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F. A. STROVINK

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PAPERBOARD MANUFACTURE

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Fig. 1.

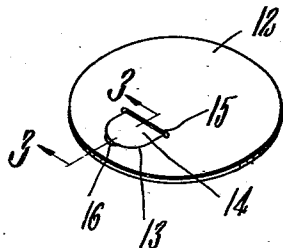


Fig. 2.

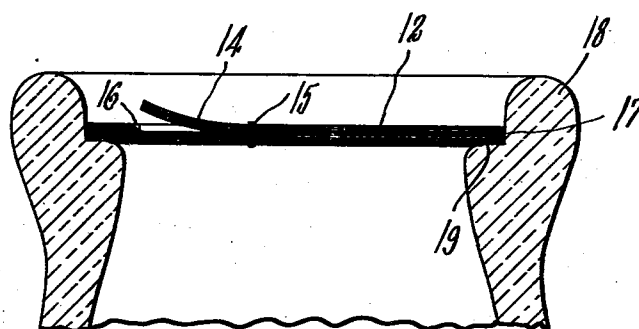


Fig. 3.

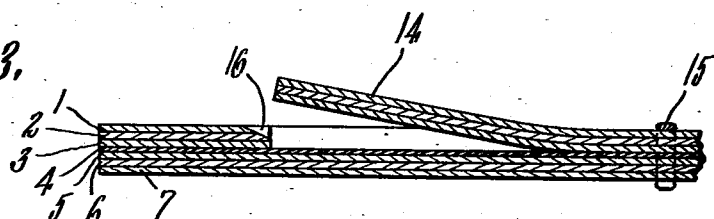
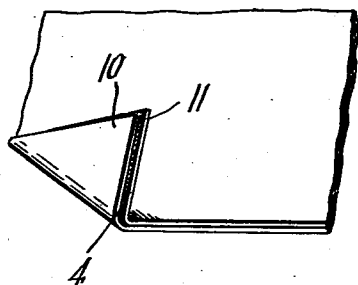


Fig. 4.

Inventor
FLORIAN A. STROVINK
by Nathaniel P. Wharton
Attorney

UNITED STATES PATENT OFFICE

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PAPERBOARD MANUFACTURE

Florian A. Strovink, Medford, Mass., assignor to
Bennett Incorporated, Cambridge, Mass., a corporation of Massachusetts

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168,234. Divided and this application March
31, 1939, Serial No. 265,219

10 Claims. (Cl. 92—39)

This invention relates to paperboard manufacture and deals more especially with paperboard adapted to be cut into milk-bottle closures. Such paperboard is usually produced on a multi-cylinder papermaking machine as a multi-ply sheet of substantial stiffness and thickness; and it is customarily well-sized and sufficiently dense or hard to exhibit the water-repellent and grease-resistant properties desired in the milk-bottle closures cut therefrom. In bottle-closures of the foregoing character, it is common practice to create a tab-defining incision extending from the face of the closure part way into its body. Such a tab enables ready removal of the closure from the bottle mouth wherein it is frictionally held, since grasping of the free-end portion of the tab by the fingers is attended by cleavage and raising of the tab from the body of the closure and by lifting or removal of the closure from the bottle mouth as cleavage of the tab is interrupted at the inner ends of the incision whereat the tab joins the main or intact body of the closure.

Paperboard bottle-closures equipped with lifting tabs of the character described are sometimes faulty in that the tab is torn away completely from the body of the closure before lifting of the closure from its frictionally held position is accomplished. Such faultiness or trouble arises from the fact that cleavage or peeling of the tab does not occur smoothly or cleanly at the desired depth of cut in the body of the closure but rather on haphazard planes and, accordingly, that the tab as it is being raised, is of insufficient strength or substance throughout to withstand being ruptured or torn in being pulled to overcome the resistance of the closure to being lifted from its frictionally held position.

In accordance with the present invention, I produce a multi-ply paperboard or sheet especially adapted for bottle-closures and containing an interior ply, say, a center ply, of such relatively low ply adhesion that when a tab-defining incision is created in such paperboard bottle-closures from the surface up to or into the interior ply, there is no difficulty whatever in raising the tab from the body of the paperboard on a plane within such internal ply or on the plane of bondage of such ply to an adjacent ply, for such internal ply imposes minimum resistance to the cleavage or raising of the tab from the body of the paperboard. It is thus seen that the paperboard product of the present invention ensures positively a raising or strike-up of the tab away from the body of a paperboard closure at

the desired predetermined depth as a gripping element of the desired substantially uniform thickness and strength, that is, of a strength sufficient to resist being ruptured or torn away from the body of the closure in the course of its being pulled to overcome the resistance against lifting or removal of the closure from its frictionally held position in a bottle mouth.

There are various ways of producing the multiply paperboard hereof containing an interior ply of the desired relatively low ply adhesion, but I have found that the most positive or effective way of so doing is to incorporate cellulose-softening or lubricating agents into the papermaking stock from which the internal ply of the paperboard is formed. It is distinctly preferable to use water-repellent, cellulose-softening agents so as to realize an internal ply possessed of appropriate water-repellence as well as softness or relatively low ply adhesion. I have found that the addition of wax, oils, sulphonated oils, and like lubricating materials to the papermaking stock for the internal ply results in an internal ply of the desired combined characteristics. Only a small percentage of such lubricating materials, based on the weight of the papermaking stock, need be used, the precise amount used in any particular case depending upon the character of the stock. For instance, paraffin or other wax in the form of an aqueous emulsion may be added in an amount of about $\frac{1}{2}\%$ to 5%, based on the dry weight of the papermaking stock; and it is possible to realize similar effects with oil in the form of aqueous emulsions in an amount as low as $\frac{1}{4}\%$, based on the dry weight of the papermaking stock. The rest of the plies of the paperboard may be made from sized papermaking stocks designed to yield relatively hard and dense plies, as ordinarily.

With the foregoing and other objects and features in view, the invention hereof will now be described in further detail with reference to the accompanying drawing, wherein—

Figure 1 shows in perspective a milk-bottle closure formed from paperboard embodying the invention hereof.

Figure 2 represents a section through the mouth portion of a milk-bottle containing the closure with its lifting tab partially raised or struck up therefrom.

Figure 3 is a greatly enlarged fragmentary section of the closure on the line 3—3 of Figure 1 but with the lifting tab in partially raised or struck-up position.

Figure 4 depicts in perspective what happens

when a small corner portion of the paperboard hereof is bent sharply.

The paperboard hereof from which the bottle-closures are died out may be fabricated on a multi-cylinder papermaking machine from a plurality of plies, each one of which may be formed to the desired thickness from suitable papermaking stock. As is well known, each ply is formed on an independent cylinder mold from dilute papermaking stock supplied to the vat in which the cylinder mold rotates partially submerged; and the wet plies progressively being formed on the successive cylinder molds are picked up in superposed and integrated relationship by the carrier or transfer felt of the machine and delivered to the drier of the machine as a plied or unitary sheet of the desired thickness. The paperboard sheet as thus fabricated for the milk-bottle closures may be of various thicknesses, for instance, thicknesses ranging from about 0.020 to about 0.060 inch. The number of plies entering into the paperboard sheet hereof is also subject to variation and may, for instance, be 3 to 9 or even more plies.

A typical paperboard sheet hereof designed for bottle-closure purpose may, as best shown in Figure 3, be composed of seven superposed and integrated plies. Various papermaking stocks or furnishes may be used for the several plies, provided that the finished paperboard and bottle-closures fulfill the requirements or desiderata of the present invention. Thus, plies 1, 2, 6, and 7 may be composed of well-beaten bleached sulphite and/or bleached kraft pulp containing a substantial amount of suitable sizing material, such as rosin size or wax-rosin size. Similarly, plies 3 and 5 may be composed of well-beaten and well-sized papermaking stock, for instance, the stock already indicated or stock containing more or less groundwood pulp. The plies thus far mentioned impart the desired stiffness to the paperboard as well as water-repellence and grease-resistance. The fourth or center ply 4 is distinguished from the others in that it is of low ply adhesion. In using the expression "low ply adhesion" in characterizing the ply 4, I mean that such ply integrates or bonds relatively weakly with the adjacent plies and that its internal structure is also relatively soft and weak in the sense that, when such structure is split, as with a knife, at its edges, it displays relatively low resistance to being separated or pulled apart on its plane of split into plies.

The desired relatively low ply adhesion in the ply 4 may be realized by incorporating into the papermaking stock from which it is formed a suitable cellulose-softening agent in appropriate amount, as already indicated. For instance, the stock for such ply 4 may be groundwood pulp and/or other pulp preferably beaten only to a degree enabling smooth or uniformly textured ply formation on the cylinder mold and treated with about 2% to 5% of paraffin wax or its equivalent, based on the dry weight of pulp. The wax may be added to the beaten papermaking stock as a fine particle size aqueous dispersion or emulsion stabilized by soap or other suitable stabilizer; and the wax particles may be fixed or precipitated on the stock, as usual, by alum or its equivalent before the stock is diluted with water to papermaking consistency and delivered to the cylinder vat for the fourth ply of the paperboard hereof.

A test for demonstrating the relatively low ply adhesion of the fourth ply 4 of the paperboard sheet hereof involves sharply bending a

small corner portion of the sheet, as depicted in Figure 4. Because of the internal stress to which the sheet is put by such bending, there is a tendency for the lower portion 10 of the sheet, which undergoes stretching stress, to separate or move relatively to the upper portion 11, which undergoes compressing stress. Inasmuch as the internal ply 4 of the paperboard sheet hereof is of relatively low ply adhesion, the lower portion 10 of the sheet, rather than being stretched, readily moves or slips relatively to the upper portion 11 and tends to split away on a plane of bondage between the ply 4 and an adjacent ply or on a plane within the structure of the ply 4. When such a test is positive, the paperboard can be regarded as being eminently suitable for use in making bottle-closures equipped with lifting tabs of the character hereinbefore described.

A milk-bottle closure or disk 12 cut from the paperboard sheet hereof is shown in Figure 1 as containing a U-shaped incision 13 definitive of a lifting tab 14 somewhat offset from the center of the disk. Adjacent to the ends of the incision 13 may be the usual wire staple 15 struck through the body of the closure for reinforcing the tab 14 and preventing its rupture or break-away from the body of the closure when it is raised to the limit of its closure-removing position. The incision 13 preferably extends, as appears in Figures 2 and 3, to the fourth ply 4 of the closure, whereat the paperboard is of the desired distinctly lowest ply adhesion. So as to facilitate raising of the tab 14 from the body of the closure by the fingers or fingernails, a niche or gouge 16 may be created in the uppermost plies, for instance, the first two plies, adjacent to the free end of the tab 14.

A bottle-closure formed from paperboard embodying the instant invention may, as already described, be removed from its frictionally held position in a milk-bottle mouth without any trouble whatever, since its lifting tab 14 is raised or struck up as an element of substantially uniform thickness throughout and hence of sufficient strength to resist rupture or break-away from the body of the closure. The closure is shown in Figure 2 with its edge engaging frictionally the inner wall 17 of the bottle lip 18 and with its bottom margin resting on an inner annular ledge or shoulder 19 definitive of the lip bottom, as ordinarily. When the free end portion of the tab 14 is raised by the fingers or fingernails, the tab parts or cleaves away cleanly from the body of the closure at a plane of minimum weakness, that is, at the surface of or within the ply 4; and there is no tendency whatever for cleavage to take place on hap-hazard planes, for instance, on planes appreciably above the fourth ply, on which latter planes the tab might well be of insufficient thickness or tenacity to withstand rupture as it is being subjected to the pulling force necessary to dislodge the closure from its frictionally held position in the bottle mouth.

It is possible to vary the structure of the paperboard or sheet hereof in various respects. Thus, one may produce paperboard or paperboard closures whose plies are of different thicknesses and whose internal ply of distinctly minimum ply adhesion is thinner or thicker than the other plies and occurs as a layer more or less offset from the center or medial plane of the paperboard sheet. Again, the closures made from the paperboard hereof may serve for closing other than milk-bottles, for instance, for closing cups, cartons, and other receptacles, such as are used for

vending ice-cream, relishes, or other foodstuffs. So, too, the paperboard sheet hereof has utility for various other purposes for which it is desirable or necessary to effect a removal or raising of some of its plies on a definite or predetermined plane of cleavage. For instance, it is sometimes desirable to strike up flanges from the body of paperboard members, such as paperboard disks, to constitute the bottoms of cups or cartons and to be equipped with such flanges for adhesive securement to the walls of the cups or cartons. The paperboard sheet hereof enables flanges of substantially uniform thickness to be readily struck up from a plane within or on the surfaces of its ply of minimum ply adhesion. In shoe insoles formed of multi-ply paperboard or leatherboard, it is sometimes desired to remove or tear out some of the insole plies at its forepart within an intact marginal area or insole rand to which the shoe upper is secured. This can be advantageously done by using paperboard or leatherboard insoles whose multi-ply structure embodies the invention hereof, since the zone of insole material to be removed at the forepart may be defined by an incision surrounding such zone and terminating within the body of the insole at the ply of distinctly minimum ply adhesion. Paperboard or leatherboard sheets embodying the present invention also afford media for receiving inlays of other materials therein to predetermined substantially uniform depths, since the recesses or pockets for receiving the inlaid materials can be formed without trouble by cutting their boundaries into the sheets to the ply of minimum ply adhesion and then pulling out the incised layers or plies above such ply of minimum ply adhesion.

In characterizing a bottle-closure made from the paperboard hereof as containing a tab-defining incision extending from its face to the internal ply of minimum ply adhesion, I mean that the incision may terminate at a plane within the body of such ply or substantially at a plane of bondage of such ply with an adjacent ply, since in either event the desired easy and smooth cleavage and raising of the tab on the desired predetermined plane within the body of the closure can be realized. Inasmuch as the principles of the instant invention may have utility otherwise than accordant with the particular embodiments of invention hereinbefore described, it is to be understood that the scope of the invention is to be determined from the appended claims.

In producing paperboard for the milk-bottle closures or the like hereinbefore described, the internal ply on whose planes the paperboard or the lifting tabs of the closures are designed to cleave apart most readily is of relatively high softness as well as of relatively low ply adhesion, for the qualities of softness and low ply adhesion evidently go hand-in-hand. These conjunctive qualities are readily realized in the internal ply by the use of about 2% to 5% of a suitable wax, such as paraffin wax, based on the dry weight of the papermaking stock used for such ply. Besides imparting the desired high softness and low ply adhesion qualities to the internal ply, the wax affords the desired degree of water-repellence in such ply, especially when admixed in finely emulsified or dispersed condition with the papermaking stock for such ply and fixed on the fibers of the stock by alum or its equivalent. The papermaking stock for the internal ply is, moreover, preferably beaten or hy-

drated only lightly or moderately so as to minimize the amount of wax necessary for imparting the desired softness and low ply adhesion to such ply. On the other hand, the other and external plies of the paperboard sheet hereof intended for milk-bottle closures or the like are preferably formed from well-beaten or hydrated papermaking stock, that is, from stock beaten more drastically than that for the internal ply and hence capable of yielding plies much stiffer or denser than the internal ply. In order to provide the appropriate water-repellence and grease-resistance to the other or external plies of the paperboard sheet or bottle-closures hereof, the well-beaten papermaking stock for such plies preferably contains a substantial amount of rosin size, say, about 2% or more, based on the dry weight of the papermaking stock; and the rosin size, unlike wax, has the effect of increasing the stiffness and ply adhesion qualities of such plies, inasmuch that they are of much stiffer and higher ply adhesion qualities than the internal ply containing wax as a cellulose-softening agent. It might be noted that wax presents the advantage over an oleaginous or liquid cellulose-softening agent for the internal ply of the paperboard hereof in that the wax does not tend to migrate or "bleed" from the internal ply to the other or external plies.

The internal ply of the paperboard hereof characterized by minimum ply adhesion by reason of its content of wax or other cellulose-softening agent may be formed from papermaking stock treated with the cellulose-softening agent elsewhere than in the beater engine. Thus, the aqueous wax dispersion or other cellulose-softening agent may be added to the stock after it has been diluted with water, for instance, while the diluted stock is on its way or has already entered the cylinder vat for the internal ply. The alum or other precipitant for the aqueous wax dispersion may be added to the stock together with the wax dispersion or before or after the addition of the wax dispersion to the stock. For instance, good results for the purposes hereof have been realized by adding alum to the stock in the beater engine and adding the aqueous wax dispersion to the stock after its dilution and delivery to the cylinder vat. It is unnecessary for the purposes hereof that the sizing or water-repelling quality desired in the internal ply be gained through the use only of a cellulose-softening, water-repelling agent, such as wax. Thus, part of the water-repellent quality developed in the internal ply may be derived from rosin or other size added to the papermaking stock conjunctively with the wax dispersion. It is generally preferable, however, to develop the water-repelling quality desired in the internal ply by the use only of paraffin wax or its equivalent having conjunctive cellulose-softening and cellulose-sizing values. Apropos of adding cellulose-softening agent to an internal ply of the paperboard hereof so as to impart to such ply the minimum ply adhesion desired in the paperboard, it might be noted that the cellulose-softening agent may be applied as by a "kiss" roll or other suitable applicator to the surface of such internal ply in freshly formed or moist condition, that is, immediately before such moist ply is picked up by the carrier felt of the multi-cylinder papermaking machine in superposed or plied relationship with the other moist plies to enter into the finished, multi-ply paperboard sheet. When an

aqueous wax dispersion is thus applied, preferably in thick or concentrated form, to the surface of the freshly-formed or moist internal ply, there is some penetration of the dispersed wax particles into the body of the ply, but most of the dispersed wax particles remain on the surface of the ply, in consequence of which the resulting multiply paperboard sheet is of minimum ply adhesion at the plane of bondage between the waxed surface of the internal ply and the adjacent ply, as will be appreciated from the fact that the wax or cellulose-softening agent is concentrated to a maximum degree and thus exerts its maximum softening effect at the plane whereat the waxed surface of the internal ply is integrated or united with the adjacent ply.

This application is a division of my application Serial No. 168,234, filed October 9, 1937, which has matured as Patent No. 2,167,783, dated August 1, 1939.

I claim:

1. In a multi-ply paperboard sheet, an internal ply containing a water-repellent, cellulose-softening agent, which is selected from a class consisting of oil and wax and which is present in said internal ply in amount ranging from about $\frac{1}{4}\%$ to 5% so as to impart thereto a ply adhesion much lower than that of its adjacent plies, said sheet being characterized by the tendency of said adjacent plies to move relatively and to split apart selectively on said internal ply when a small corner fragment of said sheet is sharply flexed.

2. In a multi-ply paperboard sheet, an internal ply containing wax in amount ranging from about $\frac{1}{2}\%$ to 5% so as to impart thereto a ply adhesion much lower than that of its adjacent plies, said sheet being characterized by the tendency of said adjacent plies to move relatively and to split apart selectively on said internal ply when a small corner fragment of said sheet is sharply flexed.

3. In a multi-ply paperboard sheet, an internal ply containing oil in amount of at least about $\frac{1}{4}\%$ so as to impart thereto a ply adhesion much lower than that of its adjacent plies, said sheet being characterized by the tendency of said adjacent plies to move relatively and to split apart selectively on said internal ply when a small corner fragment of said sheet is sharply flexed.

4. A multi-ply paperboard sheet comprising an internal ply of relatively high softness and low ply adhesion qualities and containing wax in amount of about $\frac{1}{2}\%$ to 5% as an agent imparting said qualities thereto and comprising other and external plies of much stiffer and higher ply adhesion qualities and containing sufficient rosin size as an agent imparting said last-named qualities thereto.

5. A multi-ply paperboard sheet comprising an internal ply of relatively high softness and low ply adhesion qualities made from relatively moderately beaten papermaking stock and containing wax in amount of about $\frac{1}{2}\%$ to 5% as an agent imparting said qualities thereto and comprising other and external plies of much stiffer and higher ply adhesion qualities made from more drastically beaten papermaking stock and containing sufficient rosin size as an agent imparting said last-named qualities thereto.

6. In the production of a paperboard sheet designed to cleave apart most readily on predetermined internal planes, that method which

comprises independently forming an internal ply of such paperboard sheet from papermaking stock containing sufficient oil, namely, at least about $\frac{1}{4}\%$ of its dry weight, to yield a ply of relatively low ply adhesion, independently forming the other and external plies of such paperboard from papermaking stock capable of yielding plies of much higher ply adhesion, superposing and integrating all such plies while wet into a multi-ply paperboard sheet, and drying the resulting sheet.

7. In the production of a paperboard sheet designed to cleave apart most readily on predetermined internal planes, that method which comprises independently forming an internal ply of such paperboard sheet from papermaking stock containing a water-repellent cellulose-softening agent in amount ranging from about $\frac{1}{4}\%$ to 5% of its dry weight so as to yield a ply of relatively low ply adhesion, said agent being selected from a class consisting of oil and wax, independently forming the other and external plies of such paperboard sheet from well-beaten and sized papermaking stock capable of yielding plies of much higher ply adhesion, superposing and integrating all such plies while wet into a multi-ply paperboard sheet, and drying the resulting sheet.

8. In the production of a paperboard sheet designed to cleave apart most readily on predetermined internal planes, that method which comprises independently forming an internal ply of such paperboard sheet from moderately beaten papermaking stock containing wax distributed therethrough in amount ranging from about $\frac{1}{2}\%$ to 5% of its dry weight so as to yield a relatively soft ply of relatively low ply adhesion, independently forming the other and external plies of such paperboard sheet from more drastically beaten papermaking stock containing sufficient size, including rosin size, to yield relatively stiff plies of relatively high ply adhesion, superposing and integrating all such plies while wet into a multi-ply paperboard sheet, and drying the resulting sheet.

9. In a multi-ply paperboard sheet, an internal ply made from papermaking stock on whose fibers wax has been precipitated from an aqueous wax emulsion in amount ranging from about $\frac{1}{2}\%$ to 5%, based on the dry weight of the stock, to impart to said ply a ply adhesion much lower than that of its adjacent plies, said sheet being characterized by the tendency of said adjacent plies to move relatively and to split apart selectively on said internal ply when a small corner fragment of said sheet is sharply flexed.

10. In the production of a paperboard sheet designed to cleave apart most readily on predetermined internal planes, that method which comprises independently forming an internal ply of such paperboard sheet from papermaking stock on whose fibers wax has been precipitated from an aqueous wax emulsion in amount ranging from about $\frac{1}{2}\%$ to 5%, based on the dry weight of the stock, to yield a ply of relatively low ply adhesion, independently forming the other and external plies of such paperboard sheet from well-beaten and sized papermaking stock capable of yielding plies of much higher ply adhesion, superposing and integrating all such plies while wet into a multi-ply paperboard sheet, and drying the resulting sheet.

FLORIAN A. STROVINK.