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CORRUGATING PAPERBOARD

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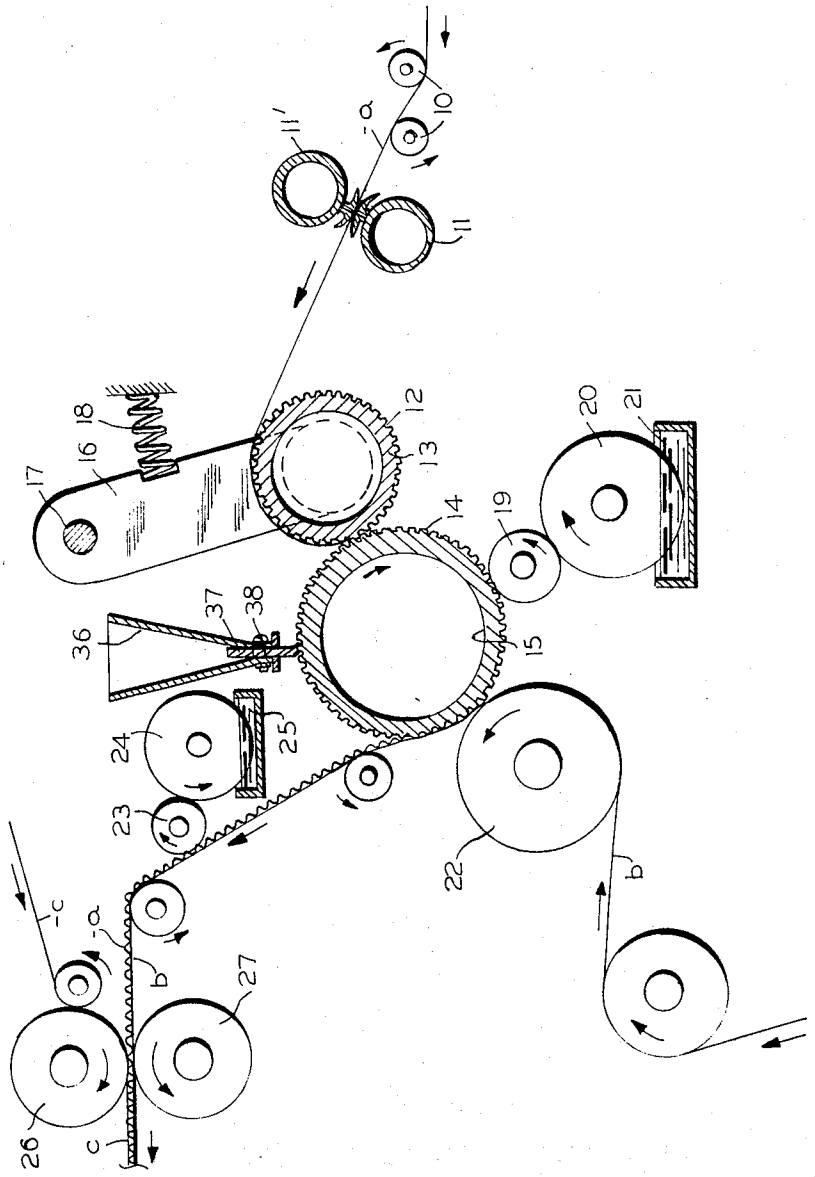

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CORRUGATING PAPERBOARD

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Int. Cl. B31f 1/22
U.S. Cl. 156—205 12 Claims

ABSTRACT OF THE DISCLOSURE

A method of corrugating paperboard at cold (ambient) or intermediate temperatures up to 320° F. but at conventional speeds or higher by treating both sides of the medium prior to corrugation with a lubricant such as a mixture of stearates and paraffin wax so that the coefficient of kinetic friction between the medium and corrugator is less than would be obtained by conventional heat and steam pretreatment.

This invention relates to the corrugating of cardboard, paper and similar deformable materials referred to generally herein as "paperboard."

Corrugated paperboard and containers made therefrom are widely used in the packaging industry whenever strength, light weight, and economy of construction are needed. The corrugated paperboard is generally formed by corrugating a flat sheet of stiff but inexpensive paper made usually from semi-chemical pulp furnishes usually made on a Fourdrinier machine, and the bonding to one or both sides thereof flat sheets termed "liners" by means of adhesive placed on the outer ridge of the flutes. The paper used for corrugating is called "medium" or "corrugating medium" in the industry.

In the conventional corrugating process the medium passes into a nip formed by two longitudinally toothed rollers rotating in mesh to form a series of parallel flutes, corrugations or undulations that are generally of substantially constant predetermined amplitude and wavelength. The toothed rollers are normally heated by steam so as to have an operating temperature ranging approximately from 320° F. to 380° F. The medium is also subjected to preheating on a roll, steam heated to from 300° F. to 380° F. approximately and showering with steam on one or both sides before reaching the corrugating rolls in order to render it sufficiently plastic to mould and to accept the corrugating stresses without fracture or malformation of the flutes.

U.S. Pat. 3,103,459 (D. E. Kane) refers to the use of a special grade of polyethylene as a surfactant to increase the runnability of corrugating medium used in the normal corrugating process. Kane considers this to be an improvement on lubricants such as waxes, asphalt and oils which he alleges do not substantially reduce fracturing of the medium and hence allegedly do not increase runnability to satisfactory levels.

The present invention relates to a process in which the use of lubricants enables the corrugating to be effected under conditions other than normal i.e. the medium can be corrugated at ambient temperatures but at conventional speeds or higher.

It is generally accepted in the industry that the medium cannot be corrugated in any of the usual flute forms without the use of heat and/or steam. In our experiments based upon industrial experience every attempt to corrugate cold in one of the usual flute forms always led to a substantially complete fracturing of the flutes even at very low corrugator speeds. The belief is widespread in the art

that the primary role of the heating and steaming is to plasticise the medium to permit of easier moulding into the desired shape, and it is very well known that too low a level of heating and/or steaming leads to fractured and/or malformed flutes.

As a result of our detailed systematic study of the corrugating process we have found that the primary effect of the heating and/or steaming is to cause a lowering of the kinetic friction coefficient between the medium and metal surface of the corrugating rolls. We have found that when this coefficient is reduced independently of heat or steam e.g. by the application of lubricants, the medium can be corrugated successfully at any desired intermediate temperature level below the range normally employed, even down to ambient temperatures. and that the end product is superior.

Several types of corrugated paperboard are currently produced for packaging applications. That in which a liner is adhered to one face only of the corrugated medium is termed a "single-face corrugated board," and that in which liners are adhered to both faces of the corrugated medium is termed a "double-face corrugated board." The liner of the single face corrugated board is usually heated on a steam heated roll on the machine termed the "single-facer" or "corrugator" before being pressed against the corrugated medium to the ridges of which adhesive has been applied.

An object of the invention then is to provide for the corrugation of paperboard at speeds in the conventional range and above, even exceeding 1,000 feet per minute, without the need for heating and/or steaming the medium.

Accordingly the present invention provides improvements relating to the manufacture of corrugated paperboard by the method which includes passing a medium in the form of a flat sheet of paperboard through corrugator means adapted to deform the medium into a series of parallel flutes or undulations of predetermined amplitude and wavelength, and securing a flat liner to ridges on one or both surfaces of the corrugated medium to form a single- or double-faced board respectively, characterized in that the corrugation is carried out, without significant fracture, at temperatures from ambient level up to 320° F. but at speeds up to or exceeding 1000 feet per minute, and in that to both surfaces of the medium or portion thereof prior to corrugation is applied a lubricant whereby the coefficient of kinetic friction between the medium and corrugator means is less than 0.22.

The figure is a diagrammatic representation of mechanism by which my improved process may be practiced.

The web *a* of material to be corrugated passes over guide rolls **10** and lubricating devies **11** and **11'** to the surface of a corrugating roll **12**. This roll has teeth **13** meshing with similar teeth **11** on a second corrugating roll **15**. The roll **12** is mounted on a bracket **16** pivoted at **17** to a stationary part of the machine and is pressed towards the roll **15** by a compression spring **18**. As the paper web passes between the two corrugating rolls, it is forced into its final corrugated condition, and is set in this condition by the heat of the rolls, generally kept at over 300° F. This heat is generally supplied by steam circulated through the hollow interior of the rolls. An adhesive applying roll **19** runs in contact with the corrugated paper on roll **15** and applies a film of adhesive such as sodium silicate to the high points of the corrugations.

This roll receives adhesive from a supply roll **20** dipping into a tank **21**. A lining web *b* is passed over a roll **22** running adjacent to the surface of roll **15**, and is pressed thereby into adhering contact with the corrugated paper. The composite web then passes an adhesive applying roll **23**, which receives adhesive from a roll **24** and a tank **25** and applies adhesive to the second side of the corrugated web. The second lining sheet *c* is passed around a roll **26**

and is pressed against the corrugated web by this roll and a mating roll 27.

"Cold-set" adhesives that will be used for securing the liner(s) to the corrugated medium at intermediate or at ambient temperatures may be basically of the polyvinyl acetate type or of the polyvinyl alcohol type or any other adhesive requiring little or no heat respectively to cause it to "tack" or to "gel-up" as it is termed in the trade. Other adhesives which may be used in the fully cold (i.e. ambient temperature) process or in processing at "intermediate" temperature levels are the so-called "contact adhesives" which are usually a natural rubber base or synthetic rubber base. The "contact adhesive" is applied in the cross machine direction in narrow lines, which may be full or dotted, to either or both the liner and the medium flute tips before the two mating paperboard surfaces are brought into contact or otherwise pressed together.

We have found that by using our invention any normal corrugating medium when treated by lightly coating both surfaces with certain materials can be corrugated satisfactorily at maximum existing commercial speeds and above, without the need for heat or steam treatment. It has been found that when both surfaces of the medium are treated with certain lubricants such as stearin or stearates mixed with paraffin wax or similar materials in roughly equal proportions, the paper-to-metal kinetic friction coefficient assumes a value of approximately 0.15. Neither the proportions of the admixture of wax and stearin nor the coating weight applied to the corrugating medium is critical.

The required coating weight depends primarily upon the caliper and furnish of the medium used and more particularly upon whether magazine or other coated papers containing clay and fillers have been used as a component of the paper making furnish employed on the machine producing the medium. If the clay or filler content is high, the coating weight per unit area needs to be greater. This can vary from 0.1 pound up to 10 pounds per million square feet of surface area of medium, and although a coating of one pound per million square feet is desirable, some of the tested samples of medium have been capable of cold corrugation with coating weights as low as 0.01 pound per million square feet of surface area.

In the absence of added lubricants the kinetic friction coefficient between paper and metal corrugator surface is approximately 0.50 under cold (ambient temperature) conditions. At the high temperature usually required for corrugating, the kinetic friction coefficient assumes a value of approximately 0.22 but on occasions determined by the characteristics of the medium it may rise to approximately 0.28 and causes either malformation or fracturing of the flutes. The fracturing is a tension type failure and is due to the high tension which builds up in the medium on its passage through the toothed labyrinth to the corrugator nip centre whenever the coefficient is higher than the normal level of approximately 0.22. We have found that it is absolutely necessary to have lubricant on both surfaces of the medium since its presence on one side produces only very little benefit. In practice it is more desirable to monitor the lubricant application so as to apply the same weight per unit area to both sides of the medium rather than to apply the lubricant to one side only and then wind into a reel for example so as to allow an unspecified portion of the lubricant to be transferred to the untreated side.

The lubricant may be applied to the medium at any period during or after its manufacture, as an emulsion in water or in a solvent carrier at the size press or calendar stack of the paper machine or by simply allowing the paper to run over bars of the solid lubricant. The lubricant need not be applied directly to the medium at all, and may instead be applied directly to the corrugator. The most desirable and economical method is to apply the lubricant to the curved tips of the flutes of both corrugating rolls.

The lubricant does not need to be applied over substantially the entire surface area of the medium and for preference is applied to the surface protrusions only, since this results in more economical usage of lubricant.

We have found that both the cold process and the corrugated containers made by the cold process have substantial advantages over the usual hot process and the corrugated containers made by that process. In the hot process the single facer and double facer machines are complex and expensive, occupy a large floor space area, require boiler attendants and steam generators to produce steam for heating the corrugating rolls, preheating rolls, double facer hotplates and steam showers, require a considerable level of maintenance of steam joints, traps, valves and the like and have a considerable warm up period. The corrugated containers made by the hot process also exhibit a considerable number of defects known in the trade as "washboarding," "warp," "blistering" and "linerlift" of the liners together with "high-lows" ("leaning"), and "fracture" of the flutes.

In corrugated containers made by the cold process the aforesaid defects are substantially absent and production losses from rejected end products are substantially eliminated, top to bottom compression strength is maintained and both inner and outer appearances and washboarding in particular are improved markedly. Also, less troubles are experienced with cracking of the liner in the subsequent creasing and slotting operations. Other advantages of the cold process are the reduced space requirement, reduced cost and complexity of the single facing and double facing units due to the elimination of heat and of rolls designed to operate as pressure vessels, its greater tolerance to moisture variation in particular to moisture streaks in liners and mediums, and its greater tolerance to operator skills in that the operator is no longer required to choose critical levels of heating, steaming and tension required by liners and medium in the double faced board.

It is believed that substantial advantages to the industry will accrue from the present invention. New corrugators designed specifically for cold corrugating are simpler, smaller and less costly than existing hot corrugators. The attachment of either or both liners may also be carried out under cold conditions with cold-set or contact adhesives and provided the water uptake from adhesive to liners is limited to a low value no heat is required in the process. The water uptake from adhesive to liners can be limited by selecting an adhesive having a low water content or by lowering the rate of the adhesive application. The water content of polyvinyl acetate base adhesives is about 50% and this is generally found to be a satisfactory level. Some of the contact adhesives have no water. To reduce not only the water uptake but also the cost of the adhesive, the use of gravure or print type adhesive applicator rolls is recommended.

If it should be desired to use a cheaper adhesive containing more water, some form of auxiliary heating may be required to drive out the excess water. If the corrugating rolls are run cold, such auxiliary heating may be by any known method e.g. hot air or infra red radiation. However the corrugating operation itself is at ambient temperatures.

A very important advantage of this invention to the industry is that the existing hot corrugators could be modified without major expenditure to operate at ambient temperatures or at intermediate temperatures up to 320° F.

Other practices are known in the industry in which oil or wax lubricants are used on the medium or corrugator, and although these have no bearing on the cold corrugating process they are referred to here only because oil or waxes are used to serve their purposes. One of these is the partial or complete coating or impregnation of any or all of the components of the corrugated paperboard with wax or other materials in order to impart water resistance. Paraffin wax based composition are used in quantities varying from 5 to 50 pounds per 1,000 square

feet depending upon the level of water resistance required. Examples of these are to be found in the United States patents of McKee (3,033,708) and Kresse et al. (3,308,-006).

Another known practice involves applying trace quantities of wax or lubricant to one side of the medium in quantities of about 10 pounds per million square feet so that the corrugated medium will not stick in the flutes of the lower corrugating roll. The wax may be applied directly to the lower corrugating roll i.e. that adjacent to the pressure roll or more usually to that side of the medium which contacts the aforesaid corrugating roll. An example is disclosed in U.S. Pat. 1,796,542 of Schoo. Such has been largely replaced in the industry by paraffin oil sprays which direct a very fine oil mist onto the aforesaid corrugating roll from which the corrugating medium must be separated. When difficulties are experienced with low runnability medium it is known that an additional speed of about 50 feet per minute can be achieved by turning on the oil spray. It is also known that when oil sprays are also fitted to the other side so as (hopefully) to gain an additional speed increment, the oil will continuously or intermittently seriously interfere with the adhesion of the liner and hence the application of oil must be limited to one side only.

It has also been found that substantial benefits will accrue from this invention even when all parts of the single facer and double facer are not operated fully cold but at some intermediate temperature below the normal minimum of 320° F. These benefits will accrue when the level of heat applied to both liners is such that the moisture level and dimensions of the liners is substantially unaffected and these conditions are defined as those in the warm process.

In addition it has been found that the greater tolerance permitted by this invention may permit modifications to the contour of the flutes of the corrugating rolls to obtain optimum performance in the final container.

Having now described our invention, what we claim as new and desire to secure by Letters Patent is:

1. A process for manufacturing corrugated paperboard at ambient temperatures and at intermediate temperatures up to 320° F. comprising applying a lubricant to a surface of a paperboard medium to bring the coefficient of kinetic friction between the medium and a corrugator means to less than 0.22, passing said medium in the form of a flat sheet of paperboard through said corrugator means to deform said medium into a series of parallel undulations with ridges of predetermined amplitude and wave length, performing said undulations without significant fracture and securing a flat liner to said ridges on a surface of said corrugated medium to form a faced paperboard.

2. A process as set forth in claim **1** wherein said medium is passed through said corrugator means at speeds up to and exceeding 1000 feet per minute.

3. A process as set forth in claim **1** wherein said lubricant is applied to both surfaces of said paperboard medium to bring the coefficient of kinetic friction between said medium and said corrugator means to less than 0.22 and a flat liner is applied to the ridges on both sides of said corrugated medium to form a double faced paperboard.

4. A process as claimed in claim **1** wherein said lubricant is applied to both surfaces of said medium in substantially equal quantities per unit area.

5. A process as claimed in claim **1** wherein 0.1 to 10 pounds of lubricant is applied per million square feet of medium substantially confined to the macroscopic protrusions in the surface of the medium.

6. A process as claimed in claim **1** wherein said lubricant consists essentially of stearin.

7. A process as claimed in claim **1** wherein the coefficient of kinetic friction is substantially 0.15.

8. A process as claimed in claim **1** wherein said lubricant is applied to said medium prior to entering said corrugator means.

9. A process as claimed in claim **1** wherein said lubricant is applied by said corrugator means.

10. A process as claimed in claim **1** wherein said liner is secured to the corrugated medium by a cold-set adhesive.

11. A process as claimed in claim **10** wherein said adhesive has a polyvinyl acetate base.

12. A process as claimed in claim **10** wherein said adhesive has a polyvinyl alcohol base.

References Cited

UNITED STATES PATENTS

2,695,652	11/1954	Segil	264—286
1,796,542	3/1931	Schoo	156—205
2,029,390	2/1936	Rodgers	264—282
2,968,335	1/1961	Monaco et al.	264—286
3,103,459	9/1963	Kane	156—471

BENJAMIN A. BORCHELT, Primary Examiner

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U.S. Cl. X.R.

156—210, 471; 264—286

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,676,247 Dated July 11, 1972

Inventor(s) Andrew W. Morris and Reginald J. Norman

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 53, after "teeth", change "11" to --14--,

Signed and Sealed this

Twenty-second Day of *May 1979*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

DONALD W. BANNER
Commissioner of Patents and Trademarks

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,676,247 Dated July 11, 1972

Inventor(s) Andrew W. Morris and Reginald J. Norman

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, lines 58-60, delete "and,...supplied" and substitute --which, if they are to be operated at temperatures above ambient, may be heated--.

Signed and Sealed this

Twenty-third Day of *October 1979*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

LUTRELLE F. PARKER
Acting Commissioner of Patents and Trademarks