thin the resin to any extent desired by adding thereto, water. A suitable sizing temperature in this example is 130° F. As in former examples of making coated abrasives, a suitable weight of abrasive grains may be coated onto the backing by using the making coat of adhesive described and the established methods of the art. In making this grit I coat onto the adhesively coated backing about 60 lbs. per sandpaper ream of the No. 36 fused aluminum oxide abrasive grains, after which the abrasively coated web is subjected to drying conditions to partially cure the making coat of adhesive. A suitable drying cycle for my purpose is one hour at 100° F., one hour at 105° F., one hour at 110° F., one hour at 115° F., one hour at 120° F., one hour at 125° F., one hour at 130° F., one hour at 135° F., one hour at 140° F., one hour at 145° F., and one hour at 150° F. After this curing cycle, the making coat is still readily softenable by the sizing coat hereafter applied. After the curing cycle described, referring to the means of Figure 1, the abrasively coated web is passed from the festoons over idler rolls 12, preferably rubber covered, as illustrated by the web 10 in Figure 1, and thence by the idler rolls 13 previously described between the calender rolls 14 where a sizing coat of the resinous adhesive previously mentioned and held at a temperature of 130° F. in the glue box 15 is applied over the abrasive grains in substantially the usual quantity in commercial practice. From the calender rolls 14 the sized abrasive web 10 is quickly turned about idler rolls 16 and 17 to face the abrasive side downwardly, and with the abrasive facing downwardly the web is led through the treating chamber 18, entering the chamber at slot 19 and leaving it at slot 20. Within the chamber 18 the web is subjected to a treatment with warm solvent vapors. Since the resin used by way of illustration is readily softenable by water, I add through the supply line 21 in controlled quantities, steam, which in this case may be ordinary wet steam at 15 lbs. pressure produced from steam in a line at 90 lbs. by a suitable reducing valve. While wet steam may be used, steam with a few degrees of superheat is preferred. Steam is a cheap, readily available and convenient softening vapor for addition to chamber 18. It is to be understood, however, that alcohol or other softening vapors may be used instead of steam or along with steam. Within the chamber 18, the fluidity of the sizing resin is controlled and increased as desired, but in any event, a highly fluid condition of the sizing adhesive is brought about and maintained within the chamber 18. Upon emerging from slot 20 in the chamber 18, the web may be passed over roll 25, roll 27, roll 28 and the suction drum 29, thence to the drying racks. Between the emergence of the web from the slot 20 and its turn from the controlled direction of travel with the abrasive side facing downwardly into a vertical direction to approach the suction drum 29, the adhesive sets to an extent that loss of orientation or dislocation of the grains, after the web is turned from its controlled position of travel, is avoided. In this variation of my process, the driven vibrator or whipper, such as that illustrated by 26, has not been used but a superior result has been obtained as compared with the coated webs of the prior art. However, a preferred method of operation includes the driven vibrator or beater 26 which, in this case, may be so set against the backing of the web that at the point of contact between the vibrator and the web, the web is displaced about five-eighths of an inch from the straight line drawn between the bottoms of damper rolls 25 and 27. A suitable speed of the vibrator, in this case, is about 2800 revolutions per minute. The speed of the traveling web and the size of the chamber 18 in this case may be so adjusted that the web is within the chamber for a period of about two and one-half to three seconds, although longer times within the chamber are often desirable.

The temperature within the chamber and near the surface of the goods may be approximately 160° F. but often higher temperatures are preferred, especially where superheated steam is used. Furthermore, the time of travel with the abrasive facing downwardly after emergence from the chamber 18 is, in this case, not less than about eight seconds but often longer times are preferred.

The treated web is passed from suction drum 29 of Figure 1 over idler rolls 30 and thence to

a commercial sandpaper drying room where the goods are festooned and heated to cure the resin according to the usual means. Good practice is to cure the goods in festoon form to a point where the grains are well anchored in place but at the same time not cure the goods to a point where they cannot be readily removed from the curing racks for final curing at high temperatures in either roll form or sheet form according to present known methods.

Discs so made by the special methods illustrated, referred to in Fig. 1, are found to be rougher and sharper than goods made similarly but in which the novel methods disclosed herein are not employed.

Coated abrasive, Example 4, has been given as a concrete illustration of the use of synthetic resins in my new processes. It is to be understood that other resins may be used and that the means of Figure 2 may be employed in carrying out the processes. Furthermore, reasonable modifications of all of the means shown in Figures 1 and 2 and described herein are contemplated.

Figures 1 and 2 illustrate the application of my process and apparatus to coated abrasive machines now current in the industry. Instead of sizing the web and then turning it so that the abrasive side faces downwardly, I may provide an arrangement of the sandpaper equipment, as for instance, in which the making machines and the drying festoons between making and sizing are on an upper floor and the sizing machine is on a lower floor. In such a case, the web may be removed from the festoons as shown in Figures 1 and 2, carried downwardly through the floor and turned so that the abrasive side faces downwardly before the sizing operation. In this case, the sizing operation may be carried out with the abrasive facing downwardly after which any of my treatments may be applied such as those of chamber 18 of Figures 1 and 2 and the various vibrator or beater treatments, while the web is travelling with the abrasive side facing downwardly. After the treatments, the web is continued along a path with the abrasive side facing downwardly until the adhesive sets up sufficiently to anchor the grains after which the web may be moved by any convenient means to a drying room if the web has not been sufficiently dried while travelling with the abrasive side facing downwardly.

While I have illustrated the web passing through the chambers 18 in Figures 1 and 2, horizontally in a slightly inclined direction to the normal, it is to be understood that the web may be traveled through the said chambers horizontally in a direction perpendicular to the normal. Likewise, as the web issues from the chambers 18, it may travel in an inclined direction or in a horizontal direction perpendicular to the normal.

I claim:

1. A coated abrasive comprising a backing, a coating of abrasive grains held to said backing by an adhesive making coat, the majority of said abrasive grains being oriented with their long axes substantially at right angles to the plane of the backing, a sizing coat of adhesive applied over said grains, the oriented abrasive grains within the coating having a random spacing of their ends adjacent the backing and away from the backing but within the making coat of adhesive and having, as a result thereof, their exposed ends extending a correspondingly variable distance above the average level of the said sizing adhesive, the exposed points and edges of the abrasive grains being free from any deleterious quantity of said sizing adhesive and the exposed ends of the grains in the top of the coat being spaced far apart and open.

2. A coated abrasive comprising a backing, a coating of abrasive grains held to said backing by an adhesive making coat, said coating of grains, as initially applied, consisting of a single layer of grains one grain deep and substantially all of the grains being oriented, as initially applied, with their long axes substantially at right angles to the plane of the backing, a sizing coat of adhesive applied over said grains, the abrasive grains within the final coated abrasive being oriented with substantially all of their long axes substantially perpendicular to the plane of the backing, but having a random spacing of their ends adjacent the backing and away from the backing but within the making coat of adhesive and having, as a result thereof, their exposed ends extending a correspondingly variable distance above the average level of the said sizing adhesive, the exposed points and edges of the abrasive grains being free from any deleterious quantity of said sizing adhesive and the exposed ends of the grains in the top of the coat being spaced far apart and open.

3. The method of making coated abrasives comprising applying a making coat of adhesive to a backing, applying a layer of abrasive grains upon said making coat, at least a substantial proportion of said grains as initially applied having their long axes substantially normal to the plane of the backing, at least partially setting the making coat to anchor the grains to the backing, applying a sizing coat of adhesive over said grains while the said making coat is in such a state that it is softenable by said sizing coat, and quickly after sizing, prior to substantial loss of said orientation of grains, maintaining the backing so coated and sized with its abrasive surface facing downwardly while permitting the sizing coat to soften the making coat and while setting the adhesive at least sufficiently to prevent substantial movement of the grains within the adhesive when the coated backing is moved so that the abrasive surface no longer faces downwardly in subsequent operations whereby to produce a final sized coated abrasive in which a substantial proportion of the grains have their long axes substantially normal to the plane of the backing.

4. The method of making coated abrasives comprising applying a making coat of adhesive to a backing, applying a layer of abrasive grains in oriented relationship upon said making coat whereby a substantial proportion of the grains have their long axes substantially at right angles to the plane of the backing, at least partially setting said making coat to anchor the grains to the backing, applying a sizing coat of adhesive over said grains while said making coat is in such a condition that it may be softened by said sizing coat, vibrating the backing while the sizing coat is still fluid and the making coat is being softened by said sizing coat whereby to prevent the abrasive grains from losing said orientation with their long axes perpendicular to the backing, facing the abrasive surface downwardly, and while the coated backing is in such position fluidizing the sizing coat, softening the making coat and vibrating the coated backing while the said sizing coat and making coat are in such a condition, and setting the adhesive at least sufficiently

to prevent movement of the grains within the adhesive when the coated backing is subsequently disposed in other positions whereby to produce a coated abrasive product in which a substantial proportion of the grains have their long axes substantially normal to the backing, their exposed ends extending a variable distance above the average level of the said sizing adhesive and their exposed points and edges free from any deleterious quantity of said sizing adhesive.

5. The method of making coated abrasives comprising applying a making coat of adhesive to a backing, applying a layer of abrasive grains in oriented relationship upon said making coat whereby a majority of the grains have their long axes substantially at right angles to the plane of the backing, at least partially setting the making coat to anchor the grains to the backing, applying a sizing coat of adhesive over said grains while the making coat is in such a state that it is softenable by said sizing coat and quickly after sizing, prior to substantial loss of said orientation, maintaining the backing so coated with its abrasive surface facing downwardly while setting the adhesive at least sufficiently to prevent movement of the grains within the adhesive from their initially applied positions when the coated backing is moved so that the abrasive surface no longer faces downwardly in subsequent operations, whereby to produce a final sized coated abrasive in which a majority of the grains have their long axes substantially normal to the backing.

6. The method of making coated abrasives comprising applying a making coat of adhesive to a backing, applying a layer of abrasive grains in oriented relationship upon said making coat whereby a majority of the grains have their long axes substantially at right angles to the plane of the backing, at least partially setting the making coat to anchor the grains to the backing, applying a sizing coat of adhesive over said grains while the making coat is in such a state that it is softenable by said sizing coat, disposing the backing so coated and sized with its abrasive surface facing downwardly before substantial loss of said orientation of grains has occurred and while the backing is in such position fluidizing the sizing coat, softening the making coat and vibrating the said coated and sized backing and, subsequently, while the coated backing still has its abrasive surface facing downwardly, setting the adhesive at least sufficiently to prevent substantial movement of the grains within the adhesive when the coated abrasive is moved so that the abrasive surface no longer faces downwardly in subsequent operations whereby to produce a final sized coated abrasive product in which a majority of the grains have their long axes substantially normal to the backing, their exposed ends extending a variable distance above the average level of the said sizing adhesive and their exposed points and edges free from any deleterious quantity of said sizing adhesive.

7. The method of making coated abrasives comprising applying a making coat of adhesive to a backing, applying a layer of abrasive grains upon said making coat, a substantial proportion of said grains having their long axes substantially at right angles to the plane of the backing at least partially setting the making coat to anchor the grains to the backing, applying a sizing coat of adhesive over said grains while the making coat is in such a state that it is softenable by said sizing coat, disposing the backing so coated and sized with its abrasive surface facing downwardly before substantial loss of said orientation of grains has occurred and while the backing is in such position fluidizing the sizing coat, softening the making coat and vibrating the said coated and sized backing and, subsequently, while the coated backing still has its abrasive surface facing downwardly, setting the adhesive at least sufficiently to prevent substantial movement of the grains within the adhesive when the coated abrasive is moved so that the abrasive surface no longer faces downwardly in subsequent operations whereby to produce a final sized coated abrasive product in which a majority of the grains have their long axes substantially normal to the backing, their exposed ends extending a variable distance above the average level of the said sizing adhesive and their exposed points and edges free from any deleterious quantity of said sizing adhesive.

8. The method of making coated abrasives comprising applying a making coat of adhesive to a backing, applying a layer of abrasive grains upon said making coat, at least a substantial proportion of said grains as initially applied having their long axes substantially normal to the plane of the backing, at least partially setting the making coat to anchor the grains to the backing, applying a sizing coat of adhesive over said grains while the making coat is in such a state that it is softenable by said sizing coat, and prior to substantial loss of said orientation of grains maintaining the backing so coated with its abrasive surface facing downwardly while fluidizing the sizing coat, and, subsequently, while the abrasive coated surface of the backing is still facing downwardly, setting the adhesive at least sufficiently to prevent movement of the grains within the adhesive when the coated backing is moved so that the abrasive surface no longer faces downwardly in subsequent operations whereby to produce a final sized coated abrasive in which a substantial proportion of the grains have their long axes substantially normal to the backing and the exposed points and edges of the grain are free from any deleterious quantity of said sizing adhesive.

9. The method of making coated abrasives comprising applying a making coat of adhesive to a backing, applying a layer of abrasive grains upon said making coat, at least a substantial proportion of said grains as initially applied having their long axes substantially normal to the plane of the backing, at least partially setting the making coat to anchor the grains to the backing, applying a sizing coat of adhesive over said grains while the making coat is in such a state that it is softenable by said sizing coat, at some stage while the sizing coat is fluid and the making coat is softened, vibrating the backing so coated and sized by a vibrating force applied to the non-abrasive side of the backing effective to maintain or improve the orientation of said grains, and maintaining the backing so coated with its abrasive surface facing downwardly while setting the adhesive at least sufficiently to prevent substantial movement of the grains within the adhesive when the said coated and sized backing is moved so that the abrasive surface no longer faces downwardly in subsequent operations, whereby to produce a final sized coated abrasive in which a substantial proportion of the grains have their long axes substantially normal to the plane of the backing.

10. The method of making coated abrasives

comprising applying a making coat of adhesive to a backing, applying a layer of abrasive grains upon said making coat, at least a substantial proportion of said grains as initially applied having their long axes substantially normal to the plane of the backing, at least partially setting the making coat to anchor the grains to the backing, applying a sizing coat of adhesive over said grains while the making coat is in such a state that it is softenable by said sizing coat, and prior to substantial loss of said orientation of grains maintaining the backing so coated with its abrasive surface facing downwardly while subjecting its abrasively coated side to a solvent-bearing atmosphere effective to fluidize the sizing coat and subsequently while the abrasive surface is still facing downwardly, setting the adhesive at least sufficiently to prevent substantial movement of the grain within the adhesive when the said coated and sized backing is moved so that the abrasive surface no longer faces downwardly in subsequent operations, whereby to produce a final sized coated abrasive in which a substantial proportion of the grains have their long axes substantially normal to the plane of the backing and the exposed points and edges of the grains are free from any deleterious quantity of said sizing adhesive.

11. The method of making coated abrasives comprising applying a making coat of adhesive to a backing, applying a layer of abrasive grains upon said making coat, at least a substantial proportion of said grains as initially applied having their long axes substantially normal to the plane of the backing, at least partially setting the making coat to anchor the grains to the backing, applying a sizing coat of adhesive over said grains while the making coat is in such a state that it is softenable by said sizing coat, vibrating the backing so coated by a vibrating force applied to the non-abrasive side of the backing which is effective to maintain or improve said orientation of said grains, and prior to substantial loss of said orientation of grains maintaining the backing so coated and sized with its abrasive surface facing downwardly while setting the adhesive at least sufficiently to prevent substantial movement of the grains within the adhesive when the coated and sized backing is moved so that the abrasive surface no longer faces downwardly in subsequent operations, whereby to produce a final sized coated abrasive in which a substantial proportion of the grains have their long axes substantially normal to the plane of the backing.

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