

April 30, 1940.

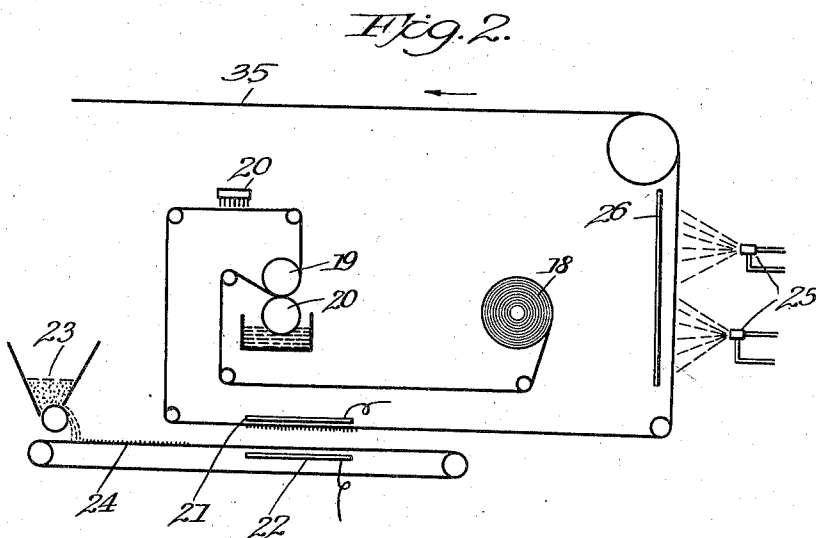
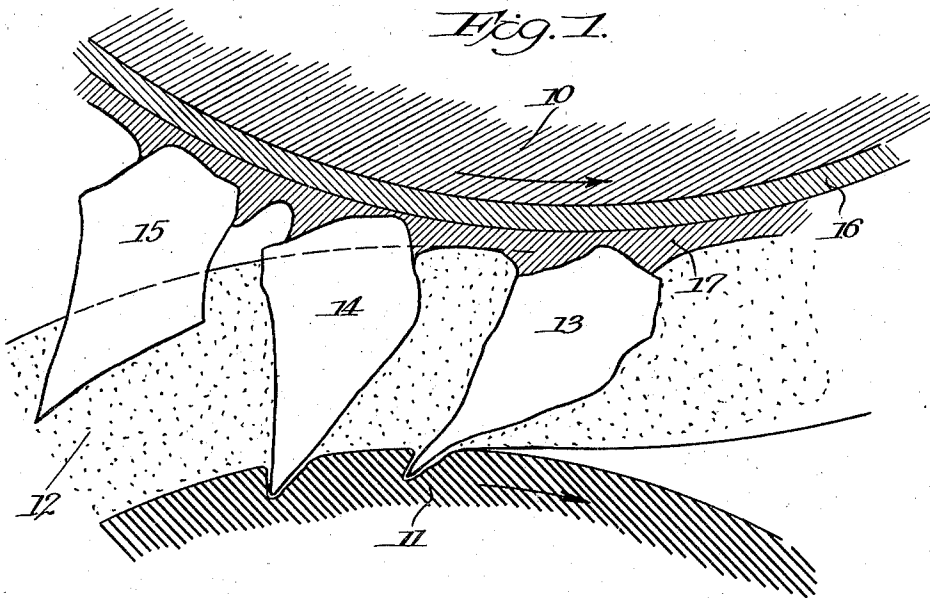
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2,198,766

METHOD OF MAKING FLEXIBLE ABRASIVES

Filed Dec. 22, 1932

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

Fig. 3.

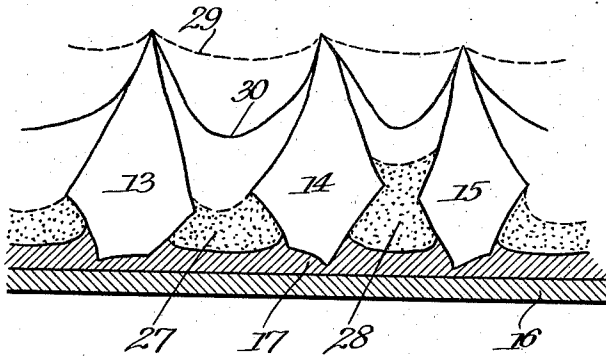


Fig. 4.

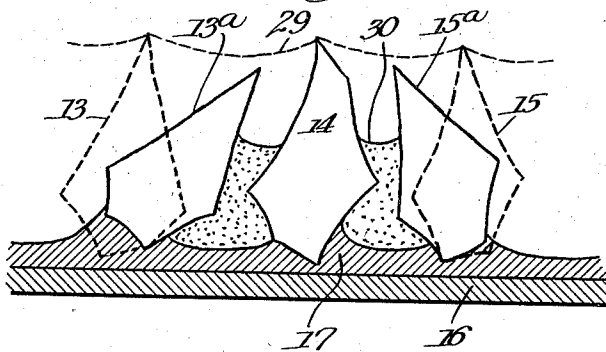
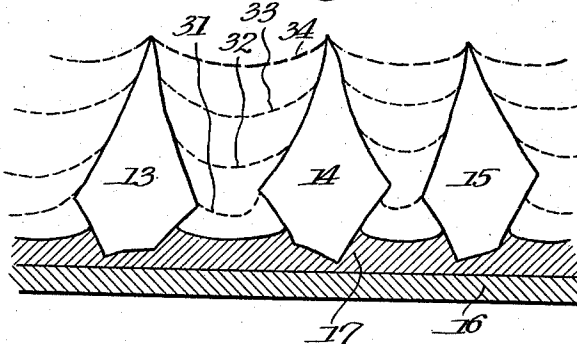


Fig. 5.



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3 Sheets-Sheet 3

Fig. 6.

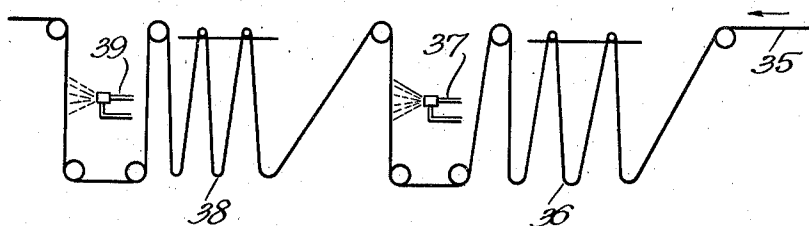
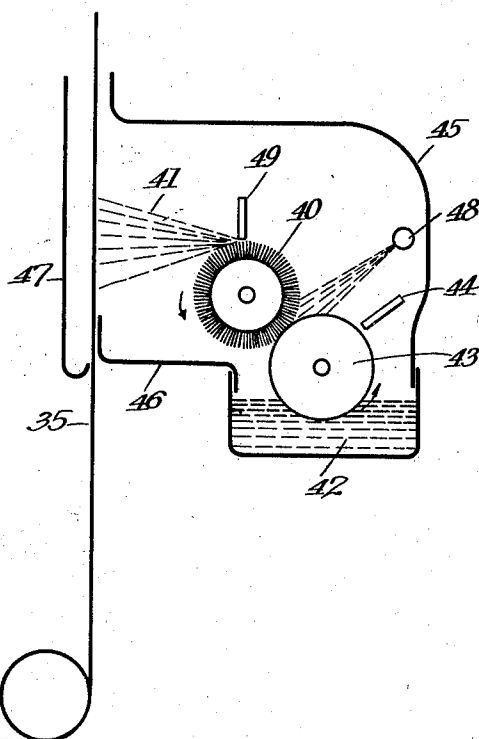


Fig. 7.



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UNITED STATES PATENT OFFICE

2,198,766

METHOD OF MAKING FLEXIBLE ABRASIVES

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Application December 22, 1932, Serial No. 648,520

9 Claims. (Cl. 51-295)

This invention relates to new and useful im-
provements in methods of making flexible
abrasives, such as sand paper or abrasive cloth,
and to the new and improved product resulting
therefrom.

In conventional methods of manufacturing
abrasive paper or cloth, or sand paper, it has been
customary to coat the backing sheet of paper or
cloth with a layer of adhesive such as glue,
known in the art as the "making" or base coat-
ing. The next step has been to drop or sprinkle
the abrasive grains onto this freshly coated ad-
hesive surface, which results in the retention
of a layer of abrasive, lightly held to the back-
ing sheet, by the thin making or base coat of ad-
hesive.

To provide adequate bonding of the abrasive
particles to the backing sheet, it has been cus-
tomary to dry the coated sheet after the abrasive
particles have been applied, and then pass the
sheet through a pair of calender rolls which apply
additional adhesive solution, as a size or bond-
ing coat over and around the abrasive particles.
When this size coat dries, the adhesive shrinks
and dries around the abrasive grains, holding
them firmly in position.

It has been developed recently that the cutting
efficiency of flexible sheet abrasives depends
largely upon the relative position of the individual
abrasive grains with respect to each other. Since
the cutting is performed by the sharp exposed
edges of each of the abrasive particles, it is de-
sirable, in order to secure maximum efficiency
from the abrasive sheet, to deposit and maintain
the abrasive particles in an upright position with
their major axes at right angles to the abrading
surface, so that these sharp points and edges are
disposed outwardly with respect to the backing
sheet and are positioned to come into cutting con-
tact with the work. Recent improvements in the
art of distributing, positioning and orienting of
the abrasive grain (as disclosed, for instance, in
Patent No. 1,854,071, issued April 12, 1932, to E. C.
Schacht), have made it possible to secure sub-
stantially greatly improved initial positioning of
the grains on the making sheet. As a result of
electrostatic or electromagnetic deposition of the
grains, or by means of other special methods, the
abrasive particles are lightly secured to the mak-
ing coat in substantially equally spaced relation to
each other, and positioned with their major axes
disposed perpendicular to the backing. These
methods have emphasized the importance of
maintaining the carefully positioned grains in
their desired upright relation when the bonding

or size coat of adhesive is applied, so that the
grains will be permanently bonded to the back-
ing sheet in this desired relation. I have dis-
covered that conventional methods of applying
the size coat are inadequate for this purpose,
because the mechanical pressure applied to the
grains by calender rolls or the like will tip over
and flatten out, or otherwise displace, many of
the accurately positioned and properly oriented
abrasive grains. Naturally, these old sizing meth-
ods destroy, to a great extent, the improved cut-
ting efficiency which would be expected to fol-
low from the improved methods of distributing,
positioning and orienting the abrasive grains.

Consequently, it is an object of the present in-
vention to provide new and improved methods by
which the sizing of abrasive papers can be car-
ried out, without disturbing or damaging the
favorable positioning or orientation of the abra-
sive particles, as achieved by the recently devel-
oped methods at the abrasive coating machine.
Furthermore, the invention is useful in maintain-
ing whatever desirable positioning of the grains
may have been accomplished by chance through
the old abrasive depositing methods.

With former old, conventional methods of ap-
plying the abrasive grains, in which no special
positioning or orientation thereof was accom-
plished, the disadvantages of conventional roll
application of the sizing coat (or other mechan-
ical methods) were not recognized, because the
positioning of the grains was, at best, poor, and
the transmission of calender roll pressure to
the grains was not regarded as a material disad-
vantage. Because the product to which the siz-
ing coat was applied was a rather poor one, with
not substantially all or even a substantial per-
centage of particles standing on end, an inefficient
method of applying the sizing coat to that product
was tolerated, which method tended to make the
final product only slightly less efficient by flat-
tening some of the few upright grains. Many
methods of applying the sizing coat to sand paper
upon which the grains had been deposited with-
out individual control were known prior to this
invention. These methods included the several
conventional coating processes of the prior art,
such as are effected by a brush, a roll, a spray,
an immersion tank, or the like. The various
methods of applying this coat, and particularly
by spraying, were described with reference to a
particular composition (cellulosic lacquers) in
the patent to Power, 1,615,231, January 25, 1927
(Reissue 17,494).

It will be appreciated, therefore, that when old,

conventional, methods of applying the abrasive particles to the coated backing sheet were used, it was found to be immaterial whether the sizing coat of adhesive was applied by a roll, spray, brush, or any other conventional means. No particular unobvious advantage of one means could be found over another. Calender rolls were the recognized and accepted means.

Since the development of special methods of depositing the abrasive grains on the coated backing sheet in controlled relation to each other, and in individually oriented relation to the sheet, the problem has arisen of permanently and securely affixing the particles to the sheet without changing that careful positioning or orientation. As stated above, the primary object of the present invention relates to a solution of this problem.

Although the present invention relates primarily to special methods of applying the sizing coat to abrasive grains which have been previously applied to the backing sheet by special positioning and orienting methods, I wish it distinctly understood that the invention is not limited to the application of the sizing coat to specially positioned grains, but may be used with great advantage with sheets upon which the grains have been deposited by old uncontrolled methods. It will be understood that the advantages which flow from the use of the present invention will apply to sand papers or the like having the grains applied by the old methods, and will result in a product which, although less efficient than one using the recently developed methods of applying the abrasive grains, will be more efficient than products made in accordance with the old methods of depositing the grains and the old methods of applying the sizing coat. Consequently, although there is a definite combination between the new methods of depositing the grains and my improved methods of applying the sizing coat, the invention is also useful with conventional methods of depositing the abrasive.

As stated above, when a backing sheet having specially positioned abrasive grains lightly secured to the making coat is passed through calender rolls for the purpose of applying the sizing coat, a large proportion of the increased efficiency naturally expected to be derived from the special methods of applying the grains is lost. This follows from the fact that many of the grains are dislodged from their upright position by the calender roll pressure. The heated glue solution applied by the rolls tends to soften the making coat and destroy the relatively weak bond between that coat and the abrasive particles, with the result that the calender roll pressure tips the grains over, flattens them out and destroys the cutting efficiency of the sheet as a whole.

In order to prevent the transmission of calender roll pressure to the abrasive particles, I conceived the idea of applying the sizing coat by means of a spray, and experimented with spray methods such as are disclosed in the Power Patent 1,615,231, mentioned above. I discovered, however, that such a method, that is, the broad idea of applying the sizing coat by a spray instead of a roll, effects but small improvement over roll application. The large body of hot glue solution comprising the sizing coat when applied by a single application of a spray tends to transmit heat and moisture to the making coat and greatly softens the same. The result is that the initially weak bond between the making coat and the

abrasive particles is further appreciably weakened and the particles are surrounded by a layer of soft glue made up of the bonding coat and the sizing coat substantially merged together. When this coat dries out and hardens, great contracting forces are set up in the body of the glue, the abrasive particles are drawn together in groups or clusters, and the desirable positioning and orientation of the grains is destroyed.

In order to obviate these disadvantages of the spray method and in order to solve all problems which arise from the use of a spray coat, the present invention contemplates first preventing the softening of the making coat and consequently preventing a destruction of the light bond between that coat and the abrasive particles, and, secondly, it contemplates applying and drying the sizing coat in such a manner that contracting forces sufficient to disturb the orientation of the particles are not set up.

In order to prevent softening of the making coat by heat and moisture derived from the sizing coat, I apply the sizing coat by means of a spray in such a thin layer that it has neither sufficient heat nor moisture to affect adversely the making coat. This thin preliminary size coat reinforces the bond between the making coat and the abrasive particles, and establishes a sufficiently strong union therebetween to permit the application of a subsequent sizing coat or coats by a roll or by a spray. As will be pointed out below, the invention contemplates several specific variations of means for building up the sizing coat, the important feature, common to all, being that the bond between the making coat and the grains is unimpaired and consequently the desired orientation of the grains is not disturbed. In some cases, and as specifically pointed out below, it is found desirable to prevent softening of the making coat by interposing a cooling step simultaneously with or immediately after the application of the hot glue solution comprising the sizing coat.

The application of the sizing coat in small increments reduces shrinkage forces of the adhesive, and clustering of the abrasive particles is prevented. Thus, the principal problems arising from the use of a sprayed sizing coat are completely solved by the present invention, while the advantages of a spray application, as opposed to a mechanical application, are retained.

The adhesive most commonly employed in the making of sand paper is glue. This is dissolved or dispersed in water and used at temperatures ranging from 135° to 165° F. The processes herein described are also applicable to binders or adhesives used in making water proof papers, such as China-wood oil, resin varnishes diluted with turpentine, or naphtha, and to a variety of artificial resin varnishes such as those of the phenol condensation type and of the alkyl type.

Several modifications of the present invention are illustrated diagrammatically in the accompanying drawings and are fully described in the following specification.

In the drawings:

Figure 1 shows an enlarged diagrammatic view of the application of a sizing coat to previously oriented grains by calender rolls.

Figure 2 represents diagrammatically a plant layout for spray sizing oriented grains, according to this invention.

Figure 3 is an enlarged diagrammatic view of the application of the sizing coat in two increments.

Figure 4 is a diagrammatic illustration, on an

enlarged scale, of the clustering action of the grains, resulting from the application of an unduly thick sizing coat.

Figure 5 is a diagrammatic representation, on an enlarged scale, of the application of the sizing coat in a plurality of increments.

Figure 6 is a diagrammatic view of a plant layout for applying the sizing coat in a plurality of layers, interposed by drying stages.

Figure 7 is a specific spray construction which may be used to advantage in the method of the present invention.

Figure 1 illustrates on a somewhat magnified scale the general prior art make-up of an abrasive paper and the manner in which the abrasive particles are deranged during a roll sizing operation. In this drawing is shown a section of a top calender roll 10 in operating relation to bottom calender roll 11 which is carrying up sizing solution 12 into contact with abrasive particles 14 and 15 indicated in a desirably spaced and oriented position on the backing 16 and lightly held in position by a thin dried adhesive layer 17 applied at the making machine. Sizing solution 12, of glue, may contain 30% to 40% of glue by weight and 70 to 60% of water at a temperature of 140° F. This considerable mass of hot adhesive solutions tends to quickly wet and soften the adhesive layer 17, which further permits the displacement of the abrasive particles under the pressure of roll 11. Abrasive particle 13 illustrates how this displacement can take place. It is evident that a wide variety and degree of displacement can take place, depending on the spacing of rolls 10 and 11, on the arrangement of the abrasive particles, the degree of contact with and the bonding action of adhesive layer 17, and on the temperature and amount of size solution 12.

In Figure 2 there is shown one method of applying a size solution as a spray to the positioned and oriented abrasive particles without subjecting these particles to any upsetting mechanical action. This drawing also illustrates a modern workable method of positioning and orienting the abrasive particles on the making coat of adhesive. In this drawing, 18 shows a roll of paper backing that passes through coating rolls 19 and 20 where a 40 to 50% glue solution is applied to one side of the backing. This glue coating is smoothed out by brush 20 after which the adhesively coated paper passes through an electrical field maintained between electrodes 21 and 22, which causes abrasive grains, fed from sand hopper 23, to belt conveyor 24, to be propelled electrically to the adhesive surface and in such manner that the individual abrasive grains are dispersed relative to each other and oriented with their longer axis substantially perpendicular to the plane of the paper.

Suitable methods for substantially uniformly orienting the grains are disclosed in the United States patent to Schacht 1,854,071, April 12, 1932, the British patents to Schacht 378,014, March 28, 1931, and 379,379, March 28, 1931, and in the United States patent to Smyser 1,788,600, January 13, 1931.

Such favorably coated sheet is dried to any required extent, either by exposure to warm, dry air or otherwise, after which it passes, abrasive side out, under a battery of spray nozzles 25 which spray the finely divided size solution over and between the abrasive particles. The number of spray nozzles must be such as will deposit the required volume of size solution over the abrasive and the spacing of the nozzles must

be such as to even out, as uniformly as possible, the size solution over the entire surface of the abrasive sheet. It is not my intention to describe here the detailed arrangement and operation of the spraying equipment. The general operation of spraying equipment is an old art and need not be expounded by me, while certain new and specific improvements that relate to the spraying of adhesives onto abrasive papers, and which I would choose to employ in carrying out my invention, are disclosed in the copending application of N. E. Oglesby, Serial No. 659,565, filed March 3, 1933. It will be evident from this description that the entire quantity of size glue required can be sprayed over the abrasive particles at one operation and without mechanically deranging the spaced and oriented particles during the sizing operation. However, as stated above, such a heavy coat, applied in a single layer results in certain inherent disadvantages, and is not preferred. Following the spraying of the size solution, the sized sheet is festooned onto drying racks and dried in the usual manner.

While I have described above a method of applying the size coat exclusively as a spray in a single operation, I have found that there are practical advantages of applying only a part of the size glue as a first operation in order to anchor and hold the abrasive grains in place well enough so that the sizing operation can be completed on a regular roll sizer without disturbing the position of the abrasive particles. This modification of my invention avoids the necessity and difficulty of obtaining perfect distribution of the size liquid as it is sprayed on the sheet. Most forms of spray nozzles project a conical form of spray which covers a circular area with an uncertain or irregular distribution of spray globules over the area of the circle. Irregularities in the quantity of solution deposited on a moving sheet can therefore result from overlapping of the spray patterns from multiple nozzles and from the irregularity of distribution within the circle of a single spray nozzle. Although it is possible to fairly well equalize these irregularities, I have found that it is simpler to put on only part of the size as spray and complete the operation by more automatic as more easily controlled means which will insure a uniform sizing over the entire area of the finished abrasive product.

There is also an additional and equally important advantage in avoiding the necessity of applying a large mass of liquid as a spray at one time. If only part of the size is to be applied as a spray this can be done immediately beyond the abrasive coating operation without extensive drying of the making adhesive coat. The typical layout shown in Fig. 2 is applicable to the practice of this modification. Spraying nozzles 25 for putting on only part of the size can be located a short distance beyond the point of application of the abrasive. The partly sprayed sheet 35 passes directly to the drying racks between making and sizing machine, so that when the partly sized sheet passes through the roll sizer the abrasive is held in position by a sufficient amount of dried adhesive to prevent the displacement of the abrasive by the sizing rolls. Abrasive partly sized in this way can also resist displacement or damage due to contact with guide rolls or any other part of the equipment other than the size rolls. A magnified representation of the disposition of the size by

this modification is shown in Fig. 3. The positioned and oriented abrasive grains 13—14—15 are held lightly in place by making adhesive 17 as they leave the making machine. As a result of spraying on part of the size back of the maker and then drying, the abrasive on entering the sizing rolls will be held not only by making coat 17 but will be quite rigidly held by the adhesive 27 and 28 so that they can withstand the tipping over action of the sizing rolls which will flood the abrasive with say the usual 30 to 40% adhesive solution up to the wet level 29. The latter on subsequent drying will dry down to level 30 as required for a completely and adequate bonded abrasive paper. Even though the partial spray sizing is applied to a non-uniform level as indicated by 27 and 28 compensating quantities of size solution from the rolls will be taken up in each space so as to produce the commercially uniform result indicated by 30.

As a modification of this method the invention contemplates that an additional set of spray nozzles may be used in place of the roll sizing machine if it is desirable with some coated abrasive articles to avoid entirely the use of rolls on top of the oriented abrasive. Carrying out the spraying operation in two stages would avoid spraying too much size solution at one time and would serve to compensate somewhat for or distribute the irregularities of the first spraying operation.

I have also discovered an advantage in fractionally adding the size in partial increments rather than in large quantities at a time, and that is the prevention of displacing the abrasive particles through the forces set up in the drying and shrinkage of the sizing adhesive layer. This displacement is quite distinct from any mechanical displacement by rolls or other outside agencies. The character of this displacing effect is explained by means of Fig. 4 which shows in magnified form positioned and oriented abrasive particles 13—14—15. If a size solution is added to wet level 29 without mechanically displacing the abrasive, this solution, due to its large mass, moisture, and temperature, will soften adhesive making layer 17 so that it will not rigidly hold the abrasive. Wet layer 29 on drying will dry and shrink down to dry level 30 and in the process of so doing will exert large forces on the abrasive particles which will deflect them into a variety of new positions. Actually as this process takes place the tops of adjacent abrasive particles are drawn together as indicated by 13a—14 and 15a to produce a series of clusters or agglomerates of abrasive particles over the surface instead of individually oriented and positioned particles. The result is a less uniform abrasive assembly resulting in decreased cutting efficiency and inferior sanding finish.

This undesirable result can in large measure be avoided by applying the sizing solution in small increments. The first increments had best be applied by spraying to avoid displacement of the abrasive by mechanical means. The later increments can be applied either by spraying or by rolls provided enough dried size is in position to prevent displacement of the abrasive. Figure 5 diagrammatically indicates the method of fractionally applying the size solution. The number of fractions required will depend somewhat on the special abrasive articles being made and had best be determined by experiment.

Abrasive particles 13—14—15 are lightly held in an oriented position by making coat 17, there

is first applied a fractional part of the size adhesive 31 so proportioned that the heat input from solution 31 will not too greatly soften making coat 17, and so that the shrinkage and drying forces exerted by thin layer 31 will not displace or tip the abrasive grain. Layer 31 is dried to rigid condition after which fractional layer 32 is added. On account of the combined holding action of 17 and 31, layer 32 can be heavier than 31. After drying in each case wet layers 33 and 34 can be added without seriously displacing the abrasive.

The nearer the abrasive particles are packed together the less derangement results from the drying and shrinkage of the size. The more dispersed the abrasive coating the greater care must be used to avoid derangement by the size layer or layers.

A typical arrangement of apparatus for carrying out fractional spray sizing is indicated in Fig. 6. The abrasively coated sheet 35 coming from the making machine or from the sprays 25 of Fig. 2 is dried in festoons 36 and then passed under a battery of sprays 37, redried at 38, and again fractionally sprayed at 39. Sizing rolls could be used in place of 39 or in a similar position further along.

In many cases, it will be found desirable, in addition to spraying the glue solution in thin or fractional layers, to cool the first of the fractional layers sprayed on, in order to dispose of the heat input of the freshly sprayed adhesive before it has time to soften the glue already in place. The softening of the glue already in place is a function of the quantity, temperature, and moisture of the newly applied adhesive. It is also a function of time. If the freshly applied adhesive were more quickly cooled and the heat input dissipated by such cooling, less of the heat would penetrate into and soften the bottom layers of glue. This cooling may be done, if desired, by passing the freshly sprayed paper through a refrigerated area, or by blowing on refrigerated air, or by the cooling action of the evaporating liquid during a regular drying operation so regulated as to produce this result. I may, for example, use moderately cool, dry air in considerable volume, which would cause a rapid evaporation of water from the freshly sprayed surface which would quickly remove a large part of the heat recently added through the fractionally sprayed sizing.

In place of the typical spray nozzles described and shown for applying a spray of liquid adhesive to the abrasive sheet other methods of throwing liquid globules or a spray can be used such as the rotating brush spraying method indicated in Fig. 7 in which a rotary brush 40 extending entirely across the abrasive sheet 35 throws a spray of adhesive 41 onto the adhesive sheet. The adhesive is transferred from the pot 42 to brush 40 by means of calender roll 43 on which the thickness of the glue film can be regulated by doctor blade 44. The spray chamber is enclosed by housings 45—46—47. Steam can be admitted to this housing through steam pipe 48 or directed onto spray roll 40. The brush 40 can be replaced by any other suitable rotating roll, such as a roll covered with card clothing as used in the textile industry or scored or slotted rubber rolls which will permit the adhesive to be sprayed or projected by centrifugal force. A doctor blade 49 can be pressed against the brush roll to aid in throwing the liquid adhesive tangentially from the roll. An advantage of such an arrangement over spray nozzles is the uniform distribution of spray over the width of the abra-

sive sheet without overlapping patterns of varying density that constitute a problem in the use of spray nozzles. The spray roll apparatus is also easier to maintain and is not subject to clogging as may be the case with spray nozzles. It is evident that this type of apparatus can be applied to all the modifications of my invention described herein wherever I have indicated the use of spray nozzles.

It is also possible to use a type of non-clogging spray device which consists of a means to bring the liquid adhesive in front of an orifice which admits air or steam at high velocity against a flap lip and which projects the liquid in a fan shaped spray across the width of the abrasive paper. This type of spray equipment throws a flat spray very suitable for covering a wide width of continuously moving abrasive paper and can be used wherever spray nozzles are indicated throughout this specification.

I claim:

1. The method of manufacturing coated abrasives comprising depositing abrasive particles on an adhesively coated backing sheet in oriented position and adhering the particles to the sheet, applying thereon a layer of an adhesive sizing, and then applying another layer of adhesive sizing upon the first mentioned layer.

2. In the manufacture of coated abrasives having the particles in oriented position, the method of sizing the abrasive adhered upon a backing sheet comprising the steps of spraying adhesive sizing in solution form thereon in fractional increments proportioned in amount to avoid displacing of the abrasive particles from their original oriented position, and drying one increment before another increment is applied.

3. The method of manufacturing coated abrasives comprising depositing abrasive particles on an adhesively coated backing sheet in oriented position and adhering the particles to the sheet and applying thereon successive layers of adhesive sizing under conditions to avoid substantial softening of the adhesive coating, whereby substantial displacement of the abrasive particles from their original oriented position is prevented.

4. In the manufacture of coated abrasives having the particles in oriented position, the method of sizing the abrasive adhered upon a backing sheet comprising the steps of applying adhesive sizing solution in fractional increments under conditions to avoid substantial softening of the adhesive and substantial displacing of the

abrasive particles from their original oriented position, and cooling and drying one increment before another increment is applied.

5. The method of manufacturing coated abrasives comprising depositing abrasive particles on a backing sheet in oriented position and adhering the particles to the sheet by an adhesive interposed between the sheet and the abrasive particles and applying thereon successive layers of an adhesive sizing in small increments avoiding displacement of the abrasive particles from their original oriented position.

6. The method of manufacturing coated abrasives comprising depositing abrasive particles on a backing sheet in oriented position and adhering the particles to the sheet by an adhesive interposed between the sheet and the abrasive particles and applying thereon successive layers of an adhesive sizing in small increments avoiding displacement of the abrasive particles from their original oriented position, the sizing being applied to maintain efficient clearances between the abrasive particles.

7. In the manufacture of coated abrasives having particles in oriented position, the method of sizing the abrasive adhered upon a backing sheet comprising the steps of spraying adhesive sizing in solution form thereon, in fractional increments proportioned in amount to avoid displacement of the abrasive particles from their original oriented position and to substantially concentrate one increment before another increment is applied.

8. In the manufacture of coated abrasives having the particles in oriented position, the method of sizing the abrasive adhered upon a backing sheet comprising the steps of applying adhesive sizing solution in fractional increments under conditions to avoid substantial softening of the adhesive and substantial displacing of the abrasive particles from their original oriented position, and cooling and drying one increment before another increment is applied.

9. In the manufacture of coated abrasives having the particles in oriented position, the method of sizing the abrasive adhered upon a backing sheet comprising the steps of spraying adhesive sizing thereon in fractional increments provided in amount to avoid displacement of the abrasive particles from their original oriented position and to substantially rapidly solidify one increment before another increment is applied.

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