Nov. 17, 1942. D. H. PLEWES ET AL 2,302,144

METHOD OF MAKING TRANSVERSELY FLEXIBLE CORRUGATED PAPER

Original Filed June 24, 1939

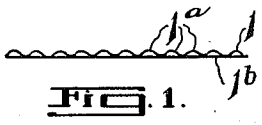


Fig. 1.

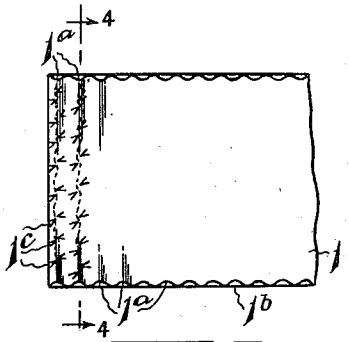


Fig. 2.

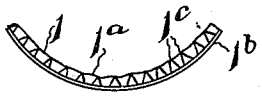


Fig. 4.

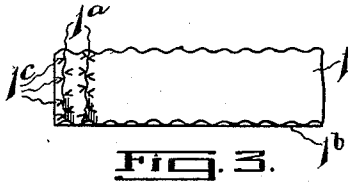


Fig. 3.

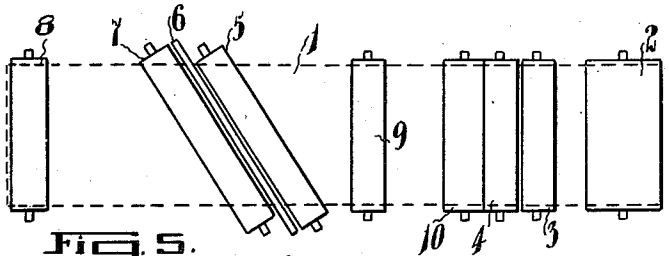


Fig. 5.

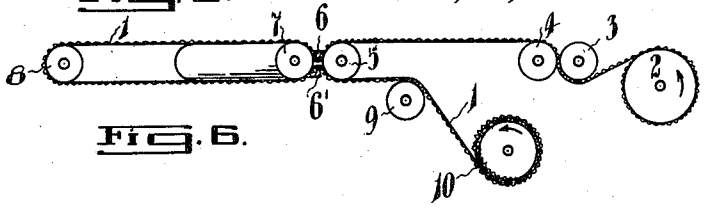


Fig. 6.

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METHOD OF MAKING TRANSVERSELY FLEXIBLE CORRUGATED PAPER

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Original application June 24, 1939, Serial No. 281,024. Divided and this application February 17, 1942, Serial No. 431,284

5 Claims. (Cl. 154—33.05)

This application is a division of co-pending application Serial No. 281,024, filed June 24, 1939, issued March 17, 1941, Patent No. 2,276,737.

This invention relates to a method for making transversely flexible corrugated paper, more particularly corrugated paper which is faced on at least one surface with a ply of plane material.

Corrugated paper for wrapping purposes has been used for many years, but is open to the objection that it is not readily flexible in a direction transverse to the ribs or corrugations. Where bending is to take place on a predetermined definite line or lines bending or folding may be effected by cutting or creasing along a straight edge or by making preformed creases or cuts along the line at which the bending is to take place. Also sheets of corrugated paper have been made which may be bent transversely at any desired place by forming closely spaced cuts or depressions in the ribs. Applying the depressions to the sheet tends to flatten the corrugations, thus reducing the thickness of the sheet so that, such sheets are weakened so far as resistance to vertical pressure is concerned, and are also marked in such a manner as to adversely affect the appearance of the same. In commercial practice a heavier facing sheet is sometimes used to compensate for the loss of strength of the corrugations.

The object of the present invention is to devise a method of making a sheet which will be sufficiently flexible to permit transverse bending or folding at any desired place on the sheet either diagonally of the length of the ribs or at right angles thereto, while retaining the normal thickness and appearance of the sheet with a minimum loss of strength to the sheet.

The object of this invention is attained by means of the method hereinafter particularly described and illustrated in the annexed drawing. A sheet made in accordance with the method and suitable apparatus are also described and illustrated. In the drawing

Fig. 1 is an end elevation of a sheet of corrugated paper made in accordance with this invention;

Fig. 2 a plan view of the same sheet slightly curved lengthwise of the rib to indicate the nature of the lines of weakness formed therein;

Fig. 3 a cross sectional view taken on the lines 3—3 in Figure 2;

Fig. 4 a longitudinal sectional view on the line 4—4 in Figure 2;

Fig. 5 a diagrammatic plan view of apparatus for making the sheet; and

Fig. 6 a side elevation of the apparatus shown in Figure 4.

In the drawing corresponding numerals in the different figures refer to corresponding parts.

The corrugated sheet 1 consists of a plurality of longitudinal ribs 1a and a facing sheet 1b adhesively secured to one side thereof. The preferred method of making the sheet is by progressively bending it along a line first diagonally across the ribs in one direction and then diagonally across the ribs in a substantially opposite direction to form a multiplicity of diagonal transverse lnes of weakness therein throughout their length. Preferably the first bending is at substantially 45° to the length of the ribs in one direction and the second bending is at substantially 45° in the other direction, although bending at angles of 30° and 60° respectively or at other angles may be effective. Alternatively the sheet may be subjected to a single transverse bending at right angles to the length of the ribs, in which case the lines of weakness would run across the rib substantially at right angles thereto; but the product so made is inferior to that illustrated inasmuch as it is not so flexible, particularly for diagonal bending of the sheet, and moreover the method is more difficult to perform inasmuch as rupture of the paper may occur, thus weakening the sheet. In carrying out the process the corrugated sheet is moved forward and sharply bent transversely of the ribs during its course of travel. The sheets are bent inwardly towards the corrugated side, since to bend them toward the facing side would rupture the corrugations.

As will be seen from Figure 1 when a sheet of corrugated paper 1 made in accordance with this invention is laid out flat the ribs are of the same fully rounded shape as in ordinary corrugated paper so that the sheet presents substantially the same appearance as any ordinary sheet of corrugated paper, although on close inspection even in its flat form the corrugations or ribs 1a will be seen to bear on their surfaces barely discernible lines, which represent the lines of weakness which have been formed therein by the process above described. When a sheet made in accordance with the preferred method above described is curved longitudinally of the ribs 1a, thus forming a transverse bend in the ribs, these lines of weakness form a multiplicity of closely spaced wrinkles 1c in substantially the form illustrated in Figures 2, 3, and 4. The wrinkles are somewhat irregular and their form would depend somewhat on the material of which the sheet is made, the amount of bending which they

are subjected to, and the tension under which the bending takes place, but in general, when the sheet is curved or folded as in Figures 2, 3, and 4, the wrinkles 1^c are substantially V-shaped formed on the sides of the ribs by lines extending diagonally of the ribs from the bottom of the troughs between the ribs and meeting on either side of the apex thereof. These wrinkles occur along the lines of weakness formed in the sides of the ribs and the wrinkles on opposite sides do not quite coincide, so that when the sheet is curved or folded transversely of and at right angles to the ribs, the sides of the ribs on the line or lines of curving or bending collapse inwardly causing the apex or top of the rib to take on an irregular zig-zag formation. The lines of weakness are not uniformly spaced but when the sheet is curved as illustrated the wrinkles which are thereby formed show that they occur throughout the length of the ribs approximately one quarter to one-half inch apart.

Figures 5 and 6 show diagrammatically means for effecting the desired bending of the material. The material is preferably in the form of a long sheet or strip which may be fed to the apparatus directly from the corrugating machine or which may be wound on a roll **2** and carried from such roll through guide rollers **3** and **4** to and over a supporting bar or roller **5**. The material passes over the roller and downwardly, slightly bending the material towards its plane side, the bending being insufficient to rupture the corrugations, and then passes around a deflecting and bending bar **6**, where it is bent sharply upward towards its corrugated side, and then passes over another supporting bar or roller **7** to and around the guide roller **8** and back under the supporting roller **7** and around a deflecting and bending bar 6^1 and then down and under the bar or roller **5** to another guide roller **9** and from thence to a rewind roller **10** which may be positively driven to draw the sheet through the apparatus. The roller **2** and any of the guide rollers or supporting rollers may be positively driven, but it is essential that the strip be under tension when passing around the bending bars. Instead of utilizing the rollers **5** and **7** for the transverse bending in the opposite direction from the first transverse bending, another set of supporting rollers and bending bar may be used and may be in the same plane as the first rollers and bending bar or above or below them.

It will be seen that a sharp bending action is produced by the apparatus described above. The corrugations are preferably on the upper side of the sheet as shown in Figure 5 and extend across the sheet or strip. The pull of the sheet around the bending bars **6** and 6^1 form wrinkles which result in lines of weakness. When the sheet is passed over the roller **7** after passing under the bending bar **6** and when it is passed under the roller **5** after passing around the creasing bar 6^1, the wrinkles formed by the bar straighten out so that the treated sheet has a normal appearance unless closely examined or unless bent transversely of the length of the ribs.

It is to be understood that in the specification and claims the word "transversely" used in reference to the ribs or corrugations is not, of course, limited to a direction at right angles to the length of the ribs, but applies also to a direction diagonally across the ribs.

What we claim as our invention is:

1. A method of imparting transverse flexibility to corrugated paper, faced on one surface with a ply of plane material, comprising bending the ribs transversely of their length and throughout their length to form a multiplicity of closely spaced transverse lines of weakness along the sides thereof throughout their length without appreciable permanent deformation of the ribs.

2. A method of imparting transverse flexibility to corrugated paper, faced on one surface with a ply of plane material, comprising bending a sheet of such paper towards its corrugated side first across the ribs diagonally in one direction and then across the ribs in a substantially diagonally opposite direction to form a multiplicity of closely spaced diagonally transverse lines of weakness along the sides of the ribs throughout their length without appreciably permanently deforming the ribs.

3. A method of imparting transverse flexibility to sheets of corrugated paper, faced on one surface with a ply of plane material, comprising progressively moving the corrugated sheet, and progressively sharply bending the sheet towards its corrugated side transversely of the ribs during its course of travel, to form a multiplicity of closely spaced transverse lines of weakness along the sides of the ribs throughout their length, without appreciably permanently deforming the ribs.

4. A method of imparting transverse flexibility to sheets of corrugated paper, faced on one surface with a ply of plane material, comprising progressively moving the corrugated sheet and progressively slightly bending the sheet transversely of the ribs first downwardly towards its plane side, the downward bend being insufficient to rupture the corrugations, and then sharply upwardly towards its corrugated side during its course of travel, to form a multiplicity of closely spaced diagonally transverse lines of weakness along the sides of the ribs throughout their length without appreciably permanently deforming the ribs.

5. A method of imparting transverse flexibility to sheets of corrugated paper, faced on one surface with a ply of plane material, comprising progressively moving the corrugated sheet, and progressively sharply bending the ribs inwardly first in a diagonal transverse direction and then inwardly in a substantially opposite diagonal transverse direction, to form a multiplicity of closely spaced diagonally transverse lines of weakness along the sides of the ribs throughout their length without appreciably permanently deforming the ribs.

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