METHOD OF PRODUCING A CORRUGATED MEMBER
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ABSTRACT OF THE DISCLOSURE
The method of producing a corrugated member including the steps of feeding a plurality of first strips and separate second strips of the elongated web material along predetermined paths, folding each of the first and second strips into trough-shaped configurations, positioning each of the first strips between adjacent second strips with the trough-shaped sides of the first strips facing in the opposite direction from the trough-shaped sides of the second strips, and securing the first strips to the second strips.

This invention relates to an improved corrugated structure and in particular to a continuously formed longitudinally corrugated board possessing a high degree of strength not present with conventional transversely corrugated board and to a composite corrugated member comprised of a longitudinally and transversely corrugated board connected together in such a way whereby the corrugations of the individual boards extend crosswise of each other to produce a member that is resistant to both crushing and bending. Corrugated boards are usually produced in a continuous fashion from an elongated web of paperboard with the corrugations extending transversely of the web. For producing these corrugations, the web is fed in a direction along its length and through a pair of parallel rolls having flutes on their outer surfaces extending along the axes of the rolls. The flutes of the rolls cooperate in a mating relationship to bend the web into a fluted pattern extending across its width. Facing material is then glued to one or both sides of the fluted or corrugated web to produce the final product. During the corrugating of the web, it is apparent that its overall effective length is shortened due to the production of flutes. This, however, presents no problems in the continuous operation of the corrugating machinery since the corrugations extend transversely of the length of the web and the decrease in overall length is compensated for by simply controlling the speed of movement of the web on either side of the corrugating rolls.

Attempts have been made in the past to produce an elongated corrugated board from a single web of material with the corrugations extending longitudinally thereof; however, the production of such boards presents certain difficulties due to the necessary contraction in the overall width of the web that must be effected in producing the corrugations. The machinery used in producing such boards must be constructed to permit the web to move transversely of its forward path of movement and such transverse movement is complicated by the fact that each longitudinally extending segment of the web that will form the sides of the longitudinally extending flutes must move in opposite directions to produce such flutes. Due to the difficulties encountered in producing longitudinally corrugated boards such as described above, industry has generally come to prefer and accept corrugated boards formed from a continuous web of material which has been corrugated transversely of its length. These boards possess good resistance against crushing but because the corrugations of these boards extend in only one direction, they give only one-way strength or stiffness; that is, they resist bending along lines extending at right angles to the corrugations but are readily bendable in a direction along the corrugations.

Attempts in the past have been made to unite separate corrugated boards with the corrugations extending crosswise of each other; however, boards of this construction do not have the overall thickness of the composite board. Also, limitations are imposed on the overall length of such boards where they are formed from transversely corrugated webs in the sense that the length of the composite board is limited by the width of the board that is to be used as the longitudinally corrugated member. Also, in order to construct such composite structures from individual boards previously produced by transversely corrugating a web material, the individual boards must be cut to the appropriate size before assembly to each other. This can involve additional time and require that the assembly operation be carried out in an intermittent fashion or at best with complicated machinery operating in a continuous fashion. It is apparent that such manufacturing methods can easily add to the overall expense of such composite constructions.

In accordance with the teachings of the present invention, a continuous length of longitudinally corrugated board is produced by employing two web materials, each of which is slit into individual strips, subsequently folded into a trough shape, and adhesively attached to each other along their longitudinal edges in a fluted or corrugated relationship. By employing two webs as opposed to a single web, and by dividing each of these webs into individual strips, the problems that might otherwise be encountered in compensating for the necessary transverse movement of the web are avoided; and by simple offsetting one of the webs laterally in the other, each of the individual strips of one of the webs will automatically be aligned with the strips of the other web as they are brought together in their longitudinally folded condition. As a result of using a pair of slit webs, the entire longitudinal corrugating operation may be effected in a continuous fashion and the board which is produced fed directly into alignment with a transversely corrugated board formed by conventional methods. Attachment of these two boards together will then produce a composite board with the corrugations extending at right angles to each other.

For purposes of structurally reinforcing the composite structure, the transversely corrugated board is provided with longitudinally extending rows of apertures in the raised flutes with each of the rows spaced apart by a distance equal to the spacing of the flutes of the longitudinally corrugated board. When the two boards are brought together, the flutes of the longitudinally corrugated board are seated in mating relationship within the apertures of the transversely corrugated board and adhesively united in this relationship.

The adhesive used in attaching the various parts of boards together is advantageously a hot melt adhesive which is rendered tacky upon being heated. This adhesive is impregnated into the web materials and adds to the integral strength of the final structure. In addition, the strength of the longitudinally corrugated member is increased by the double thickness produced by the overlapping of the individual strips, and since the longitudinally corrugated member is formed from individual strips that require only one folding, it is not necessary to preconditio the strips to render them soft and pliable before such folding is effected. With a single web folded in a reverse pattern to form the corrugations, it is usually necessary to pre saturate the web material with water or steam so that the corrugations will “set” upon the drying of the
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3,449,157 corrugated board. The addition of this moisture to the material is in some situations undesirable in that it tends to weaken the strength of the resulting board. The board is produced in accordance with the teachings of the present invention possesses certain advantageous characteristics that render it particularly useful in producing many types of shipping containers. The board is not only lightweight; but due to the cross-corrugations, it is extremely rigid and will resist both crushing and bending in all directions. These features also render the board uniquely suited for use as building panels in much the same manner as plywood sheets are now used today. Also, due to the voids formed by the corrugations, these boards possess desirable soundproof characteristics; and these voids may be filled with suitable material to render the composite structure fire resistant and at the same time give it good insulating qualities.

A more complete understanding of the invention will be obtained from a reading of the following detailed description with reference being made to the accompanying drawings of which:

FIG. 1 is a schematic side elevation of the portion of the apparatus for forming the longitudinally corrugated member;

FIG. 2 is a schematic side elevation of the portion of the apparatus for unrolling the transversely corrugated member to the longitudinally corrugated member;

FIG. 3 is a partial side elevational view of the scoring rolls shown in FIG. 1;

FIG. 4 is a partial side elevational view of a modified embodiment of the scoring rolls;

FIG. 5 is a partial side elevational view of the slitting rolls shown in FIG. 1;

FIG. 6 is a partial cross-sectional view of the folding rolls taken along line 6--6 of FIG. 1;

FIG. 7 is a partial cross-sectional view of the cutting rolls taken along line 7--7 of FIG. 2;

FIG. 8 is a perspective view partially broken away of a portion of a composite corrugated member formed by the apparatus of FIGS. 1 and 2;

FIG. 9 is a perspective view of a modified embodiment of a composite corrugated member;

FIG. 10 is a perspective view partially broken away of another modified embodiment of the composite corrugated member;

FIG. 11 is a perspective view of the board formed by the apparatus of FIG. 1.

As shown in FIG. 1, the portion of the apparatus for producing the longitudinally corrugated board comprises upper and lower sections. Each of these sections includes substantially identical parts and accordingly, in describing this portion of the apparatus, the reference numbers used to designate like parts will be the same with those of the lower section followed by the character prime (').

Referring to FIG. 1, two rolls of web materials 1 and 1', such as paperboard, are shown as being rotatably positioned on suitable supports. The webs drawn from these supplies are led through various operating sections of the apparatus, the first of which is the scoring mechanism 2 and 2'. With reference to the upper section of the apparatus, the scoring mechanism consists of a pair of cooperating rolls 3, 4 disposed on opposite sides of the web 1. These scoring rolls may be of any conventional construction and as represented in FIG. 3, the lower roll 4 of the pair is provided with a smooth cylindrical surface while the other cooperating roll 3 is provided with a plurality of spaced circumferentially extending scoring ribs 5 for producing longitudinally extending fold lines on the web 1. The scoring mechanism shown in FIG. 3 produces a plurality of laterally spaced single fold lines; however, as an alternative to this, the scoring ribs may be constructed in the shape shown in FIG. 4 where a plurality of raised closely aligned ribs 5' are provided so as to produce a plurality of closely aligned fold lines at spaced intervals across the web. By having a plurality of closely aligned folding lines, the folding of the web along these lines will produce a more pronounced curved configuration.

After the web 1 passes through the scoring rolls, it is fed to an adhesive applicator 6. This applicator is comprised of an applicator roll 7 partially disposed within an adhesive trough 8 and a cooperating back-up roll 9. As the web moves between these rolls, the adhesive roll is caused to rotate and transfer adhesive from the trough 8 to the bottom side of the web 1. The adhesive employed for this purpose is a hot melt adhesive which may be comprised of hot asphalt or a suitable synthetic resin such as Tuffin manufactured by The Atlantic Refining Company. The adhesive becomes tacky upon heating and in applying the adhesive to the web material in either a continuous or stripped pattern, pressure is exerted by the rolls 7 and 9 so as to effect an impregnation of the adhesive into the web material and a coverge retinat sys p:x3De-rTAIN made from starch or alicante of soda has been used as the adhesive in making corrugated paperboard. Such an adhesive contains a considerable amount of water, and the addition of this water to the web material tends to weaken it. With a hot melt adhesive such as hot asphalt, the stiffness of the corrugated web is increased rather than weakened.

Once the adhesive has been applied to the web, the coated material is fed through a slitting mechanism generally designated at 10. This slitting mechanism is comprised of a pair of cooperating rolls 11 and 12 for slitting the web longitudinally midway between the fold lines. As shown in FIG. 5, the roll 11 is provided with a plurality of spaced blade-like surfaces 13 cooperating with grooves 14 formed in the roll 12. The strips 15 formed by the slitting mechanism have their longitudinal edges closely aligned with respect to each other as they pass toward the next operating station in the apparatus where the two webs, both of which are now slit into strips, are joined together in a corrugated pattern.

For producing the composite corrugated web, a corrugating mechanism generally designated at 16 is provided. This mechanism includes a pair of cooperating rolls 17 and 18 disposed on opposite sides of the web materials 1 and 1'. These two rolls are identical in construction and as shown in FIG. 6 are provided with circumferentially extending folding ribs 19, 20, respectively. Between each of these folding ribs, the rolls 17, 18 are provided with grooves 21, 22. These grooves extend radially inwardly of the folding surface of the ribs to provide a free space into which the folded edge of the strips may extend without contacting the rolls. The first strips 15 formed from the first web material 1 are passed between the rolls 17, 18 and about the folding ribs 19 of the roll 17. These folding ribs are aligned with respect to the spaced fold lines in the first web so that the fold line of each strip will contact one of the ribs along its outermost edge 19'. As the strips are drawn under the roll 17, they will be folded about the folding ribs and automatically spaced laterally of each other. The second strips 15' formed from the second web 1' are passed about the cooperating roll 18 in the same manner as the first strips are led about the roll 17. At the point where the second strips are fed into the corrugating mechanism, they are offset laterally of the first strips so as to be in proper orientation with the folding ribs 20. This is effected by mounting the supply roll for the first web material and its associated scoring, adhesive, and slitting mechanism at a position offset laterally from that used with the first web material. As the first strips and second strips are fed between the rolls 17 and 18, the sides to which the adhesive has been applied will face each other and be in pressure engagement therewith. The rolls 17 and 18 are heated by suitable means represented diagrammatically at 23, 24 so as to assure that the hot melt adhesive is tacky at the time when the strips are brought together to effect a uniting thereof.
As shown in FIG. 6, the first strips span the lateral spaces between the second strips and the exposed portions 25 of the sides to which the adhesive has been applied are received within the grooves 22 out of contact with the roll 18. Likewise, the second strips span the spacing between the first strips and are similarly oriented with respect to the channels of the roll 17.

Dispised beyond the rolls 17 and 18 is a feeding mechanism generally designated at 26. This mechanism comprises cooperating feed rolls 27, 28 disposed on opposite sides of the compensate corrugated web as it exits from the rolls 17 and 18. These rolls provide the pulling power for drawing the corrugated web through the various mechanisms by which the strips are formed, folded, and united. As shown in FIG. 2, the corrugated composite web exiting from the corrugating mechanism is provided with a liner board or facing web 29 on its underside. The facing web is fed between cooperating rolls of an adhesive applicator 30 generally similar to applicators 6 and 6' and then about the feed roll 28 into engagement with the lower side of the composite corrugated web. The roll 28 is heated by the means shown diagrammatically at 31 and presses the facing web 29 into pressure engagement with the exposed surfaces 25 of the strips 15. It is to be noted that these surfaces 25 have already received a coating of adhesive and are thus ready to receive the facing web 29. The application of additional adhesive to the facing web 29 assures a proper uniting of the web 29 to the corrugated web and in addition, adds stiffness to the web 29 upon setting.

As the longitudinal member exits from the machine of FIG. 1, it may also be provided with a facing web 29' on its upper face to produce the structure shown in FIG. 11. This structure possesses a high degree of strength not obtainable with a conventional transversely corrugated member formed of the same weight material. This is so, due to the fact that the strips forming the corrugations are overlapping and because the structure has been formed without the usual saturation of the material that is required with conventional transversely corrugated boards in order to permit the material to set once it has been bent into the corrugated pattern.

Disposed on the upper side of the composite corrugated web is a length of transversely corrugated board 32. This board is comprised of a facing web 33 to which is attached a transversely corrugated web 34. The board, as it is led toward the longitudinally corrugated board, is first passed through a cutting mechanism designated at 35. As shown in FIG. 7, this cutting mechanism is comprised of a pair of rolls 36, 37 disposed on opposite sides of the board 32. The roll 36 is constructed with a plurality of grinding ribs 38 spaced laterally across the roll 36. The roll 36 is driven at a high speed relative to the movement of the board 32 to form the longitudinally extending apertures 39 in the transverse corrugations. These apertures cut the raised flutes 40 of the corrugations along laterally spaced rows. As shown in FIG. 8, the spacing between these rows of apertures corresponds to the spacing of the raised flutes on the longitudinally corrugated board exiting from the corrugating mechanism 16. The transversely corrugated board is passed through an adhesive applicator 41 and then under the feed roll 27 into overlying engagement with the longitudinally corrugated member with the exposed flutes of the longitudinally corrugated member seated against the bottom of the apertures formed in the transversely corrugated member.

The corrugated composite board formed by the apparatus just described is shown in FIG. 8. It is to be noted that the overall thickness of the composite structure is not much greater than the individual thickness of either of the boards and that the two boards are securely locked together with a type of tongue and groove connection.

With the corrugations of the individual boards extending crosswise of each other, resistance against bending in either direction is obtained. This makes the composite structure well suited for use as building panels.

Instead of using an interlocking connection as shown in FIG. 8, the composite board may be formed in the manner shown in FIG. 9 where both of the corrugated members are provided with a facing web 42 on the sides abutting each other. Alternatively, these interior facing webs may be omitted altogether and the two boards secured together with the exposed flutes of one of the boards lying directly upon and across the exposed flutes of the other board.

It is to be noted that in FIGS. 8 and 9 the corrugations within the borders of the composite structure form voids. These voids give the structure good acoustical qualities which are particularly desirable where they are used as wall or ceiling panels. In addition, these voids permit the boards to be readily adapted for use as insulating or fire resistant material. A mixture of asbesto fibers and expanded perlite particles not only gives the board good thermal insulating qualities but also renders it fire resistant. A composite board construction filled in this manner is shown in FIG. 10 where the mixture of asbesto fibers and expanded perlite particles is shown at 43. The voids may also be filled with other suitable materials to add insulating or fire resistant qualities. For example, asphalt and expanded perlite particles or asbesto fibers may be used. In addition, vermiculite, a very absorbent material, can be used together with asphalt. Although asphalt is subject to burning, it needs oxygen in which to burn, and with the voids of the composite structure completely filled, oxygen is prevented from supporting combustion of the asphalt. In addition, the exposed facing webs of the composite structure may be made of any material which may advantageously be fireproof and/or decorative in nature. For example, single or double wood veneers may be used for building panels.

The above description of my invention is made with reference to the preferred embodiment; however, it is to be understood that various changes thereto may be made without departing from the scope of the invention as set forth in the following claims.

1. The method of producing a corrugated member comprising the steps of:
(a) feeding first and second continuous webs of flexible material along first and second paths, respectively, with one side of said first material facing one side of said second material at a predetermined point along said paths;
(b) slitting said first and second webs longitudinally at spaced intervals across their widths to form individual first and second strips;
(c) applying adhesive to one side of said first and second webs;
(d) folding each of said first and second strips longitudinally thereof into a general trough shape;
(e) bringing said first strips into adhering engagement with said second strips at said predetermined point along the paths with the one side sides thereof facing each other and with the trough shaped sides of said first strips facing the opposing trough shaped sides of said second strips to form a corrugated composite web; and
(f) adhesively applying a separate facing member to at least one side of said corrugated composite web.

2. The method according to claim 1 further including the step of:
(a) longitudinally scoring said first and second lengths of web material before said folding steps and at spaced intervals across their widths to define fold lines about which said strips are folded to form said trough shapes.

3. The method according to claim 2 further including the steps of:
(a) spacing said first strips laterally of each other;
(b) spacing said second strips laterally of each other;
and
(c) bringing said first strips into adhering engagement
with said second strips with said first strips spanning
the lateral spaces between said second strips.
4. The method of producing a corrugated member com-
prising the steps of:
(a) feeding first and second webs of flexible material
along first and second paths, respectively;
(b) scoring said first and second webs longitudinally at
predetermined spaced intervals across their widths
to form fold lines;
(c) applying adhesive to one side of said first and
second webs;
(d) slitting said first and second webs longitudinally
intermediate said fold lines;
(e) folding each of said first and second strips about
said fold lines into a general trough shape with the
strips of each web spaced laterally from each other;
(f) bringing the one sides of said first strips into ad-
hering engagement with the one sides of said second
strips with the first strips spanning said lateral spaces
between said second strips and with the trough shaped
sides of said first strips facing away from the trough
shaped sides of said second strips to form a corrugated
composite web; and
(g) applying a separate facing web to at least one side
of said composite web in adhering contact with the
exposed positions of the one sides of said strips.
5. The method according to claim 4 wherein:
(a) said adhesive is heat sensitive and is impregnated
into the one side of said first and second webs of
material; and
(b) said strips are heated as they are brought into ad-
hesive engagement with each other.
6. The method of producing a corrugated member com-
prising the steps of:
(a) feeding first and second webs of flexible material
along first and second paths, respectively;
(b) scoring said first and second webs longitudinally
at predetermined spaced intervals across their widths
to form fold lines;
(c) applying adhesive to one side of said first and
second webs;
(d) slitting said first and second webs longitudinally
intermediate said fold lines;
(e) folding each of said first and second strips about
said fold lines into a general trough shape with the
strips of each web spaced laterally from each other;
(f) bringing the one sides of said first strips into ad-
hering engagement with the one sides of said second
strips with the first strips spanning said lateral spaces
between said second strips and with the trough shaped
sides of said first strips facing away from the trough
shaped sides of said second strips to form a corrugated
composite web; and
(h) adhesively applying a transversely corrugated
member to the other side of said composite web;
said transversely corrugated member including:
(1) a transversely corrugated elongated web,
(2) facing web adhesively united to one side of
said web; and
(3) a plurality of apertures formed in the exposed
flutes of said corrugated web along longitudi-
nally extending rows spaced laterally of each
other with the apertures of each row aligned in
matting relationship with one of the exposed
flutes of the longitudinally corrugated composite
web.

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MORRIS SUSSMAN, Primary Examiner.
U.S. Cl. X.R.
52—618; 156—210, 227, 257; 161—133
It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Page 1, Column 2, line 44 - "board" should read --boards--

Page 2, Column 4, line 18 - "coofgo neinat sys p,av3De-seTAOIN" should read --coating of one side thereof. In the past, glue--

Page 2, Column 4, line 51 - "waterial" should read --material--

Page 3, Column 6, line 58 - "one side sides" should read --one sides--

Page 4, Column 7, line 33 - "ad" should be deleted

Page 4, Column 8, line 19 - "2) facing web" should read --2) a facing web--

SIGNED AND SEALED
MAR 24 1970

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR
Commissioner of Patents