Oct. 8, 1940. A. BENDA 2,216,803

CARDBOARD AND CARDBOARD WEB AND METHOD OF MAKING SAME

Filed Aug. 24, 1939

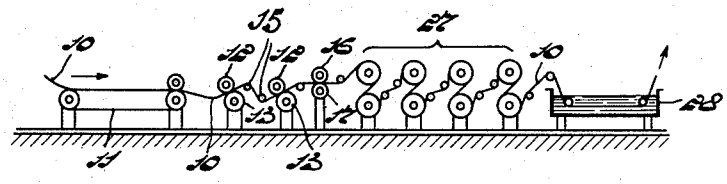


Fig. 1

Fig. 2

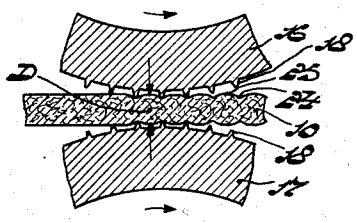


Fig. 4

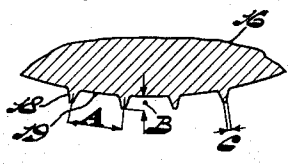
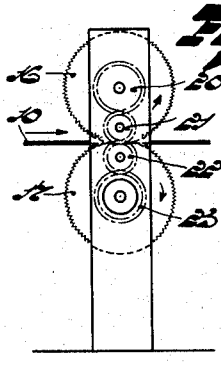


Fig. 3



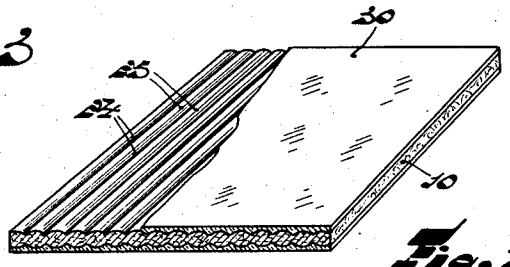


Fig. 5

Fig. 6

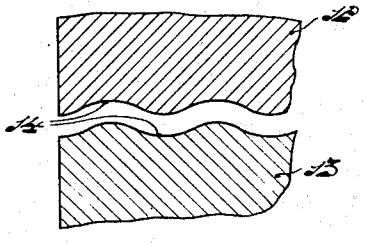
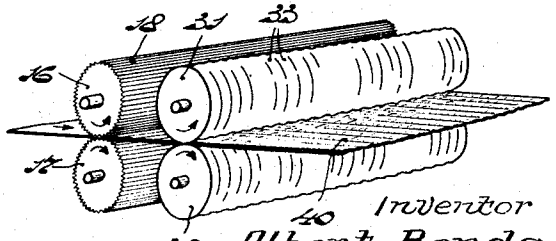


Fig. 7



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CARDBOARD AND CARDBOARD WEB AND METHOD OF MAKING SAME

Albert Benda, Bussum, Netherlands, assignor to Edge Company Limited, London, England

Application August 24, 1939, Serial No. 291,769
In Czechoslovakia March 21, 1934

6 Claims. (Cl. 92—39)

My invention or discovery relates to flexible, strong, felted webs, sheets and boards and to a method of making the same from wood pulp or other cellulose fibers.

This application is a continuation-in-part of my copending U. S. application Ser. No. 67,132, filed March 4, 1936, and Ser. No. 281,295, filed June 26, 1939.

Cheap, strong, flexible webs, sheets and boards of wood pulp and other cellulose fiber origin are a desideratum in many arts. When a web stronger than paper is required it has been customary to use multi-ply cardboards or pasteboards, but such fabricated card products have the disadvantages that either they are quite brittle in their dry state, or that they do not take impregments or coatings in a satisfactory manner. Moreover they can only be manufactured in flat sheets which cannot be bent and made into rolls without damaging and this circumstance constitutes an unfavourable factor in carrying out impregnating processes. On the other hand, ordinary carboards made from pulp have the disadvantages that they are brittle, of short fracture, tear easily, and have a low resistance to crushing or impact stresses. At best, these cardboards have a very low mechanical strength and are not well suited for application where resiliency, mechanical strength and resistance to abrasion are required. To secure a reasonably flexible fibrous web it has previously been necessary to use very large proportions of wool, with a minimum of cellulose fibers. While such products have a good flexibility corresponding to the degree to which they approach pure wool felt in composition, wool is, of course, costly compared to wood fibers, and the strength is insufficient for many purposes.

The main object of my invention is to overcome the above disadvantages and to make from paper-making fibers, webs, sheets and boards which have a degree of mechanical strength, flexibility and absorbing power hitherto unobtainable in webs made from such materials.

A further object is to produce strong and flexible webs, sheets and boards from waste paper.

Another object is to produce from paper-making fibers, webs, sheets and boards which are especially well adapted to be impregnated or coated with any of the usual materials.

A still further object is to produce an inexpensive sheet which is particularly adapted for use as a chair bottom, linoleum base or trunk material.

Further objects of my invention will appear as the description progresses.

I have found that webs, sheets and boards having the desired properties can be obtained by impressing relatively-deep grooves in both surfaces of a thick web of paper-making pulp so as to produce high-density compacted strengthening zones separated by non-compacted zones of open texture. More particularly, in the finished web the cellulose in the portions of the web between the bottoms of opposing grooves is in a compressed condition of high tensile strength, while cellulose in the portions between the grooves is of a soft, open-textured and well absorbent character. By properly spacing the grooves and selecting the proper degree of indentation, the felting in the web is ideal both as regards securing maximum strength and flexibility, and as regards absorbency. The grooves act something like hinges to give the web a high flexibility in a direction perpendicular to the grooves, while at the same time there is no corrugation effect so that the web remains flexible in the direction of the grooves.

In accordance with the method of the invention, I form aqueous pulp into a relatively thick web, expel some of the water from this web, and then impress closely-spaced narrow indentations or grooves in both surfaces of the web while it is still wet so as to locally expel further water from the web and thereby compact the web fibers in the portions between the bottoms of opposing grooves while leaving intervening open-textured uncompacted portions. The grooved web is then dried while preserving said alternating compacted and uncompacted portions and, if desired, impregnated or coated with suitable water-proofing materials, etc.

More particularly, an aqueous wood paper-making pulp is beaten in the usual way, refined in a jordan engine and formed into a rather thick web on a Fourdrinier or cylinder machine. This web is then passed between press rolls of the type generally used in expressing water from webs in making pulp sheets. These rolls may have coarse, shallow radial (circular) grooves extending around the periphery to facilitate drainage of water by loosening the web fibers. The grooves of one roll lie opposite the intergroove spaces of the other roll.

According to the invention, the web, while still in a relatively wet condition, i. e., containing at least about 50 per cent water by weight, is passed between a pair of rolls each provided with very closely-spaced parallel ribs having rather sharp edges. These rolls are so spaced from each other

and so rotated that the ribs form fairly deep indentations or grooves in the wet web, and the pulp is compressed between the edges of opposing ribs at regular intervals.

The relatively thick cellulose fiber web produced by the method of the invention has high tensile strength and flexibility. Such a web, even when made from material containing large amounts of waste paper, has a tough, leathery texture and high mechanical strength. At the same time the remarkable strength of my new sheets and boards is obtained without a sacrifice of absorbency.

The web is entirely suited for many purposes without any further treatment other than drying, because it is tough and flexible. However, it is especially well adapted to be coated, saturated or impregnated with any of the well known materials in order to make it suitable for some particular purpose. The web takes a wide variety of coatings which can be applied in any of the usual manners, and this operation can be carried out either hot or cold. The web is also adapted to receive a wide variety of impregnants, is especially adapted to be hot impregnated and can be quickly passed through the impregnating bath. For this purpose it is advantageous to use impregnaitng baths at high temperatures, e. g., 160° C. to 180° C., i. e., temperatures which as a rule cannot be used in impregnating wool-containing webs without danger of scorching or charring the web. As the compacted portions of the web according to the invention do not take up much impregnant, the absorbent areas are localized, so that absorption is limited.

In order that the invention can be clearly understood and readily carried into effect, I shall describe the same in more detail with reference to the accompanying drawing in which:

Figure 1 is a side view of a complete apparatus organization for making the web,

Fig. 2 is a detail view in vertical section illustrating the action of the fine-ribbed rolls of Figure 1,

Fig. 3 is a detail view showing the driving means for the fine-ribbed rolls of Figure 1,

Fig. 4 is an enlarged view in vertical section of a portion of one of the fine-ribbed rolls of Figure 1,

Fig. 5 is a sectionized perspective view of a coated web,

Fig. 6 is a sectionized view of a portion of the rolls **12** and **13** of Fig. 1, and

Fig. 7 is a perspective view of apparatus including rolls for grooving the web in two directions.

As shown in Fig. 1 a relatively thick web **10**, for instance from one to several millimeters thick, of wood pulp, produced by a conventional Fourdrinier or cylinder machine, not shown, is conveyed on a conveyer belt **11** to two pairs of wet press rolls **12** and **13**, of known type, which have coarse shallow annular grooves **14** (see Fig. 6). The grooves are usually 5 to 10 mm. wide. Guide rolls **15** are interposed between the two pair of rolls **12—13**.

The press rolls **12** and **13** extract some of the water, drainage of water being facilitated by the roll grooves. The web is left with more than 50%, and preferably between about 60 to 75 per cent, of water by weight. The web should not contain over 80 per cent water by weight at this stage.

The wet web is then passed between a pair of rolls **16** and **17**, each having closely-spaced longitudinal (axial) ribs **18** (see Fig. 2) forming intervening grooves **19**. As shown more clearly in Fig. 4, the ribs **18** are preferably spaced apart a distance A equal to about 1 to 2 mm., though good results can be obtained with spacings of 0.5 to 5 mm. The ribs have a height B of about 0.5 mm. and have edges which are slightly rounded and have a width C of about 0.2 mm. As shown in Fig. 2, the ribs **18** of the two rolls **16** and **17** lie opposite each other when compressing the web, and as shown in Fig. 3 the rolls are driven in opposite directions by gears **20**, **21**, **22** and **23**, rotated by suitable power means, not shown. The rolls are spaced sufficiently close together that rather deep, narrow grooves **24** are produced in the web (Figs. 2 and 5) with intervening rounded ribs **25** which are only slightly compressed by the grooves **19** of the rolls. It appears that the fibers in the portions of the web between the bottoms of the grooves tend to become oriented in a direction at right angles to the plane of the web. The grooving imparted to the web by the wet press rolls **12** and **13** is incidental. It should be noted that the distance D between the bottoms of the grooves of rollers **16** and **17** (Fig. 2) is substantially the same as the overall thickness of the web **10** both before and after it is grooved, which, however, is not necessary.

The web is then passed through a stack of drying rolls **27**, and there is negligible shrinkage of the web during the drying. The dry web has about the same thickness, volume, and general form and appearance as the web leaving the rolls **16** and **17**.

The dry web may be considered as finished and used in this form for instance, linoleum bases, leather substitutes, trunks, wall coverings and chair bottoms. The web is very strong and flexible even when it consists solely of paper-making fibers. It is resistant to abrasion and to impact and tearing stress, and can be rolled for shipment.

If desired the dry web may be coated or impregnated, for example by passing the same through a vat **28** containing a suitable impregnant. The impregnant or coating treatment is carried out in a conventional manner, such treatments being greatly facilitated by the flexible and absorbent character of the web. Among the useful impregnants are tar, tar oil distillates, asphalts, pitches, bituminous emulsions, varnishes and lacquers, latex, solutions of depolymerized waste rubber, glue, and water-repellant salts of the type exemplified by aluminium acetate, aluminium formate and iron acetate. Coloring materials can be added at any state of operations. Impregnation or coating can be carried out by immersion, spraying, doctor rolls, brushes or other conventional ways. The pulp may have various substances added to it during the beating operations, such as sizings.

The invention is especially well suited for working up waste paper and paper pulp into useful products and a surprisingly good web is obtained from this low-grade material. It is, however, equally well adapted to making webs from freshly produced wood pulp (mechanically pulp or chemical pulp) and to pulps from other cellulose fibers including rag pulps and pulps made from straw, esparto, ramie, etc. Wool and other fibers can be worked into the pulp prior to forming the web if desired.

Fig. 5 shows a sample of a coated web made according to the invention. As shown the dry

web 10 is provided with a coating 30 forming a smooth surface and penetrating into the wet grooves, the grooves serve to hold the coating more securely. While the web shows very regular and rapid absorption properties, as described, the absorption is limited by the dense compacted portions between the bottoms of the grooves. This makes it possible from an economical view point to employ costly impregnants, such as linseed oil, whose use would be too expensive with materials which have a high absorption, such as ordinary cardboards and sheets containing large proportions of wool.

The boards according to the invention have an overall thickness of approximately one-half to several millimeters and the depth of the grooves is approximately 5% to 30% of the overall thickness. The grooves on each surface are spaced apart by distances between about 0.5 mm. and 5 mms.

The various rolls described are advantageously made of steel or stainless steel.

Ordinarily a transverse grooving on both faces suffices to impart sufficient flexibility and strength to the web, but if still greater web flexibility is required, the transverse grooving rolls 16 and 17 can be supplemented with a pair of rolls 31 and 32 (see Fig. 7). Rolls 31 and 32 have radial (circular) ribs 33, spaced and dimensioned in a manner similar to the ribs 18 of rolls 16 and 17 (see Figs. 2 and 4) so that the finished web 40 is grooved in two directions. Such cross grooving is especially useful with the heavier webs weighing 600 grams or more per square meter (a pound per square yard) and having a thickness greater than about 0.7 mm. The ribs on the several grooving rolls are not necessarily straight but are of course parallel.

While it is usually desirable to make the grooved web from a single or homogeneous wet web of the proper thickness, some of the advantages of the invention are retained when the web to be grooved comprises two or more thin webs united together. The word "board" as used in the claims is to be understood to include felt and sheet-like felted material such as is used for example as a base for floor covering and roofing materials.

While I have described my invention in connection with specific examples and applications, I do not desire to be limited thereto because obvious modifications will present themselves to one skilled in the art.

What I claim is:

1. A flexible board of fibrous paper-making material having an overall thickness of approximately one-half to several millimeters and provided on opposite surfaces with substantially-opposing grooves, said grooves being spaced apart on each surface a distance of approximately one-half to 5 millimeters and each having a depth of approximately 5% to 30% of the overall thickness of the board, said board being of substantially-homogeneous composition and having strip-shaped portions of compacted dense fibrous structure between the bottoms of the grooves, and strip-shaped portions of relatively-uncompacted and open-textured fibrous structure between the compacted portions.

2. A flexible board of fibrous paper-making material having an overall thickness of approximately one-half to several millimeters and provided on opposite surfaces with substantially-opposing grooves, said grooves being spaced apart on each surface a distance of approximately one-half to 5 millimeters and each having a depth of approximately 5% to 30% of the overall thickness of the board, said board being of substantially-homogeneous composition and having strip-shaped portions of compacted dense fibrous structure between the bottoms of the grooves, and strip-shaped portions of relatively-uncompacted and open-textured fibrous structure between the compacted portions, said board being provided with a waterproof material.

3. A method of making a flexible board, comprising the steps of forming from fibrous paper-making material a wet web having a thickness of approximately one-half to several millimeters, passing the web while still in a wet condition between cooperating axially-ribbed rollers to impress in both surfaces thereof substantially-opposing transverse grooves spaced apart on each surface a distance of approximately one-half to 5 millimeters and each having a depth of approximately 5% to 30% of the thickness of the web and thereby to form interspaced strip-shaped portions of compacted dense structure between the bottoms of the grooves, and drying the grooved web.

4. A method of making a flexible board, comprising the steps of forming from fibrous paper-making material including a large portion of waste-paper pulp, a wet web having an overall thickness of approximately one-half to several millimeters, passing the web while still in a wet condition between cooperating axially-ribbed rollers to impress in both surfaces thereof substantially-opposing transverse grooves spaced apart on each surface a distance of approximately one-half to 5 millimeters and each having a depth of approximately 5% to 30% of the overall thickness of the web and thereby to form interspaced strip-shaped portions of compacted dense structure between the bottoms of the grooves, and drying the grooved web.

5. A method of making a flexible board, comprising the steps of forming from fibrous paper-making material a wet web having an overall thickness of approximately one-half to several millimeters, passing the web while still in a wet condition between cooperating axially-ribbed rollers to impress in both surfaces thereof substantially-opposing transverse grooves spaced apart on each surface a distance of approximately one-half to 5 millimeters and each having a depth of approximately 5% to 30% of the overall thickness of the web and thereby to form interspaced strip-shaped portions of compacted dense structure between the bottoms of the grooves, drying the grooved web, and impregnating the dry grooved web.

6. In the manufacture of a flexible board, the steps of forming from fibrous paper-making material a wet web having an overall thickness of approximately one to several millimeters, passing the web between press rollers to remove between 20% and 50% by weight of water therefrom, passing the web while still in a wet condition between cooperating axially-ribbed rollers to impress in both surfaces thereof substantially-opposing transverse grooves spaced apart on each surface a distance of approximately one-half to 5 millimeters and each having a depth of approximately 5% to 30% of the thickness of the web and thereby to form interspaced strip-shaped portions of compacted dense structure between the bottoms of the grooves, and drying the grooved web.

ALBERT BENDA.