

Jan. 18, 1944.

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2,339,500

FLEXIBLE BACKED ABRASIVE AND METHOD OF MAKING THE SAME

Filed Feb. 13, 1942

3 Sheets-Sheet 1

Fig. 1.

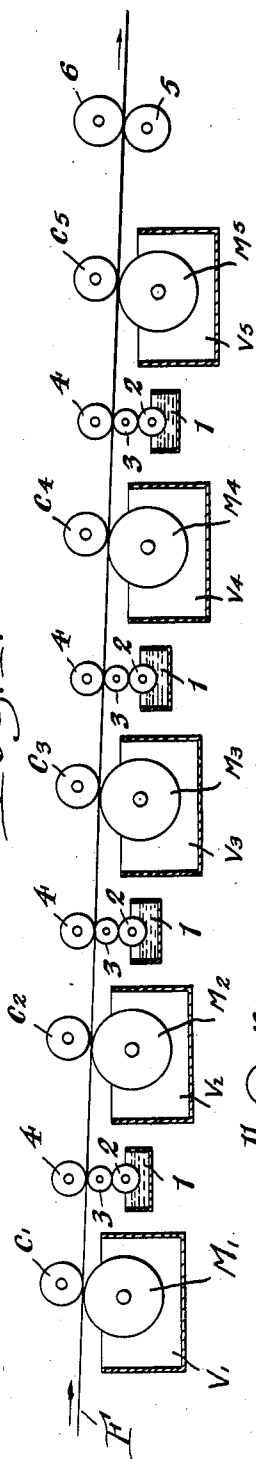
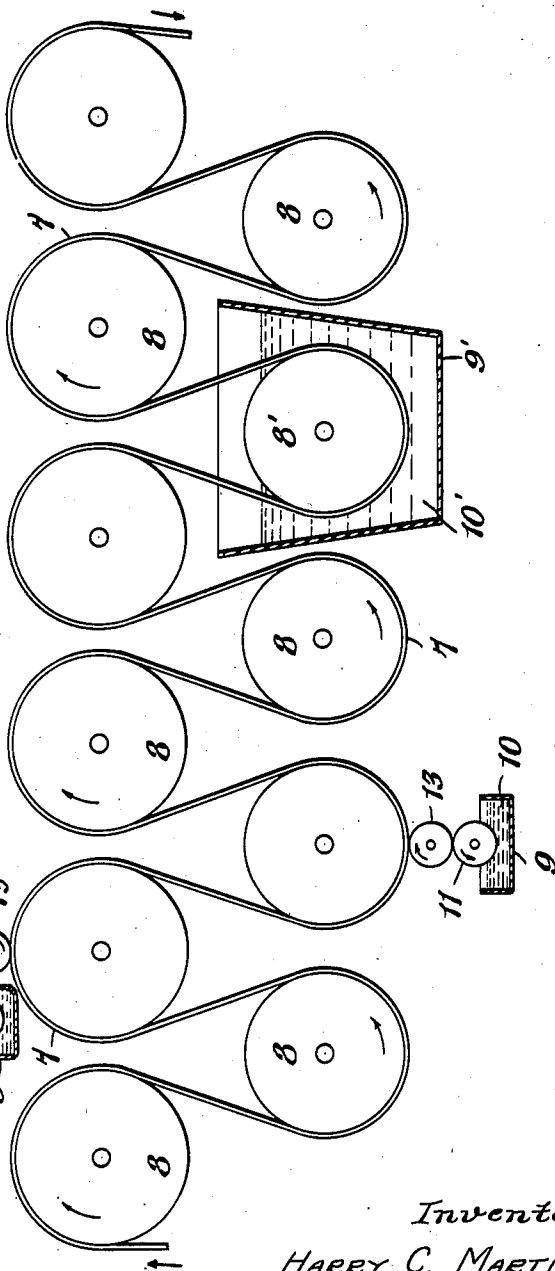


Fig. 2.



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3 Sheets-Sheet 2

Fig. 3.

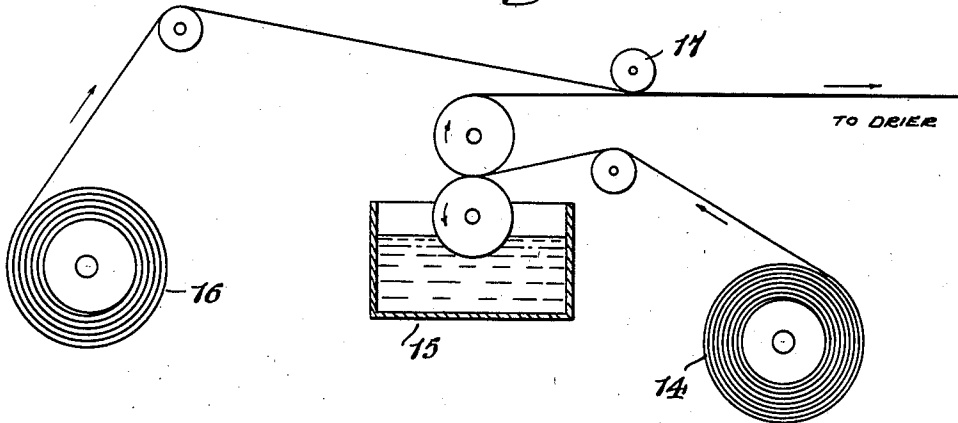


Fig. 4.

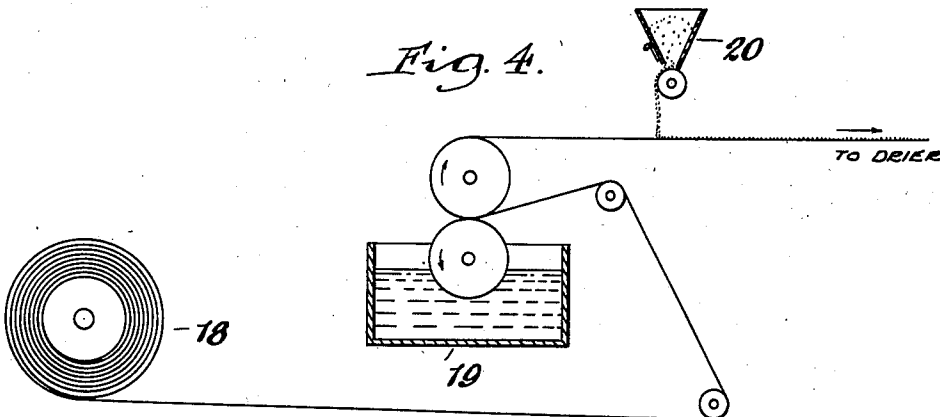
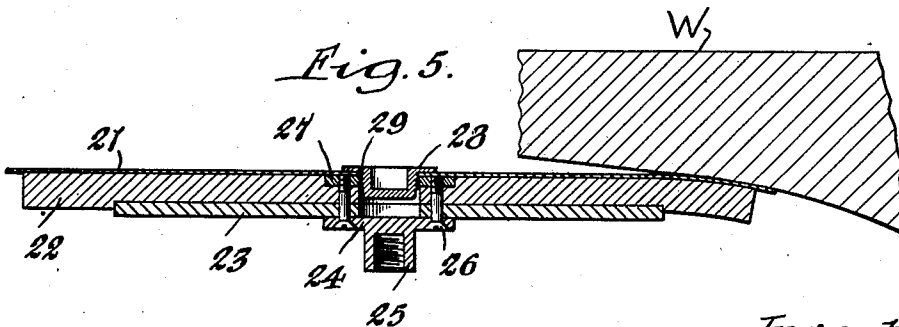


Fig. 5.



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3 Sheets-Sheet 3

Fig. 6.

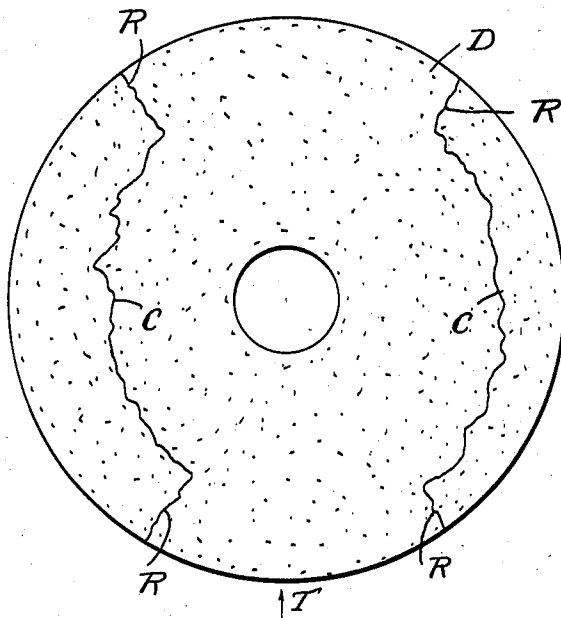


Fig. 7.

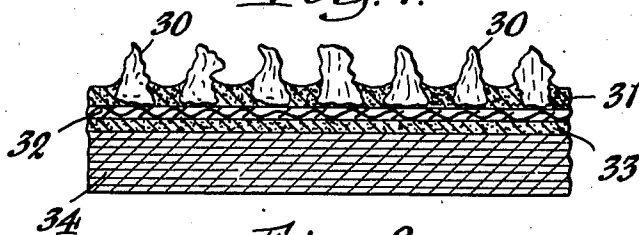


Fig. 8.

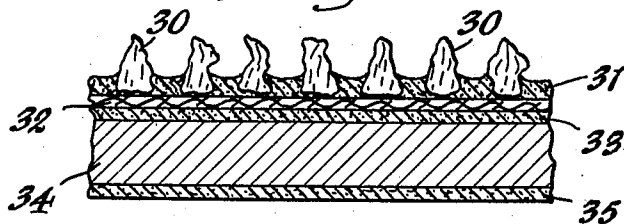
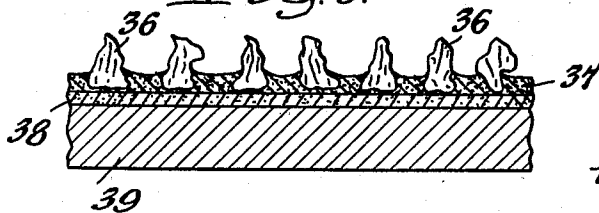


Fig. 9.



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UNITED STATES PATENT OFFICE

2,339,500

FLEXIBLE BACKED ABRASIVE AND METHOD
OF MAKING THE SAME

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11 Claims. (Cl. 51—195)

This invention relates to the manufacture of backed abrasives, and in particular to the manufacture of backings for abrasive disks and belts in which the backings are composed of a tough and flexible but comparatively cheap material.

Backings for abrasive disks and belts have been made in many cases from a comparatively expensive main constituent known as "vulcanized fibre." This material can be manufactured, for example, by pulping and sheeting pure cotton which is then subjected to the action of a solution of zinc chloride. This solution dissolves part of the fibre and leaves a gelatinous, sticky coating on the outside of the fibres. The sheets of this fibrous material are compressed between rolls and subsequently washed to remove as far as possible the last traces of zinc chloride and then dried. The drying is accompanied by considerable shrinkage. In view of the cost of the original pure cellulosic material and in view of the large number of successive treatments to which the cellulose fibres have to be subjected the cost of the "vulcanized fibre" is high. Many substitutes for "vulcanized fibre" have been tried in order to avoid the cost of this expensive material. Difficulties have arisen in the course of such attempts because abrasive disks and belts are subjected to severe mechanical stresses in operation. The disks are mounted, for example, on flexible pads driven by motors of several horse-power capacity. The mounted abrasive disks are used in such applications as the grinding down of sharp tough weld seams. Abrasive disk backings formed of many of the cheaper substitutes for "vulcanized fibre" split both radially and concentrically and thus constitute a hazard to the safety of workmen. The belts receive severe flexing in passing over the pulleys, and the cheaper backings are prone to crack crosswise of the belt. The present invention provides an economical substitute for "vulcanized fibre" (of the kind described above) in the manufacture of backed abrasives.

In the manufacture of such substitute material a very highly mechanically hydrated cellulose pulp such as kraft pulp is used. The mechanical hydration includes 30-40 hours beating while the beater roll is adjusted so that it just clears the bed plate and does not cut the pulp. The fibre length is thus retained and the resultant sheet is flexible. Pulp of the kind just described can be formed into thin webs on a paper machine of the cylinder type and a laminated paperboard stock made with a total thickness of a hundredth of an inch or a little more (0.010-0.018 inch).

It has further been found that the strength of the paperboard is much improved for use in mak-

ing abrasive disks and belts by adding to at least one of the faces of each successive layer of paper a glue or adhesive, while the layers are still moist, and then combining the layers to form a laminated paperboard stock.

A second method of strengthening paperboard made from highly hydrated kraft pulp is to apply a layer of adhesive to one side or both sides of the partly dried laminated sheet as it is being processed through the drying rolls of the paper machine. When a suitable amount of the proper adhesive is so applied the resulting sheet is found to be stronger and well adapted for use in backings for abrasive disks and belts.

The above two methods may be combined to produce a third modification of the method, that is, adhesive may be applied between laminations of the paper and after the laminations are combined and while the sheet is still only partly dried, a layer of adhesive may be applied to one or both sides of the sheet.

The character of the improved paperboard and the method of its manufacture can be better understood by reference to the drawings which illustrate the accompanying specification.

Figure 1 is a schematic view of the wet end of a five vat cylinder paper making machine provided with means for applying adhesive between laminations of the paper;

Figure 2 is a side elevation showing part of the drier roll end of a paper machine;

Figure 3 represents a side elevation of a combining machine;

Figure 4 shows a side elevation of a machine for coating abrasive particles on a backing;

Figure 5 shows, in cross-section, a flexible disk, mounted on a flexible pad, engaged in abrading a typical workpiece;

Figure 6 is a plan view of a prior art disk, abrasive side up, after use, showing types of failure;

Figure 7 is an enlarged view in cross-section of one modification of the disk of the present invention;

Figure 8 is an enlarged view in cross-section of another modification of the disk of the present invention and

Figure 9 is an enlarged view in cross-section of one modification of an abrasive belt made according to the present invention.

The principal backing constituent for the abrasive disks and belts of the present invention is obtained from kraft pulp. Kraft pulp is a wood pulp made by a chemical caustic cooking process. This process differs from the soda process in the addition of sodium sulphide. In carry-

ing out the mechanical hydration, kraft pulp is beaten for 30-40 hours in a conventional paper mill beater with the beater rolls adjusted to exert extremely light pressure and not to cut the fibres appreciably. This type of beater treatment serves to hydrate and gelatinize the cellulose fibres. The fibres become quite sticky and the freeness of the stock is greatly reduced. The beating action is preferably continued until the stock freeness is in the range of 50 to 70 as measured by the Schopper-Riegler freeness tester. The hydrated pulp is adjusted to suitable consistency and fed to a paper machine such as that shown in Figure 1.

Referring to the drawings, and first to Figure 1, there is shown diagrammatically the wet end of a five vat cylinder paper making machine, having means for applying an adhesive to the interfaces between laminations of the paper produced thereby, to carry out the first and third modifications of the method set out above. The vats are shown as V_1 to V_5 , each vat having a cylinder mold therein and a couch roll above the cylinder mold. Each vat is filled to a suitable level with stock consisting of highly overbeaten kraft pulp and water. In vat V_1 the cylinder mold is designated M_1 and the couch roll C_1 . The conventional felt F travels between the cylinder mold M_1 and its couch roll C_1 , picking up a thin layer of pulp or paper on the bottom of the felt as it passes over mold M_1 . As the felt and the one adhering layer of pulp or paper passes mold M_2 , the layer of wet paper on the felt picks off another layer of paper. The process continues as the felt and paper pass molds M_3 , M_4 , and M_5 , the resulting paper consisting of 5 layers, one produced by each mold. It is obvious that a paper of any desired number of layers may be made by employing that number of cylinder molds. The number of molds shown in the drawings is chosen for convenience only, and is not to be construed as a limitation.

Between each pair of adjacent vats there is located a means of applying a suitable glue or adhesive to the exposed face of the lowermost layer of paper on the felt, for the purpose of securing improved adherence between layers and improving the strength and endurance to repeated flexure of the resulting paper. The adhesive applying means consists of a trough 1 containing a suitable adhesive solution which may be a warm glue solution at a temperature of about 120° F. and containing 10-15% by weight of dry, high grade hide glue. Roll 2, which dips into the adhesive solution, and roll 3, which transfers the adhesive from roll 2 to the paper layer, are power driven so that roll 3 has the same peripheral speed as the paper layer it contacts, to avoid any detrimental strain on the weak paper layer. The felt F is backed up, at a point opposite roll 3, by idler roll 4. The rolls 2 and 3 and the container 1 can be adjusted vertically relatively to each other and as an assembly to regulate the amount of adhesive applied to each layer and also the amount of pressure which roll 3 exerts on the paper layer.

When the felt passes mold M_5 , the paper adhering to its underside consists of 5 layers with a layer of adhesive between each two adjacent paper layers. The felt and the adhering wet laminated paper then passes through an extractor press consisting of rolls 5 and 6, top roll 6 being a rubber covered roll and roll 5 being a wire faced hollow roll to receive water from the paper. The paper, still on felt F , passes to con-

ventional mechanism, not shown, which applies a second travelling felt to the bottom surface of the paper, and the paper is squeezed and dried between the felts until it becomes self-sustaining, at which time it leaves the felts and travels to the drier rolls shown in Fig. 2.

When the strengthening of the paper is accomplished only by an outer layer or layers of adhesive, the adhesive applying means 1, 2, 3, 4, between vats are omitted from the paper making machine.

In Fig. 2 a sheet 7, formed from highly hydrated pulp in a machine such as shown in Fig. 1 or formed in a similar machine but which is without the adhesive applicators between vats, is shown near the end of its course through a drying arrangement comprising heated rolls 8. Two adhesive applicator means are shown one for applying adhesive to each side of the partly dried sheet. One of these means may be omitted if the sheet is to be coated on one side only. The upper coating means comprises a trough 9 containing adhesive solution 10. Roll 11 dips into the solution, transfers adhesive to roll 12, which in turn transfers it to applicator roll 13. The lower coating means is similar to the upper one except that the intermediate roll is omitted. The adhesive can be a warm glue solution at a temperature of about 120° F. and containing 10-15 percent by weight of dry high grade hide glue. The rolls of the adhesive applicator means can be adjusted to apply sufficient adhesive so that when the coating is dried the glue left on each side of the sheet is about 1.5 percent of the weight of the final sheet when there is a ten percent glue solution in the containers 9. If a more concentrated glue solution, for example 15 per cent, is in the containers 9, the percentage of dry glue in the coated sheet may be as much as 2.3 percent by weight of the final sheet. Various other adhesives may be substituted for the hide glue above mentioned for use between laminations of the paper and as a coating on one or both outer surfaces thereof. Such other adhesives include urea resin, casein glue, and a phenolic resin, which is a phenol-aldehyde condensation product. The heat applied to the paper by five, more or less, subsequent heated drier rolls 8 is sufficient to dry the hide and casein glues and to partially harden the urea resin and the phenolic resin. Hardening of these two resins is completed during the curing of the abrasive bond of the product. After passing the five drier rolls, the sheet goes to the calender rolls for finishing.

The highly hydrated pulp stock produces a paper in which the individual fibers are strongly interlocked. Hydrated cellulose is a gelatinous fluid and the prolonged beating of the pulp stock results in the formation of a coating of hydrated cellulose on the outer surfaces of each fiber by reason of the hydration of those parts of the fibers. When a sheet is formed from such fibers, the gelatinous hydrates flow together with the result that the cellulose fibers which go to make up the paper sheet and which are reformed when the material is dehydrated, are so interwoven and interlocked that the resulting paper is unusually tough and strong.

Since the adhesive employed between laminations and on one or both outer surfaces of the sheet is applied while they are quite moist, it penetrates the sheet to a considerable extent, strengthening it to a marked degree by bonding the fibres of the paper laminations together and the laminations to each other. When it is de-

sired to obtain even better penetration of the adhesive, however, a wetting agent may be mixed with it. Such wetting agent may be, for example, a sodium salt of sulfonated succinic acid, such as diamyl ester of sodium sulfosuccinic acid, dibutyl ester of sodium sulfosuccinic acid, dihexyl ester of sodium sulfosuccinic acid, or dioctyl ester of sodium sulfosuccinic acid, or it may be alkyl aryl sulfonate.

It is sometimes desired to tan the hide glue or the casein glue after its application to the sheet, to improve its resistance to moisture. In such case, the sheet is passed, about four drier rolls further on from the second outer adhesive layer applicator, through a tanning solution 10', such as a potassium bichromate solution or a 10% formaldehyde solution, held in container 9' into which roll 8' dips. The outer layers of glue are thus wet by the tanning solution, and some of said solution penetrates to the inner layers of glue between paper laminations. The sheet then passes around further heated drier rolls, and when dry is forwarded to the calender rolls.

As an alternative to tanning the glue, as above, the glue between paper laminations may be waterproofed by adding methyl abietate thereto. In one example of this method, methyl abietate in the amount of 10-25% by weight based on the weight of the dry glue is added to a water solution of animal glue. The resulting mixture is employed as the adhesive between laminations of the paper, and may be contained in troughs 1 and applied by rolls 2 in the apparatus shown in Fig. 1.

In Fig. 3 the roll 14 contains a supply of paperboard which has passed through the apparatus shown in Fig. 2. The container 15 holds a glue solution from which a layer of glue is applied to one side of the paperboard; this side may or may not have been previously coated with adhesive while still moist by the apparatus shown in Fig. 2. The roll 16 contains a supply of cloth, such as light print cloth. The travelling cloth meets the travelling paperboard under the roll 17 and the two travelling sheets become united by means of the fresh layer of adhesive on the paperboard. The combined sheet then passes on to a drier.

In Figure 4 there is shown diagrammatically apparatus for coating the combination backing sheet with abrasive particles. The roll 18 contains a combination backing sheet formed by the union of paperboard adhesively attached to cloth. The travelling combination sheet receives a layer of liquid adhesive from the container 19 on the cloth side of the combination sheet. Shortly thereafter abrasive particles are dropped on the adhesive layer by means 20 and the abrasive-coated sheet passes on toward the drier. A second coating of adhesive, known as sizing coat, is usually given to the dry abrasive-coated sheet.

In Figure 5, there is shown an abrasive disk 21, of the type covered by this invention, in a typical manner of use. It is shown employed in abrading a curved surface of work piece W, and is mounted on driven flexible pad 22 so that it can flex as it comes in contact with the work, and thus have its abrasive surface assume momentarily at such zone of contact the contour of the work surface. Pad 22 is partially backed by conventional backing plate 23, and is driven by plate 24 and front plate 27, secured to the pad and to each other by machine screws 26. Plate 24 has internally threaded hub 25 thereon, so that it can be power driven, either mounted rigidly on a motor shaft or on a driven flexible shaft. Abrasive disk 21 is

secured to pad 22, at the center only, by nut 28 which has threaded connection 29 with plate 27.

It is clear from Fig. 5 that a disk employed in this manner is subjected to very severe forces of several kinds, (1) rapidly repeated bending along lines concentric with the axis of the disk; (2) radial tensional and compressional forces as the disk or work is traversed to cover the work surface, and (3) torsional forces resulting from the manner of driving the disk. Unless the backing material employed in the abrasive disk can endure such forces for a reasonable length of time, it is unsuitable, both for economic reasons and for the before-noted danger which attends use of a disk having a weak or weakened backing material.

It is obvious that an abrasive belt is likewise subjected to severe forces of several kinds, such as rapidly repeated bending and tension along the length of the belt. The backing material used in the abrasive belt must likewise endure such forces for a considerable length of time in order to make its use feasible.

In Fig. 6 is shown a prior art abrasive disk D which shows signs of failure. This disk is composed of paper, cloth glued thereon, and abrasive grains glued to the cloth. In a disk having a backing composed in a large part by a paperboard showing marked differences in directional properties, as in the disk shown in Fig. 6, failure results in radial lines R and concentric lines C, said concentric lines C being roughly parallel to the direction of travel T of the paperboard through the paper making machine. This is so because more fibres line up in the paper in the direction of its travel through the machine than transversely of such direction. Consequently, the paper is stronger in tension along line T than transverse to it, and also withstands flexure in a line across the direction T much better than it does flexure in a line parallel with direction T.

Fig. 7 shows in enlarged cross-section, the backed abrasive of the present invention employing adhesive layers between the paper laminations of the overbeaten kraft paper. The abrasive is denoted by character 30, 31 denotes an adhesive layer, 32 denotes the cloth layer, 33 is another layer of adhesive, and 34 is the paper layer in this modification.

In Fig. 8 the upper layers 30-33 of the disk are the same as those in Fig. 7. Paper layer 34 is overbeaten kraft fibre paper, with or without adhesive layers between the paper laminations. Layer 35 is the layer of adhesive applied by the apparatus of Fig. 2 during drying of the paper, as above described.

Fig. 9 shows in enlarged cross-section an abrasive belt made in accordance with the present invention. Overbeaten kraft fibre paperboard 39, with or without adhesive applied between laminations thereof, has a layer of adhesive 38 on one surface thereof, applied during drying of the paper by the apparatus of Fig. 2. A thin layer 37 of adhesive is put on the dried adhesive layer 38, and abrasive grain 36 is put on layer 37. The grain 36 penetrates layer 37 to some extent, and rests on or close to layer 38. Because the adhesive 38 is partially impregnated in the paper, it presents a rigid substantial foundation or backing for the abrasive grains. The abrasive grains, being thus held substantially unyieldingly against the work, cut very efficiently.

The belt may be further strengthened by the addition of a further adhesive layer such as layer 38, applied while the paper is still moist, on the

back of paper 39. There may be added also on such back surface a layer of cloth adhesively held thereto.

The product of the present invention compares favorably in length of life with the more expensive backed abrasive with "vulcanized fibre" backing. This is true of the abrasive of the present invention whether it has the backing made of overbeaten kraft fibre with adhesive layers between paper laminations, whether the backing is laminated overbeaten kraft fibre without adhesive layers between laminations but coated with adhesive on one or both sides during drying, or whether the backing has both these features. Furthermore, it has done away with the types of failure shown in the prior art as illustrated by Fig. 6 in connection with a disk and as described above in connection with a belt. The adhesive placed between laminations of the paper while they are wet penetrates the paper and thus stiffens and strengthens it when dry. In addition the adhesive produces a strong bond between paper laminations, eliminating any tendency for the paper to separate into layers during use. The outer adhesive coating or coatings on the paper made of highly overbeaten kraft pulp, also contribute greatly to the strength of the paper and are sufficient, when used by themselves, on a paperboard made from overbeaten kraft pulp to yield a product well suited for use in a backing for abrasive disks or belts. The outer coating layer being put on while the paper is wet, sinks into the paper to a large degree and becomes incorporated in it, thus greatly strengthening the paper. When the abrasive grain is used on such outer impregnating adhesive layer it cuts very efficiently, as has been noted in connection with an abrasive belt, because of the firm foundation for the grain which said impregnating adhesive layer affords.

Having fully described my invention, I claim:

1. A flexible backed abrasive comprising a backing of which the main constituent is a layer of laminated paperboard formed from an aqueous suspension of wood pulp fibers highly hydrated by prolonged beating in which the laminations have added adhesive layers between them, and a layer of abrasive grains adhesively attached to the backing.

2. A flexible backed abrasive comprising a backing of which the main constituent is a layer of laminated paperboard formed from an aqueous suspension of wood pulp fibers highly hydrated by prolonged beating, at least one of the lamina of said paperboard having a layer of added adhesive on at least one side thereof, and a layer of abrasive grains adhesively attached to the backing.

3. A flexible backed abrasive comprising a backing of which the main constituent is a layer of laminated paperboard formed from an aqueous suspension of wood pulp fibers highly hydrated by prolonged beating in which the laminations have added adhesive layers between them, said paperboard having a layer of added adhesive on at least one side thereof, and a layer of abrasive grains adhesively attached to the backing.

4. A flexible backed abrasive comprising a layer of laminated paperboard formed from an aqueous suspension of kraft pulp fibers highly hydrated by prolonged beating, a layer of cloth attached to one face of the paperboard, a layer of added adhesive on the side of the paperboard

opposite to the cloth, and a layer of abrasive particles attached to the cloth.

5. A flexible backed abrasive comprising a layer of laminated paperboard formed from an aqueous suspension of kraft pulp fibers highly hydrated by prolonged beating in which the laminations have added adhesive layers between them, a layer of cloth attached to one face of the paperboard, a layer of added adhesive on the side of the paperboard opposite to the cloth, and a layer of abrasive particles attached to the cloth.

6. The method of manufacturing flexible backed abrasives which comprises preparing an aqueous suspension of kraft pulp fibers highly hydrated by prolonged beating, forming the hydrated sticky pulp fibres into a thick sheet and partially drying said sheet, attaching a layer of hardenable adhesive to one side of the sheet before it is completely dry, drying the sheet and hardening the adhesive, attaching a layer of cloth to the side of the sheet not previously coated with adhesive, and attaching abrasive particles to said cloth layer.

7. The method of manufacture of flexible backed abrasives which comprises highly hydrating kraft pulp fibers by a prolonged beating until the fibres are adhesive, forming the coated fibres into a thick sheet and partially drying said sheet, applying a layer of hardenable adhesive to one side of the sheet before it is completely dry, drying the sheet and hardening the adhesive, and adhesively attaching abrasive grains to the said sheet.

8. The method of manufacture of flexible backed abrasives which comprises highly hydrating kraft pulp fibers by subjecting them to a prolonged beating until the fibres are adhesive, forming the fibres into a thick sheet by alternately depositing successive thin layers of said fibres and glue, partially drying said sheet, attaching a layer of glue to at least one side of the sheet before it is completely dry, further drying said sheet, contacting the sheet with a tanning solution suitable for at least some of the glue layers employed, attaching abrasive particles to the said sheet.

9. The method of manufacturing flexible backed abrasives which comprises subjecting kraft pulp fibers to a prolonged beating until the fibers become highly hydrated and adhesive, depositing alternate layers of the said fibers and an adhesive to build up a relatively thick sheet, drying said sheet, attaching a layer of cloth to one side of the sheet by means of an adhesive, and attaching abrasive particles to the said cloth layer.

10. The method of manufacturing flexible backed abrasives which comprises subjecting kraft pulp fibers to a prolonged beating until the fibers become highly hydrated and adhesive, depositing alternate layers of said fibers and an adhesive to build up a relatively thick sheet, drying said sheet, and attaching abrasive particles to the sheet.

11. The method of manufacturing flexible backed abrasives which comprises subjecting kraft pulp fibers to a prolonged beating until they become highly hydrated and adhesive, depositing alternate layers of the said fibers and an adhesive to build up a relatively thick sheet, treating the adhesive layers to make them water-resistant, and attaching abrasive particles to the sheet.

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