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METHOD AND MACHINE FOR MAKING TRIPLE
WALL CORRUGATED PAPER BOARD

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2 Sheets-Sheet 2

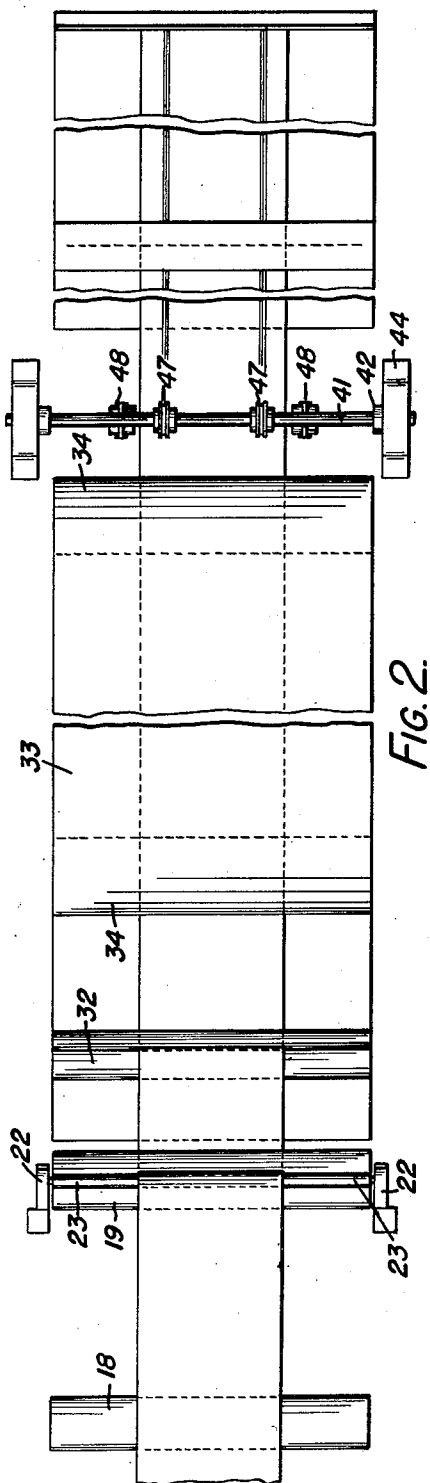


FIG. 2.

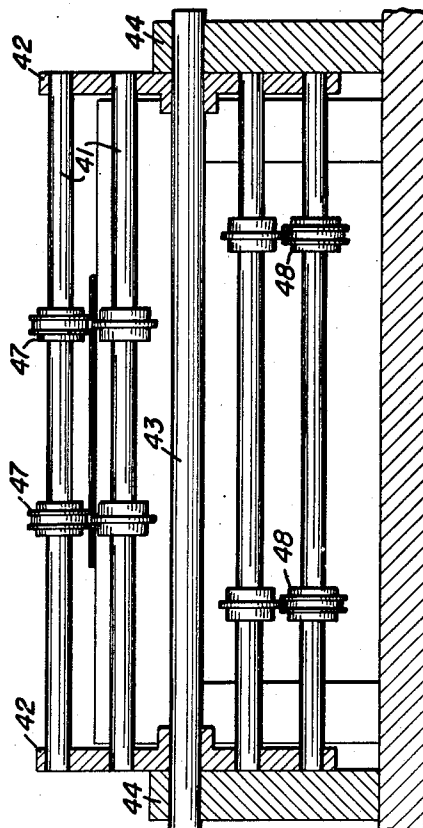


FIG. 5.

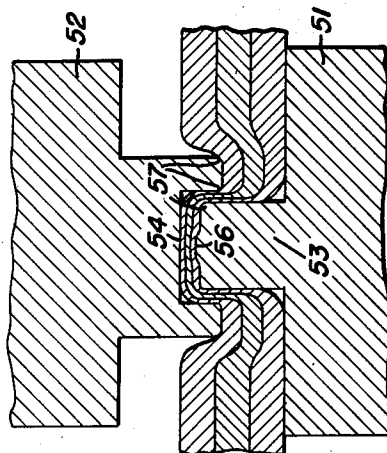


FIG. 6.

INVENTOR.
SAMUEL GOLDSTEIN
IMMANUEL LICHTENSTEIN
BY
Immanuel Lichtenstein
ATTORNEY

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METHOD AND MACHINE FOR MAKING TRIPLE WALL CORRUGATED PAPER BOARD

Samuel Goldstein, New York, and Immanuel Lichtenstein, Amenias, N. Y., assignors to Corro Ltd., New York, N. Y., a corporation of New York

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5 Claims. (Cl. 154—33.05)

Our invention relates to a method and means for making and scoring triple wall corrugated paper board.

Corrugated paper board has many uses, the major one of which is the making of cartons for shipping a large variety of products. Such cartons most commonly have been made of double face single wall or ply corrugated paper board. Cartons are also made of double ply corrugated paper board, a structure which combines two corrugated sheets interposed between three spaced liner sheets. While attempts have been made to produce triple ply corrugated paper board in which three corrugated sheets are interposed between four spaced liner sheets, insofar as we are aware, such a composite sheet of corrugated paper board has not been successfully produced commercially to any great extent. Triple wall corrugated paper board has many distinct advantages, particularly in packaging relatively heavy objects and also in protecting relatively frail objects in transit. It is rigid and strong, comparing favorably in strength with wood as a packaging medium, cost considered, and in addition has a cushioning quality which cannot be approached by wood.

An object of our invention is to provide a method and machine for making triple wall corrugated paper board economically and at relatively high speed.

Another object of our invention is to provide a method and machine for producing a composite board comprising three corrugated sheets interposed between four spaced liner sheets in which the sheets are intimately and securely bonded together.

A further object of our invention is to so control the time and temperature at which a heating medium is applied to triple wall corrugated paper board, after adhesive has been applied between the sheets, as to assure good bonding between the sheets and provide a board which is rigid and substantially non-yielding.

Still another object of our invention is to provide a scoring device for use with a relatively thick corrugated board made up of three corrugated sheets interposed between four spaced liner sheets, the scoring device being so constructed and arranged that the composite board may be bent on the line of scoring almost invariably without breaking the external liner sheet.

Our invention further contemplates the continuous production of corrugated paper board wherein three corrugated sheets are interposed between four spaced liner sheets, the sheets being rigidly bonded together, and the sheets being scored along an area or strip extending longitudinally of the direction of travel of the composite board and transversely of the corrugations in such manner that the composite sheet may be bent on the line or strip of scoring to form a carton or other structure without breaking along the scoring strip.

Other objects and advantages of our invention will be particularly set forth in the claims and will be appar-

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ent from the following description, when taken in connection with the accompanying drawings, in which:

Fig. 1 is a diagrammatic longitudinal view of the combining, scoring and cut off end of a corrugated paper board machine in which the novel features of our invention have been incorporated to enable the production of triple wall corrugated paper board by the method of our invention;

Fig. 2 is a top plan view of Fig. 1;

Fig. 3 is a plan view of a composite corrugated board sheet made by the method and machine of our invention and scored by the scoring device of our invention, parts being broken away to show the direction in which the corrugations extend;

Fig. 4 is a sectional view taken substantially on the line 4—4 of Fig. 3;

Fig. 5 is a vertical sectional view of a duplex scoring machine in which the novel scoring devices of our invention have been incorporated; and

Fig. 6 is an enlarged sectional view of the rotatable scoring dies of our invention.

In Fig. 1, we have shown the combining end of a corrugated paper board machine. Concerning the parts of the corrugated paper board machine (not shown), it is sufficient to state that the sheets of paper are corrugated transversely of the direction of travel through the machine and adhesively applied to liner sheets all in a manner well known in the art to which this invention applies.

The method and machine of this invention is directed to the production of triple wall corrugated paper board, that is, a composite board comprising three corrugated sheets interposed between four spaced liner sheets.

In steps previous to those shown in Fig. 1, three sheets 11, 12 and 13 are corrugated and the ridges of the corrugations adhesively secured to liner sheets 14, 16 and 17, thus forming three composite sheets of single face corrugated paper board.

The three sheets of single face corrugated paper board are brought into juxtaposition and brought over guides 18 and pass over hot preheater drums 19. These preheater drums are supplied with high temperature steam by means not shown, but well understood in the art. The preheater drums 19 may be supported by a frame 21 which also serves as a support for arms 22 which carry idler rollers 23. The frame 21 may be supported in any suitable manner as indicated at 24 from the main part of the machine generally indicated by the numeral 26.

An outer liner 27 mounted on a roll stand (not shown) passes around an idling roller 28 and around a preheating drum 29 and thence around an idling roller 31. The three sheets of single face corrugated paper board and the liner sheet 27 thus preheated are brought to gluing rolls 32 where glue is applied to the ridges of the corrugations which extend transversely of the direction of travel of the webs of paper and the four juxtaposed webs of paper are brought together beneath a belt 33. The belt 33 may be of canvas or any other suitable material and is mounted on pulleys 34, one of which constitutes a driving pulley driven by means not shown.

One of the problems encountered in making triple wall corrugated paper board is that the sheets are relatively heavily laden with moisture as they leave the portions of the machine to the left of the combining end of the machine shown in Fig. 1. This may be one of the major reasons no method of making triple corrugated paper board has been successful commercially insofar as we are aware.

It will be appreciated that large quantities of steam are employed in forming the corrugations, steam jets being applied to the paper to condition it for corrugating. The air of the building which the machine occupies is heavily

laden with moisture which is absorbed by the liner sheets as the webs travel through the machine to the combining end shown. The webs of paper may be described as essentially saturated with moisture. To obtain a proper and secure bond between the several layers of paper it is necessary that the glue "set." This requires heat not only for the purpose of "setting" the glue but also for the purpose, at least to some extent, of drying the paper prior to scoring and trimming it to size. The major purpose of the preheating drums 19 and preheating drum 29 is to condition the paper and cause heat transfer through the paper to enable the proper application of the glue to the corrugations and secure an initial "set" of the glue.

A further problem encountered in making triple wall paper board is that a heating or drying section which has been generally indicated by the numeral 37 in the drawings, which will supply heat to both sides of the composite sheet is difficult and complicated to build. When heat is applied to only one side of the composite sheet, as in making triple wall corrugated paper board, the heat must penetrate five layers of paper before it reaches the corrugations 11. It is therefore difficult to obtain proper "setting" of the glue and an adequate bond between the uppermost ply of corrugated paper board and the intermediate plies of corrugated paper board.

In Fig. 1, by breaking off the heating or drying section 37, we have distorted the drawing. However, it will be understood that the heating and drying section is relatively long. In the machine with which we now produce triple wall corrugated paper board, the heating and drying section is approximately 43 feet long. We have found that the various layers of paper board may be bonded together to secure a rigid board structure if the heating section is relatively long and the speed of the composite sheet and the temperature of the hot plates are maintained within certain well defined limits. A good bond can then be obtained without scorching or burning the sheet. We have carried out a large number of experiments to determine the proper speed-temperature relationship and have found that by accurately controlling the temperature and speed of movement of the composite corrugated paper board through the heating or drying section, good quality triple wall corrugated paper board may be obtained in a continuous and commercially practicable manner.

The heater section 37 comprises a long series of hot plates which have been diagrammatically illustrated at 38. These hot plates are supplied with steam by means not shown. The upper face of the lower run of the belt 33 may be somewhat weighted down by rollers 39 to apply some pressure between the belt and the hot plates to secure better heat transfer.

We have found that the temperature of the hot plates should be between 300° and 330° F. Below 300° F. the paper board is not adequately dried and the glue does not "set" properly, and above 330° F. the paper, particularly the lower liner sheet, becomes scorched. However, preferably the temperature of the hot plates should be between 325° and 330° F. Within these temperature limits, we have found that the speed of travel of the composite sheet cannot be less than 100' per minute and cannot be in excess of 175' per minute. Below the lower limit of this speed the paper tends to scorch and beyond the upper limit of this speed adequate drying and setting of the adhesive is not secured. However, far better results are secured if the speed of travel is maintained between 135' and 150' per minute. If the temperature of the hot plates is maintained, let us say at 300° F., then the speed of travel of the composite sheet should be relatively slow, approximately 100' per minute. If the temperature of the hot plates is raised to 350° F., the speed of travel of the composite sheet may be increased to as much as 175' per minute but is preferably about 135' to 150' per minute. The above limits are being considered

in connection with a heating and drying section approximately 40' long.

An exact temperature-speed relationship cannot be set forth because of the variables encountered. The temperature-speed relationship will vary with the humidity, the thickness of the paper, its porosity and other factors which may vary from hour to hour. However, it is necessary to control the temperature-speed relationship approximately within the limits above set forth.

The machine is adapted to produce A, B and C flutes for which standards have been set up by the corrugated box industry. In Fig. 4, we have shown a composite board made of an A flute which is the central ply, a B flute which is the uppermost ply, and a C flute which is the lowermost ply. Experiments have shown that the arrangement of the flutes affects the strength characteristics of the board produced although this constitutes no part of our present invention. It is sufficient to state that the machine of our invention is capable of producing A, B and C flutes in any desired combination.

After the composite corrugated paper board has passed through the drying section, it passes to a cooling and drying section and thence to a duplex scoring machine, the construction of which is well known in the art. The cooling section lies between the end of the hot plates and the duplex scoring machine. It comprises a pair of pulleys one of which is driven, over which a belt 36 passes. The upper run of the belt passes over cooling plates 40 which may be the same as the hot plates 38 but to which no steam is supplied. The belt 33 passes over both the heating section and the cooling section. In the cooling section the glue sets to secure proper adhesion of the sheets prior to the scoring and cut off operations.

In general, as shown in Fig. 5 the scoring machine comprises a pair of shafts 41 which may be driven in any suitable manner (not shown). The shafts 41 are mounted in suitable side plates 42 mounted on a shaft 43. The shaft is rotatably supported in and by means of a suitable frame 44. In a duplex scorer, two sets of scoring rolls are mounted in the end plates 42 so that one set of scoring devices 47 may be employed while a second set of scoring devices 48 may be set up for the next run of board to be placed on the machine. When the next run is started, the shaft 44 is rotated through 180° F. to bring the scoring devices 48 in the uppermost position.

One of the problems encountered in connection with the making of triple wall corrugated paper board lies in securing a proper scoring area or strip lengthwise of the web as it travels through the machine and transverse to the direction of the corrugations which will enable the bending of the board along the score area without breaking or tearing the board. In single ply or wall double face paper board a line of scoring is adequate to enable the folding of the sections on opposite sides of the score line at right angles to each other. However, triple wall corrugated paper board is relatively thick and at least three lines of scoring must be produced in the paper board which may be termed an "area" or "strip" of scoring as distinguished from a "line" of scoring. This strip scoring is produced by having a scoring strip or area in the male die as well as in the female die.

As an example, in the making of triple wall corrugated paper board having A, B and C flutes such as shown in Fig. 4, the total thickness of the composite sheet is theoretically $\frac{5}{16}$ ". This particular board has liner thicknesses of .016" and corrugating medium thicknesses of .009". Thus the total thickness of the paper employed is .091". In corrugated paper board, an A flute is .181" high, a B flute .103" and a C flute .145" high. Because the corrugating rolls may be worn and the composite sheet is somewhat flattened upon being passed through the drying section, the total thickness of the composite sheet may vary between $\frac{3}{8}$ " and $\frac{1}{2}$ ". Of course if all A flutes were employed, the total thickness of the composite sheet would be greater.

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To enable a board of such thickness to be scored properly for bending of the sections on opposite sides of the score line at right angles to each other, an area or strip of scoring must be provided to avoid breaking or tearing the liner on the external side of the bend and also to avoid completely collapsing the liner and its adjacent corrugations on the inside of the bend.

In Fig. 6 we have shown a male die 51 and a female die 52 which are mounted on the shafts 41. The male die has a continuous ring or projection 53 rectangular in cross section. The female die has a depression 54 also rectangular in cross section. We have found it to be desirable to make the width of the female die at least not materially less than the thickness of the board. In the particular illustration shown, the width of the depressed portion of the female die is $\frac{4}{100}$ ". The width of the projection 53 of the male die is substantially less than the width of the female die and in the particular illustration shown this width is $\frac{35}{100}$ " to allow for side clearance. This side clearance, indicated at 55, is approximately .045". The amount of penetration of the male die into the female die is preferably somewhat larger than the amount of side clearance.

We have found that the amount of side clearance may be made as much as $\frac{1}{8}$ of the thickness of the paper board but cannot be decreased to less than $\frac{1}{10}$ of the thickness of the composite board. With these ratios of side clearance to board thickness; with the amount of penetration somewhat larger than the side clearance; and with the width of the female die at least not materially less than the thickness of the board, we have found that a clean breaking of the board may be obtained without, almost invariably, breaking the outer liner or completely collapsing the corrugations.

A further problem encountered in making a score line for triple wall corrugated paper board lies in the fact that it is necessary to produce an "area" or "strip" of scoring as distinguished from a "line" of scoring. This fact may result, when the board is bent at right angles about the strip of scoring, in the material bending diagonally across the scoring strip. We have found that by forming a slight projection 56 in the center of the projection 53 of the male die, a line of bending is induced in the composite sheet so that in bending the paper board, the bending almost invariably occurs along a line of bend in alignment with the annular projection 56. It will be particularly noted as indicated at 57 that all corners of both the female and male dies are provided with radii to avoid tearing the material and that the dies shown produce at least three lines of scoring located along a strip.

A strip of scoring produced by male and female dies in approximately the proportions described above and provided with a projection such as 56 to induce a line of bend, enables the board to be bent along the longitudinal strip of scoring almost invariably without breaking the outer liner and with the line of bend in a straight line in alignment with the projecting annular section 56.

While we have shown and described the preferred form of our invention, it will be apparent that various changes and modifications may be made therein, particularly in the form and relation of parts, without departing from the spirit of our invention as set forth in the appended claims.

We claim:

1. A scoring device for corrugated board which includes at least four spaced liner sheets between each pair of which is interposed a corrugated sheet forming a relatively thick composite board comprising rotatable male and female dies, said male die having a projecting form-

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ing part essentially rectangular in cross section and said female die having a depressed part essentially rectangular in cross section, said depressed part having a width not materially less than the thickness of the composite board and the side clearance between the projecting and depressed parts of the dies being not less than one-tenth and not greater than one-eighth of the thickness of the composite board, said dies being adapted to produce a strip of scoring.

2. A scoring device in accordance with claim 1 in which the face of one of said dies is provided with means to induce a line of bend within the strip of scoring when the board on one side of the scoring is bent angularly with respect to the board on the other side of the scoring.

3. A scoring device in accordance with claim 1 in which the faces of said scoring dies are of a width approximating the thickness of the board to produce a strip of scoring and having means in connection therewith for inducing a line of bend approximately centrally located with respect to the edges of the strip of scoring.

4. A method of making multiple wall corrugated paper board which comprises adhesively bonding a corrugated sheet to a liner to form a single face corrugated paper board sheet, placing at least three of said single face sheets in juxtaposition and preheating them to condition the paper for the reception of adhesive, applying adhesive to the ridges of the corrugations adhesively to secure the ridges of said corrugations to the liner of an adjacent ply and to a liner sheet to form a composite board having at least three corrugated sheets and at least four liner sheets, heating said composite board for not less than 14 seconds and not more than 24 seconds at a temperature of not less than 300 degrees F. and not more than 330 degrees F., and scoring said composite board along strips extending transverse to the corrugations, each strip being defined by two closely spaced score lines and constituting a long, single relatively narrow bend area, all of said operations being carried out while the material is continuously moving through a path of travel with the corrugations transverse to the path of travel.

5. A method of making multiple wall corrugated paper board which comprises adhesively bonding a corrugated sheet to a liner to form a single face corrugated paper board sheet containing moisture, placing at least three of said single face sheets in spaced relation and preheating them separately to condition the paper by drying out some of the moisture for the reception of adhesive, applying adhesive to the ridges of the corrugations adhesively to secure the ridges of said corrugations to the liner of an adjacent ply and to a liner sheet to form a composite board having at least three corrugated sheets and at least four liner sheets, continuously applying pressure to the composite board while heating the composite board for not less than 14 seconds and not more than 24 seconds at a temperature of not less than 300 degrees F. and not more than 330 degrees F., all of said operations being carried out while the material is continuously moving through a path of travel with the corrugations transverse to the path of travel.

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