United States Patent

[11] 3,603,219

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[21] Appl. No. **539,647**
[22] Filed **Apr. 4, 1966**
[45] Patented **Sept. 7, 1971**

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[54] **METHOD FOR IMPROVING THE BENDING QUALITY OF WATER RESISTANT CORRUGATED PAPERBOARD**
8 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** ..... **193/49 M,** 93/1 G, 93/36 MM, 93/36 PC, 93/58 ST, 93/59 MT, 93/94 PX

[51] **Int. Cl.** **B31b49/02,** B31b 1/22, B31b 45/00

[50] **Field of Search** ..... 93/1 G, 36 PC, 36 S, 58 AD, 94 PX, 36 MM, 58 ST, 49 M; 229/3.1; 117/158 A, 158 B; 264/136

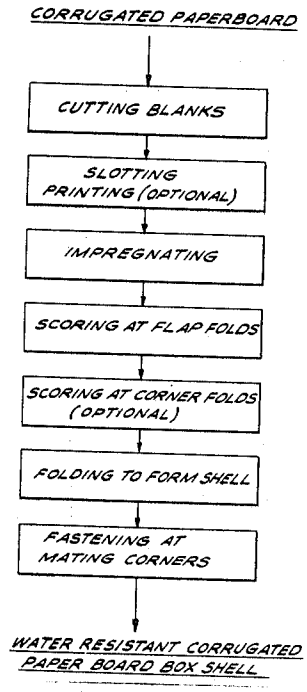
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ABSTRACT: A method for improving the bending quality of corrugated paperboard impregnated with wax or a wax-polymer composition that imparts increased rigidity to the paperboard in which the corrugated paperboard is first impregnated with the wax or wax-polymer composition and then scored at the desired folds.



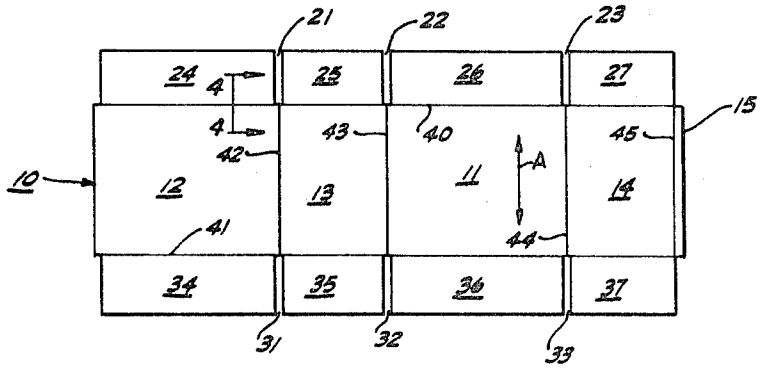


FIG-3

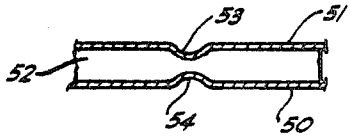


FIG-4

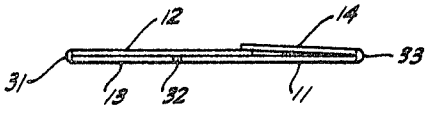


FIG-5

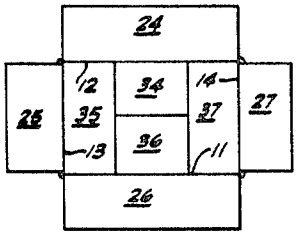


FIG-6

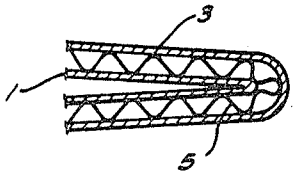


FIG-1

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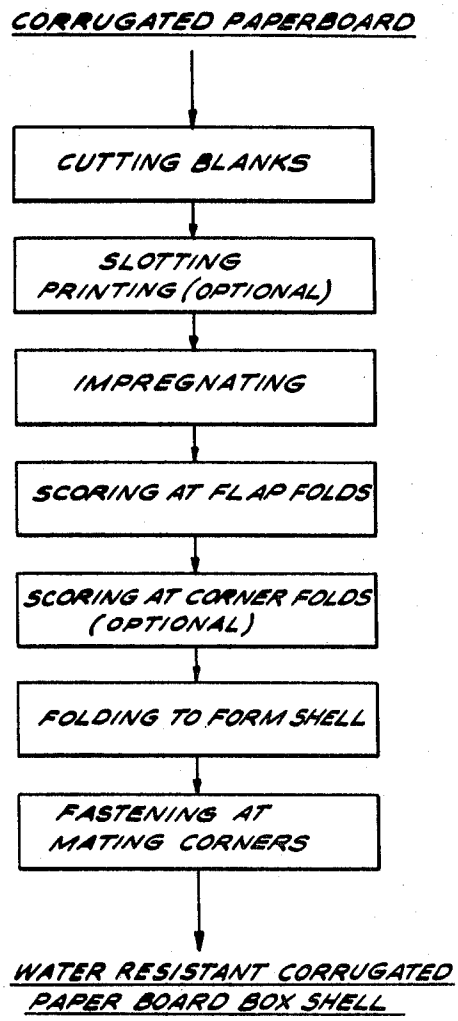


FIG-2

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METHOD FOR IMPROVING THE BENDING QUALITY OF WATER RESISTANT CORRUGATED PAPERBOARD

This invention relates to a method for improving the bending quality of a corrugated paperboard impregnated with a solidifiable material which imparts rigidity to the paperboard; and more particularly, to a method for forming a flexible fold in an impregnated water-resistant corrugated paperboard. The invention has particular application in the manufacture of water-resistant corrugated fiberboard boxes.

Corrugated paperboard has found wide use in a variety of applications where a relatively inexpensive, intermediate strength structural material is required, the manufacture of inexpensive storage and shipping containers constituting one of the primary high volume uses of this material. However, a major deficiency of conventional corrugated paperboard is its poor durability and strength when wet, which limits the type of goods suitable for handling in these containers and necessitates special precautions to prevent exposure of the container to moisture during storage and shipment. To overcome this problem, a corrugated paperboard product which exhibits superior strength on exposure to moisture has been developed. Moisture resistance is achieved by impregnating corrugated paperboard with a waterproofing agent, such as wax or wax-polymer compositions. The impregnated product retains substantial wet strength, even when contacted with liquid water, thus permitting shipment of wet goods and eliminating the necessity of protecting the carton from external water.

Water resistant fiberboard boxes formed from this impregnated corrugated paperboard, sometimes called wet-pack boxes, have been found particularly useful in the storage and shipment of certain produce and other perishable goods as the commodity can be iced without damage to the boxes. In one application, water-resistant boxes containing the perishable goods are loaded into refrigerated railroad cars or trucks and the entire cargo packed in ice. In another application, crushed ice is placed directly into the boxes, either before or after packing the perishable commodity. In either case, boxes manufactured from this impregnated corrugated paperboard are substantially unaffected by water from the melting ice, thereby maintaining their body and shape during transit and affording convenient means for handling the perishable goods at the destination.

Water-resistant fiberboard boxes are conventionally mass produced from flat paperboard roll stock by one or more automatic or semiautomatic machines performing a series of sequential steps which corrugates the raw paperboard and transforms it into finished boxes ready for assembly. Water-resistant boxes, like most fiberboard boxes, are usually produced and distributed collapsed into flat shells ready for final assembly at the point of use.

Both water-resistant and ordinary corrugated fiberboard boxes are conventionally manufactured by substantially similar methods. However, in an additional step, the water-resistant boxes are impregnated with waterproofing agent, usually by dipping the collapsed shell into a bath of molten waterproofing agent and allowing excess material to drain therefrom. The waterproofing agent solidifies on cooling to form a water-resistant solid. The saturation technique of waterproofing is superior to other techniques wherein only a coating of water-resistant material is deposited on the surface of the paperboard. With the saturation application, the waterproofing agent penetrates into the paperboard in considerable quantity to form a cohesive structure of paperboard and solidified waterproofing agent. The waterproofing agent, particularly in the case of wax-polymer compositions, imparts increased strength and rigidity to the paperboard in addition to rendering it water resistant. The degree of saturation of the paperboard with the waterproofing agent depends on the absorptivity of the paperboard, the soaking and draining times, the properties of the waterproofing agent, and the dip and drain temperatures. These variables are normally controlled so that the paperboard is partially saturated with waterproofing agent, the degree of saturation depending on an economic balance between the improvement desired and the cost of the waterproofing agent.

Bending or folding of a corrugated paperboard along a predetermined line is facilitated by scoring the paperboard at the desired fold line prior to the folding operation. Scoring is accomplished by compressing the paperboard along the fold line sufficiently to permanently deform the paper structure. Since corrugated paperboard used in the construction of boxes must be folded during the box making operation and on assembly of the box shell at the point of use, this material is scored both normal to the corrugations and parallel therewith. Corrugators used to corrugate paperboard box material are conventionally provided with score forming devices to produce those score lines normal to the flutes. The parallel score lines are conventionally formed on the printer-slotter in a separate subsequent operation. Since water-resistant corrugated paperboard boxes are usually produced similarly to dry boxes and then impregnated, it is conventional practice to completely score the box blank at all fold lines prior to impregnation of the paperboard with waterproofing material.

As in the case of conventional dry boxes, the collapsed water-resistant fiberboard shells are prepared for use by opening the collapsed shell into a rectangular box shape, and closing and sealing the bottom flaps. The box is then filled and subsequently closed by folding and sealing the top flaps. The assembly, filling and closing steps are frequently performed by machine operation, although these operations can also be accomplished wholly or in part by hand.

While conventional boxes in most cases have been satisfactorily assembled, filled and closed in the aforedescribed manner, a serious problem has resulted in the assembly and closure of water-resistant fiberboard boxes. It has been found that the impregnated corrugated fiberboard used in the manufacture of water-resistant boxes often will not withstand the bending necessary to assemble, fill and close the box without rupture or tearing of the paperboard despite scoring of the paperboard at the folds. While some failure of the panel and bottom flap folds has been experienced, the most acute problem is failure of the top flap folds since, in most cases, these flaps suffer more severe flexing. In a typical operation the top flaps are folded outward either 90° or 180° to afford easier access into the top of the box during the filling operation, and then are closed by a reverse fold of either 180° or 270°, depending on the magnitude of the initial fold. The bottom flap and panel folds are normally flexed to a lesser degree, although even so, bottom flap and panel score cracking is not uncommon.

In practice, the impregnated paperboard facings have been found to rupture and tear along the fold lines during the assembly and filling operation to the extent that the box must be discarded, often requiring the additional costly step of manually transferring the goods to a new container. It is not unusual that a flap will be completely torn from the box on bending. More seriously, a fold will be sufficiently weakened that the box will structurally fail during transit, causing loss or damage to the contained goods. Thus, not only does fold failure cause poor appearance, but these failures also have increased the cost of using water-resistant fiberboard boxes and curtailed a wider acceptance of these containers. The foregoing problem is not limited to a single box manufacturer, but has been more or less universally encountered by all manufacturers of water-resistant corrugated fiberboard boxes, despite the fact that a variety of corrugated fiberboards, waterproofing materials and score styles have been employed.

Accordingly, it is an object of the present invention to provide a method of improving the bending quality of an impregnated corrugated paperboard. Another object is to provide a method of forming a flexible fold in a corrugated paperboard impregnated with a solidifiable waterproofing agent which imparts increased rigidity to the corrugated structure, and especially where the fold is transverse to the flutes of the

corrugated paperboard. A still further object is to provide an improved method of manufacturing water-resistant corrugated fiberboard boxes. An even further object is to provide a method of manufacturing impregnated corrugated fiberboard boxes having flexible flap and panel folds. These and other objects will be apparent to one skilled in the art from the following description of this invention.

The invention is illustrated by the drawings in which the same numerals refer to corresponding parts and in which:

FIG. 1 is a schematic illustration of the structural deformation caused by bending a corrugated paperboard;

FIG. 2 is a schematic diagram illustrating the steps of manufacturing water-resistant corrugated paperboard boxes in accordance with the method of this invention;

FIG. 3 is a plan view of a box blank;

FIG. 4 is a cross-sectional view of a score line taken along the line 4—4 of FIG. 3;

FIG. 5 is a side elevation view showing the edge of the collapsed box shell obtained by folding the box blank; and

FIG. 6 is a top view of an assembled water-resistant corrugated box.

Briefly, in accordance with the present invention, the bending quality of a corrugated paperboard impregnated with a solidifiable material which imparts increased rigidity to the paperboard can be improved at predetermined fold lines by scoring the paperboard after impregnation with the solidifiable material. A flat, unfolded sheet of corrugated paperboard is impregnated with a suitable solidifiable material in conventional manner, and the impregnated sheet scored along the desired fold line by compressing the paperboard at the fold sufficiently to deform the paper structure. A fold formed in this manner can withstand many flexures at the fold line without tearing of the paperboard or rupture of the waterproofing agent. This technique is particularly suited to the manufacture of water-resistant corrugated fiberboard boxes as both the top and bottom flap folds and the panel folds are amenable to scoring after impregnation of the corrugated paperboard with waterproofing agent.

A substantially rigid corrugated paperboard structure can be folded along crease or score lines either parallel with or transverse to the flutes of the corrugating medium. The line along which the fold is made is a substantially straight line extending completely across the material being folded. The term "bending quality" as used herein is intended to mean the ability of a substantially rigid corrugated paperboard to bend or fold along these lines so that adjacent sections of a unitary piece of corrugated paperboard situated on opposite sides of a fold line are movable with respect to each other. A corrugated paperboard having good bending quality is capable of being repeatedly flexed or folded without tearing or damage of the structure to the point that the paperboard is seriously weakened.

The method of this invention is generally useful in forming flexible folds in any corrugated paperboard impregnated with a material which renders the paperboard more rigid and brittle than the untreated board. Corrugated paperboards susceptible to impregnation generally include those having one or more layers of corrugating medium adherently attached to flat facings. Commercial corrugated fiberboard structures suitable for impregnation include single face construction wherein a single-corrugating medium is adherently attached to a single flat facing, single wall (double faced) construction wherein a single medium is interposed between two exterior facings, double wall construction formed by three flat facings having a medium disposed between each of the facings, and triple wall construction formed by four flat facings and three intermediate corrugating mediums alternately disposed therebetween. The adherent layers are usually glued together with water soluble starch, although a less soluble modified starch is preferred in the case of corrugated fiberboard produced for water-resistant box construction.

A corrugated paperboard useful in the manufacture of water-resistant boxes comprises a lightweight corrugated paper adherently interposed between two relatively lightweight flat sheets of paperboard. It is to be understood that the thickness of the various individual members can be selected to impart the necessary strength to the corrugated paperboard product, the term "relatively lightweight" being employed to indicate that the thickness or gage of the component materials is relatively small as compared to the thickness of the ultimate structure. The faces of a single wall (double faced) corrugated paperboard are often of different weights, with the heavier material usually being placed on the interior of the box. In general, the minimum paper weight employed in corrugated paperboard for water-resistant box construction is 26 pounds per thousand square feet. The combined weight of facings usually ranges between 52 and 264 pounds per thousand square feet of corrugated paperboard, and between 52 and 180 pounds per thousand feet for single wall (double-faced) paperboard.

The thickness of a corrugated paperboard is dependent upon the thickness of the facings and the flute construction. Flutes have been commercially standardized by prescribing the flute height and the number of flutes per foot. Type A-flutes are three sixteenth inch in height with approximately 36 flutes per lineal foot, type B-flutes are three thirty-second inch in height with approximately 51 flutes per lineal foot, and type C-flutes are nine sixty-fourth inch in height with approximately 42 flutes per lineal foot. Other types of flute construction are also employed in special applications. The total thickness of the corrugated structure can vary from approximately three thirty-second inch to about nine sixteenth inch for heavy triple wall construction.

When a corrugated paperboard is folded, the inside face (relative to the fold) is sharply flexed on a radius of the magnitude of the thickness of the face material. Although there is a sharp bend or flexure of the face material, the fibers of the paper are not greatly stretched. The corrugating medium is subjected to a very complicated series of distortions, depending in part on whether the fold is parallel or transverse to the direction of the flutes. The outer face of the corrugated paperboard (again relative to the fold) is flexed over a larger radius than the inside face, the radius of flexure being up to 30 times the thickness of the face material depending upon the construction of the particular fiberboard. However, although the bending radius is less severe, the outside face must stretch a substantial distance. The length of the semicircle over which the outside face must stretch for a 180° bend is indicated as follows for various thicknesses of corrugated paperboard:

Thickness, Inches	Approximate Length of Semicircle, Inches
3/32	0.29
1/8	0.39
5/32	0.49
3/16	0.59

It is apparent that the stretch required increases markedly with the thickness of the paperboard.

The structural effects encountered when corrugated paperboard is folded parallel to the direction of the flutes is illustrated in FIG. 1 wherein there is shown a typical single wall corrugate comprised of interior facing 1, exterior facing 3 and corrugated member 5 folded through an angle of approximately 180°. Interior facing 1 is flexed sharply at the fold, outer facing 3 is flexed over a much larger arc, and corrugated member 5 is at least partially collapsed. Similar structural effects are encountered when the corrugate is folded normal to the direction of the flutes.

In a desirable product the paper in the outside face and the absorbed waterproofing material, either within the paper or on its exterior surface, must stretch without tearing. The exact amount of paper which participates in this stretching is not

known, but observations suggest that only fibers quite close to a line directly opposed to the inside bend line participate in the stretching phenomena. When a very hard and brittle board is folded, there is very little stretch before rupture. A relatively sharp and straight break is created extending the full width of the piece subject to bending. In commercially desirable water-resistant corrugated paperboards, stretching occurs for the full width of the piece with no tearing of the paper or rupture of the waterproofing material. In intermediate cases, small tears of various lengths appear in the section subjected to stretching. It is apparent that when a corrugated paperboard is subjected to reverse bending, the opposite result is effected with the unstretched face formerly on the inner side of the fold then subjected to stretching.

The bending quality of a corrugated paperboard impregnated with a solidifiable waterproofing agent which imparts rigidity to the paperboard can be improved by scoring the paperboard after impregnation, rather than prior to the impregnation step as is the conventional practice. The impregnated paperboard can be scored prior to solidification of the impregnate either by performing the scoring operation immediately after the impregnation step and prior to solidification of the impregnant, or by maintaining the paperboard at an elevated temperature during the scoring operation; or alternatively, the impregnated paperboard can be cooled to solidify the impregnant prior to scoring.

Although the exact mechanism by which the scoring method of this invention functions to increase the flexibility of a substantially rigid paperboard structure is not completely understood, it is believed that scoring after impregnation stretches the paper fibers, and particularly those in the face material, sufficiently to impart increased flexibility to the paperboard along the score lines. Also, the paperboard at the score line is of reduced thickness due to the compressive force applied during scoring, and accordingly, the stretch required of the outer face material at the fold is reduced. Further, and particularly with reference to the embodiment wherein the paperboard is scored after solidification of the impregnant, the rigid paper structure may be partially destroyed to the extent that its rigidity is substantially reduced. However, despite any uncertainty as to the theoretical aspects of this method, it has nevertheless been demonstrated that scoring of a corrugated paperboard after impregnation imparts sufficient flexibility that the impregnated paperboard exhibits good bending quality.

Scoring of the impregnated paperboard is accomplished by compressing the corrugated paperboard along a desired fold line sufficiently to stress the material at the fold beyond its yield point so that permanent deformation occurs which weakens the structure sufficiently to facilitate folding of the impregnated paperboard along the desired line. The scoring operation should not be sufficiently extreme as to produce a cut or tear in the facing material, or otherwise unnecessarily reduce its strength, yet must be sufficient to cause the necessary deformation of the paperboard. Scoring can be accomplished by any one of a number of commercially practiced methods whereby the paperboard is deformed in various configurations, the depth and width of the score line being controlled to afford varying degrees of flexibility. Normally, satisfactory scores are between about ⅛inch and 1 inch in width and extend the length of the section to be folded. A more preferable range of score widths for many applications is between about ¼ inch and ¾ inch. A score regarded as commercially satisfactory to impart increased flexibility to a corrugated paperboard used for conventional dry box construction can usually be employed in accordance with the method of this invention to impart flexibility to impregnated corrugated paperboard.

Scoring can be conveniently accomplished by passing the paperboard between spaced rollers which are provided with peripheral scoring rings at a position on the roll corresponding to the desired location of the score line on the paperboard. The shape and size of the scoring rings determine the score pattern.

The method of this invention is useful in improving the bending quality of a corrugated paperboard impregnated with any solidifiable material which imparts increased rigidity to the corrugate structure. Solidifiable materials found useful in increasing the water resistance of corrugated paperboard include various waxes, such as paraffin waxes derived from petroleum, and mixtures of these waxes with minor proportions of a polymer capable of improving various properties of the wax. Preferred compositions found useful in impregnating corrugated paperboard to improve its water resistance generally include a major proportion of a refined paraffin wax; a minor proportion of a polymer such as polyethylene, or the like; and a small amount of various additives imparting improved properties to the solidified composition. The polymer content of the mixture is typically between about 2 and about 20 weight percent, and the additive content less than 1 weight percent.

As previously disclosed, the method of this invention has particular application in the manufacture of water-resistant corrugated fiberboard boxes. Corrugated fiberboard boxes are conventionally manufactured on a commercial scale by an integral process in which flat paperboard roll stock is corrugated and formed into box shells. Although a wide variety of corrugated paperboards and box designs can be employed in the construction of commercial water-resistant corrugated fiberboard boxes, the bulk of these boxes are of the self-enclosing RSC (Regular Slotted Container) design constructed from a single piece of single wall (double faced) corrugated consisting of two outer facings and an intermediate fluted member. Three paperboard roll stocks are formed into an integral structure by a continuous corrugating machine which forms the corrugating medium into a series of arched trusses and attaches the flat paperboard facings to the medium with adhesive applied at the tips of the flutes.

In the practice of this invention, the corrugated paperboard exiting the corrugator is slit into appropriate widths and cut to length to form suitably sized box blanks. These blanks are passed to the printer-slotter which slots the blank normal to the flap score with slots extending from the outer edge of the blank toward the interior of the blank a distance equal to the desired width of the flap. Slots are cut into either side of the blank so as to define four flaps at each side of the blank. The slots in each of these flap sections are situated opposed to a corresponding slot in the opposite flap section. If desired, breathing vents, drain holes, handgrips, and the like can be cut into the blank. Also various advertising or identification can be printed onto the blank, the printing being oriented so that it will be properly displayed on assembly of the box.

At this stage of manufacture, the box comprises a flat sheet of paperboard having four opposed flaps on either side of an intermediate panel section, and which can be suitably imprinted. Boxes constructed in accordance with the method of this invention differ from those manufactured by conventional methods as they are neither scored nor folded prior to impregnation. Otherwise, impregnation of the paperboard is accomplished in conventional manner by dipping the unscored flat box blank into a liquid reservoir of the molten waterproofing agent for a controlled short length of time, and then draining the impregnated blank for a specified period at a controlled temperature.

The box blank can be scored along the flap fold lines normal to the flutes by passing the impregnated blank through a scoring roll in the aforedescribed manner. Score lines are formed the length of the blank at the base of the slots. The impregnated blank can be scored prior to solidification of the impregnant, or the impregnated blank can be cooled to solidify the impregnant prior to scoring. While some corrugated paperboards employed in box construction do not require scoring at the panel folds; many paperboards, and particularly the heavier boards, cannot be satisfactorily folded even parallel with the flutes without scoring. It is usually desirable to score impregnated paperboards at the panel folds prior to folding the box blank. These panel folds can be formed similarly to the flap scores by passing the impregnated paper-

board through suitable score forming rollers. It is often advantageous to employ different score patterns for the flap and panel scores.

The box shells are formed by folding the blank along the panel score line situated at approximately its midpoint so that the blank is essentially folded double, or alternatively, by folding two end sections toward the middle so that the mating end sections are at an intermediate point of the flat shell. The overlapping mating ends of the panel section, having a lip cut for this purpose, are joined by gluing, stapling, or the like, to form the manufacturer's joint which is located adjacent one corner of the box.

The foregoing method of manufacturing water-resistant corrugated paperboard boxes is more fully illustrated in FIG. 2 wherein there is shown the sequence of steps of (1) cutting a corrugated paperboard to obtain a substantially rectangular box blank; (2) slotting the blank to form the flaps; (3) impregnating the blank with molten waterproofing agent; (4) scoring at the flap folds normal to the direction of the flutes; (5) optionally scoring at the corner folds parallel to the flutes; (6) folding the blank; and (7) fastening the mating panel sections to form a collapsed box shell. Where printing is desired, it is preferably performed simultaneously with the slotting step.

One embodiment of box blank formed in accordance with the method of this invention is illustrated in FIG. 3 wherein there is shown a generally rectangular blank **10** of corrugated paperboard from which a folding box or carton is assembled. The blank is usually cut so that the flutes in the panel sections are in a vertical direction when the box is assembled, which direction is indicated in FIG. 3 by arrow A. The blank includes an integral front panel **11**, back panel **12**, right-hand (relative to the front of the box) end panel **13**, and left-hand end panel **14**. Lip **15** is adjacent to and integral with end panel **14**. Slots **21**, **22** and **23** are provided to define top flaps **24**, **25**, **26** and **27**. Opposed slots **31**, **32** and **33** define bottom flaps **34**, **35**, **36** and **37**. The blank is scored at **40** and **41** normal to the direction of the flutes to facilitate folding of the flaps. Also, the blank can be optionally scored along the lines **42**, **43**, **44** and **45** in a direction parallel to the flutes to facilitate folding at the corners. A suitable score is illustrated in FIG. 4 wherein there is shown a section of single wall corrugated comprised of interior face **50**, exterior face **51** and corrugated member **52** deformed at **53** and **54** to facilitate folding. It is to be understood that in accordance with the method of this invention, the aforementioned scores are to be formed after impregnation of the corrugate with waterproofing agent. As illustrated in FIG. 5 the blank is formed into a collapsed box shell by folding along the score lines **42** and **44** and fastening the mating ends at lip **15**. FIG. 6 illustrates one mode of assembling the impregnated collapsed shell into a water-resistant box, shown here with the top flaps opened.

While the resulting product of the foregoing process is a self-enclosing water-resistant corrugated box, it is apparent that by only slight manipulation of the process techniques within the skill of the art, various water-resistant corrugated fiberboard containers and products can be produced.

In another aspect, this invention pertains to water-resistant corrugated fiberboard boxes impregnated with solidifiable waterproofing materials, which boxes have folds rendered flexible by scoring according to the method of this invention after impregnation.

The invention is further described by the following examples which are illustrative of various embodiments thereof, but are not intended as limiting the scope of the invention.

EXAMPLE 1

A flat piece of commercial single wall corrugated fiberboard 19 ½ inches by 18 inches in size having 42 pound and 69 pound faces and a 33 pound medium corrugated in a type B-flute is scored normal to the flutes and impregnated with a waterproofing material comprising a mixture of 94.7 weight percent paraffin wax melting between about 130° F. and about 134° F., 5.0 weight percent of polyethylene polymer and 0.3 weight percent of a flexibility improving additive. Impregnation is accomplished by submerging the board in a body of molten waterproofing agent maintained at 250° F. for 60 seconds, and then draining for 3 minutes at a temperature of 230° F. The board is cooled to solidify the impregnant and tested for score line flexibility.

Flexibility is determined by folding the board along the score so that it is flexed through an angle of 180°, reversing the fold so that the fiberboard is flexed 360° in the opposite direction, and then repeating with successive 360° folds in alternating directions until the test sample has been flexed a total of 20 times. The appearance of the material at the score line is then observed. When tested in this manner, the instant sample tears along the fold prior to completion of the test.

EXAMPLE 2

A duplicate sample of the corrugated paperboard of example 1 is impregnated according to the method of that example. After impregnation, but prior to solidification of the impregnant, the paperboard is scored in a straight line across its width normal to the flutes. The scored board is then cooled to solidify the impregnant and tested according to the method of example 1 by folding along the score line. The appearance of the material at the score is then observed and found to be in good condition with no visible tears.

EXAMPLE 3

Another duplicate sample of the corrugated paperboard of example 1 is impregnated according to the method of that example. The impregnated board is cooled to solidify the impregnant and then scored in a straight line across its width normal to the flutes. The board is then tested according to the method of example 1 by folding along the score line. The appearance of the material at the score is observed and found to be in good condition with no visible tears.

Having fully described the method and product of my invention, I claim:

1. A method for improving the bending quality of a sheet of corrugated paperboard impregnated with a solidifiable material that imparts increased rigidity to the paperboard, comprising:

impregnating said corrugated paperboard with a solidifiable material selected from the group consisting of wax and wax-polymer compositions; and

thereafter forming a score line on said paperboard at a desired fold, said paperboard being maintained at an elevated temperature during the scoring operation.

2. The method defined in claim **1** wherein said corrugated paperboard is impregnated with said solidifiable material by dipping said paperboard in a liquid reservoir of said material maintained above its melting point.

3. The method defined in claim **1** wherein said score line is formed by compressing said paperboard along the desired fold line sufficiently to exceed the yield strength of said paperboard, thus causing a permanent deformation of said paperboard along said fold line.

4. A method for forming a flexible fold in a sheet of water-resistant corrugated paperboard, which comprises:

impregnating said corrugated paperboard by dipping said paperboard in a liquid reservoir of molten waterproofing agent selected from the group consisting of wax and wax-polymer compositions; and

thereafter forming a score line on said paperboard at a desired fold by compressing said paperboard along said desired fold line sufficiently to exceed the yield strength of said paperboard, thus causing a permanent deformation of said paperboard along said fold line, said paperboard being maintained at an elevated temperature during the scoring operation.

5. A method of manufacturing self-enclosing water-resistant corrugated paperboard boxes, which comprises:

cutting a corrugated paperboard to obtain a substantially rectangular box blank;

forming a plurality of slots at either side of said blank extending from the outer edge of said blank inwardly a distance equal to the desired flap width so as to define four flaps at each side of said blank, each of said slots situated opposed to a corresponding slot in said other flap section;

impregnating said corrugated paperboard by dipping said paperboard in a liquid reservoir of molten waterproofing agent selected from the group consisting of wax and wax-polymer compositions and draining excess impregnant therefrom;

thereafter forming two parallel spaced flap score lines normal to the flutes of said corrugated paperboard and extending the length of said blank at the desired flap folds, said flap score lines defining outer spaced flap sections and an intermediate panel section therebetween;

folding said blank so that the two opposite ends of said panel section are mated; and

fastening said panel section at the mated ends to form a collapsed box shell.

6. The method defined in claim 5 including the additional step of cooling said impregnated paperboard to solidify said impregnant prior to forming said flap score lines.

7. The method defined in claim 5 including the additional step of forming spaced panel scores parallel to said flutes and extending across said panel section between said opposed slots.

8. The method defined in claim 7 including the additional step of cooling said impregnated paperboard to solidify said impregnant prior to forming said panel score lines.