

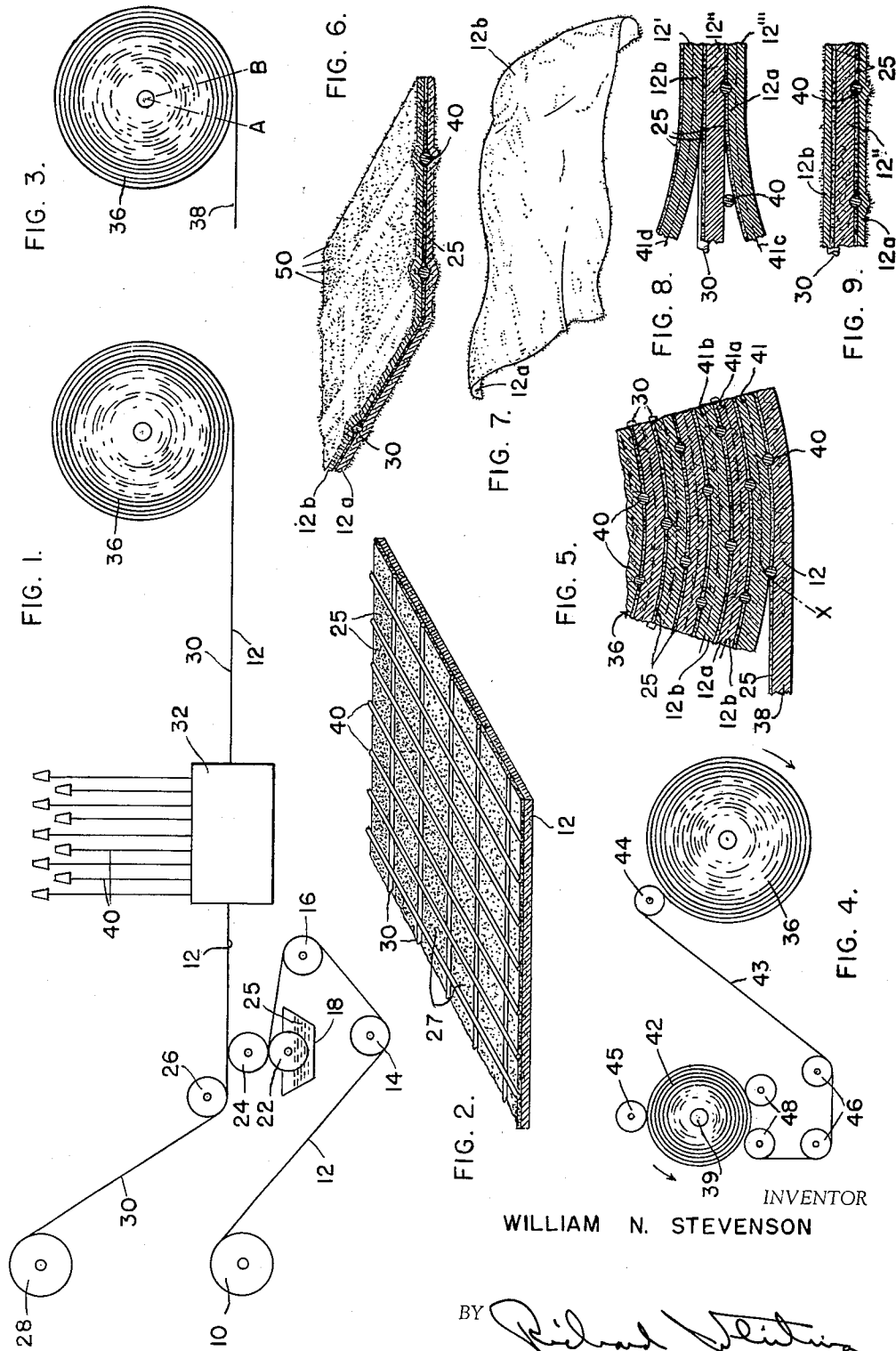
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MANUFACTURE OF REINFORCED PAPER AND PRODUCT

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## MANUFACTURE OF REINFORCED PAPER AND PRODUCT

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8 Claims. (Cl. 154—93)

This invention relates to multiply lamina of fibrous sheet material, such as paper and the like, and to methods of manufacturing the same. The primary object of the invention is to provide a laminated sheet which may be made thin and supple, and which has an uncalendered, torn-fiber surface having a soft texture not unlike that usually associated with a flannel-type textile fabric. The sheet is highly waterproof. It lends itself readily to reinforcement and when reinforced it has exceptionally high tensile strength and tear resistance for its weight and cost.

My invention also affords a novel method of manufacture by which such sheets may be manufactured at low cost.

In the drawings:

Fig. 1 is a diagrammatic illustration of certain early steps in the manufacture;

Fig. 2 is an enlarged perspective view of the adhesive coated and reinforced initial-stage web ready for setting-up;

Fig. 3 is an end view, on the scale of Fig. 1 of the setting-up roll;

Fig. 4 is a diagrammatic end elevation view of a later step in the manufacture;

Fig. 5 is an enlarged section of a segment of the roll of Fig. 3 taken between the radii A and B of Fig. 3;

Fig. 6 is a perspective diagrammatic view on enlarged scale of a piece of the finished sheet;

Fig. 7 is a perspective view on smaller scale of the finished sheet suggesting its suppleness and surface texture;

Fig. 8 is a diagrammatic vertical section of an early stage in the manufacture of a modification having three plies; and

Fig. 9 is a diagrammatic vertical section showing the finished three-ply sheet.

As shown in Fig. 1, a web of matted fibrous sheet material such as kraft paper 12 is conducted from a supply roll 10 around guide rolls 14, 16 and thence between roll 22 and back up roll 24 so that one surface of the web is coated with adhesive 25 from tank 18 in which roll 22 is immersed.

Reinforcing filaments 30 such as unspun sisal, glass fiber, etc. from supply 28 are led under roll 26 and are superimposed lengthwise of the adhesive coated web 12. Similar reinforcing filaments 40 are superimposed transversely of the web by the apparatus designated at 32 to form a web of adhesive coated paper having cross-laid filaments on the adhesive as illustrated in Fig. 2.

After the web has thus been coated with adhesive and has received lengthwise and transverse reinforcing filaments, successive portions of the coated web are then immediately superimposed on each other, for which purpose the web is then wound up in the form of the setting-up roll 36. In this winding and setting up operation, the object is to induce adjacent web convolutions to adhere tenaciously to each other, for a purpose which will appear. To that end, the winding is done while the adhesive

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is tacky and before it has had time to harden. The adhesive which coats one surface of the web has access to and is pressed against the opposite surface of that portion of the web forming the next adjacent inner convolution. Thus, Fig. 2 indicates a preferred adhesive and filament arrangement and, as there shown, areas 27 of substantial size bounded by cross laid filaments are afforded by proper arrangement and spacing of the cross-reinforcing filaments 30, 40 so that adhesive 25 on the upper surface of web 12 is exposed between the filaments to the under surface of the next adjacent inner convolution of the web. Successive convolutions of the web are pressed against each other in winding the roll 36, and this may be accomplished in any convenient way as, for example, by tensioning the web 12 during the winding. As a modification, the reinforcing filaments may, if desired, be entirely embedded in the adhesive, but this is unnecessary if the filament spacing, as shown in Fig. 2, is made adequate for access of the adhesive from one convolution to the next.

The roll 36 which has been made up in this way is next allowed to harden into a solid mass before the next operation, and usually it is stored for sufficient time to assure a fairly thorough setting up of the adhesive.

In the next operation, as shown diagrammatically in Fig. 4, the roll 36 is rewound into the roll 42 by an operation of unwinding and peeling the roll 36 so that the contiguous surfaces of the web convolutions which have been adhesively secured together in forming the roll 36 remain adhered together while the roll is stripped away by ply splitting of the web 12 along a plane intermediate the planes of successive layers of adhesive.

To facilitate initiation of the unwinding, a portion 38 of the web (Fig. 3) is left protruding when the roll is formed and stored for hardening of the adhesive, so that the stripping operation may conveniently be started by pulling on the flap 38. For convenience, the flap 38 may be drawn over guide rolls 44, 46 and 48 and secured to an arbor 39 which is rotated by powered rolls 45 and 48 to build up the roll 42 while stripping from the roll 36.

In Fig. 5, the successive convolutions of web 12 are shown alternating with intervening layers of adhesive 25 hardened so that the paper convolutions are secured to each other. As the flap 38 is pulled, a stress occurs at the place designated X in Fig. 5 which is opposed by the adhesive strength of the adhesive 25 tending to resist separation of the convolutions which it adheres together, and by the cohesive strength of the web 12 tending to hold its fibers together and resist internal ply separation of the web.

In the practice of this invention, adhesives and papers are employed which have strengths, in the respects noted, which bear a predetermined relation to each other so that when the roll 36 is acted on by pulling the flap 38 in the manner illustrated in Fig. 4, the strength of the adhesion of adjacent web convolutions to each other as reinforced by the cross-laid filaments 30 and 40, will be greater than the strength of the cohesive bond, resulting from the matting of fibers in the conventional forming of the paper sheet, effective for securing together the fibers internally of the web 12. As the result, upon adequate force being applied to the flap 38, the paper web will split along a plane of cleavage indicated by the dot-dash line 41. Continued pulling on the lead portion 43 (Fig. 4) by rotation of roll 42 counter-clockwise extends the plane of cleavage 41 around roll 36, successive occurrences of the plane being designated in Fig. 5 at 41a, 41b. Each convolution of paper web 12 will be split into plies 12a and 12b, as indicated in Fig. 5. The first convolution of material to be separated from the roll 36 will be composed of a full ply of paper 12 on one side and a split ply 12b on the other side, united

by intervening adhesive 25. Thereafter, the web that is peeled from the roll will be composed uniformly of the structure indicated diagrammatically by Fig 6, composed of top and bottom plies 12b and 12a, respectively, with intervening adhesive and reinforcing, both of which paper plies came from splitting a single ply 12 so that their aggregate thickness is equal to the original thickness of the single ply.

The exposed surfaces of the composite sheet are now, however, quite different from the smooth and perhaps calendered surfaces of the paper used as the single ply web 12 to be processed in accordance with this invention. As the result of the web splitting operation, the upper exposed surface of the ply 12b and the lower exposed surface of the ply 12a have a fibrous texture which is flannel-like and composed of short fuzzy fibers 50 torn away from their original matted positions in the fibrous sheet 12. The smooth or calendered surfaces of the starting web 12 are now disposed internally of the composite sheet in contact with the adhesive layer 25.

The showing of Fig. 6, as well as the other views, is diagrammatic, with parts exaggerated for clarity. Fig. 7 is of the same character in its showing of surface fibers, but it is intended as a true indication of the suppleness of the sheet as well as its textile-like handle which adapts it for many new uses such, for example, as in the packaging industry, and which also enhances its attractiveness for many of the conventional uses of reinforced paper. However, apart from the novelty of the paper product itself, an important advantage commending its use resides in the cost savings effected by the novel way of making it. Thus, for example, in building papers to be used internally of wall construction, as is common practice, the paper made in accordance with this invention has adequate tensile strength as the result of the filament reinforcing, adequate waterproofness as the result of the adhesive 25, with the substantial cost savings attending the use of only a single roll of paper 12, providing two sheets which are thinner than the conventional surface sheets but which are adequate and considerably cheaper. The cost of two webs of light-weight paper is usually appreciably more than the cost of a single web of paper of a weight equal to the sum of the two lighter webs so that the cost of producing a reinforced paper of a given weight is correspondingly less by my process than by conventional methods. Furthermore, composite sheets may be made by the present invention having facing sheets which are too thin to be handled easily by conventional equipment.

In some uses of reinforced paper such, for example, as in certain types of box stay tape, the tensile strength needed is afforded by the reinforcing filaments, and the water impermeability required is adequately provided by the adhesive so that although the paper plies of the tape contribute somewhat to these characteristics, they principally serve as a carrier by which the adhesive and strands may effectively be merchandised and handled in box manufacture. The present invention permits of the minimum paper weight per unit of tape length.

The degree of waterproofness of a reinforced sheet being dependent largely upon its adhesive layer, a three-ply sheet is considerably more waterproof than a two-ply sheet because it has a second adhesive layer. Such three-ply sheet may readily be made, following the teachings of the present invention employing, as shown in Fig. 8, plies 12', 12'' and 12''' of paper with lengthwise reinforcing filaments 30 interposed between the upper two plies, transverse reinforcing 40 interposed between the lower two plies, and a layer of adhesive 25 coating the upper surface of each of the plies 12', 12'' and 12'''. By winding the composite web into a setting-up roll followed by a rewinding and peeling, as described in connection with the two-ply sheet, the three-ply sheet of Fig. 9 is formed having the ply 12'' of initial thickness disposed

as the inner ply and with upper and lower plies 12b and 12a of half thickness formed by splitting.

In order to facilitate splitting of the web in the manner above described, the cohesive bond between the fibers of the web may be weakened by increasing, above normal, the moisture content of the web. This may conveniently be accomplished by providing the adhesive 25 in the form of an emulsion with water which will set up its adhesive bond by absorption of the water by the paper, thus simultaneously wetting the paper. Such an adhesive is described in the Nickerson application Ser. No. 149,641, filed March 14, 1950, now abandoned.

A number of other adhesives are suitable for the purposes of the present invention as, for example, typical animal glues, asphalts, or any adhesive which sets up to a dry, strong, continuous film. My preference, however, is for adhesives which are flexible and are in emulsion form for the advantages stated above.

The principle of this invention, while described with reference to kraft paper, is useful for laminating various matted fibrous sheet materials. Such papers as soft or absorbent papers, calendered papers or commercial wrapping papers, including but not limited to kraft papers, are suitable, and matted fibrous products other than cellulosic paper may also be used, for example, matted synthetic fibers or natural cotton fiber, or natural fiber other than cellulose, for example, wool, hair, fur, silk, or even inorganic fibrous products of the character of asbestos, may constitute a suitable sheet material after such fibers have been matted or felted in a manner known in the art. Moreover, the matted fibrous product may contain various filler materials, depending on the utility of the laminate formed. For example, the fiber may contain chalk, whiting, clay, metal powders, abrasive or polishing powders or detergent substances, as desired.

As will be understood, the invention is susceptible of further modification to suit the needs of particular users, and is not to be limited except as the appended claims require. The reinforcing filaments, which have been shown as arranged both lengthwise and transversely, may be arranged in one only of those directions, or may be disposed diagonally, or in a swirling configuration, or in any other pattern, or may be omitted entirely if an un-reinforced sheet is desired. Where filaments are used, they may be natural or synthetic, multi- or mono-filament, twisted, spun or unspun, or they may be of wire; and I use the term "filament" generically to include all such variants.

A box stay tape made in accordance with the present invention would preferably be secured to the box corner by a water-moistenable gum interposed between the box and the backing ply of the tape, and this gum may be applied to the tape before it is packaged and sold to the box manufacturer, or it may be applied to the box immediately prior to application of the tape. To enhance the stretchability of the tape in bending around a box corner it may be embossed in the manner disclosed in the Smith Patent No. 2,026,194.

I claim:

1. The method of manufacturing laminated sheet material which includes the steps of coating a fibrous web with adhesive, winding the web into a tight roll before the adhesive has hardened, setting up the adhesive so that adjacent web convolutions of the tight roll are adhered together, and then unwinding the roll while splitting the web convolutions thereon to form a multiply sheet having split fibrous plies on opposite surfaces thereof.

2. The method of manufacturing multiply paper which includes the steps of coating a paper web with adhesive, depositing reinforcing filaments on the adhesive coating, winding the web into a tight roll before the adhesive has hardened, setting up the adhesive so that adjacent paper web convolutions of the tight roll are adhered together, and then unwinding the roll while splitting the paper web convolutions thereon to form a multiply re-

enforced sheet having split paper plies on opposite surfaces thereof.

3. The method of manufacturing laminated paper sheets which includes the steps of coating a web of paper on one side with a layer of adhesive depositing reinforcing filaments on the coated surface of the web, subsequently superimposing successive portions of the web so coated to produce a lamination in which a layer of adhesive and reinforcing filaments intervenes between adjacent paper webs, and thereafter splitting the paper webs to form a duplex sheet consisting of two split paper plies having an interposed layer of adhesive and reinforcing filaments.

4. The method of manufacturing paper laminates which includes the steps of coating a paper web with a layer of adhesive, convoluting the coated web into a tight roll, hardening the adhesive to secure the roll into a laminated solid, and then unwinding the roll by splitting the paper web and peeling away the convolutions of the adhesive layer and the split paper webs adhered to both sides of said layer.

5. The method of manufacturing a two-ply reenforced paper laminate which comprises coating with adhesive one surface of a paper web having a thickness equal to the aggregate thickness desired in the two plies of the finished laminate, applying reinforcing filaments to the adhesive coating, rolling up the web while the adhesive is viscid, thereafter allowing the adhesive to harden, and finally unwinding the roll to form the two-ply laminate by splitting the paper web in a plane intermediate the convolutions of hardened adhesive coating.

6. As an article of manufacture, a laminate of a plurality of matted-fiber sheets secured together by adhesive intervening between the sheets, the inner and outer surfaces of those sheets of the laminate which are exposed being dissimilar in that one surface of each exposed sheet presents a mass of short, fuzzy fibers having free ends extending outwardly from the plane of the sheet and the

other surface has a relatively smooth texture with fibers secured in the plane thereof, the exposed sheets being arranged with their relatively smooth surfaces innermost contiguous to the adhesive and their fuzzy surfaces outermost to impart a textile-like feel and handle to the laminate.

7. The method of manufacturing laminated sheet material which includes the steps of coating a fibrous web with an adhesive comprising an emulsion containing water, winding the web into a tight roll before the adhesive has hardened, moistening the fibrous sheet materials, thereby weakening their interfiber bond, by absorption of water from the adhesive while simultaneously setting up the adhesive so that adjacent web convolutions of the tight roll are adhered together and, thereafter, before the laminated sheet material is dry of its absorbed water, unwinding the roll while splitting the web convolutions thereof to form a multi-ply sheet having split fibrous plies on the opposite exposed surfaces thereof.

8. As an article of manufacture, a laminate of two plies of paper secured together by a layer of adhesive in which reinforcing filaments are deposited, the inner and outer surfaces of each one of the paper plies being dissimilar in that the inner surface of each ply, contiguous to the adhesive, is calendered, and the outer exposed surface of each ply, remote from the adhesive, is uncalendered and presents a torn-fiber surface exposing internal paper fibers on each outer surface of the laminate.

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