

May 15, 1951

J. D. LINCOLN ET AL
MACHINE AND METHOD FOR PRODUCING
A CONTINUOUS HONEYCOMB STRUCTURE

2,553,054

Filed Jan. 2, 1948

3 Sheets-Sheet 1

Fig. 1

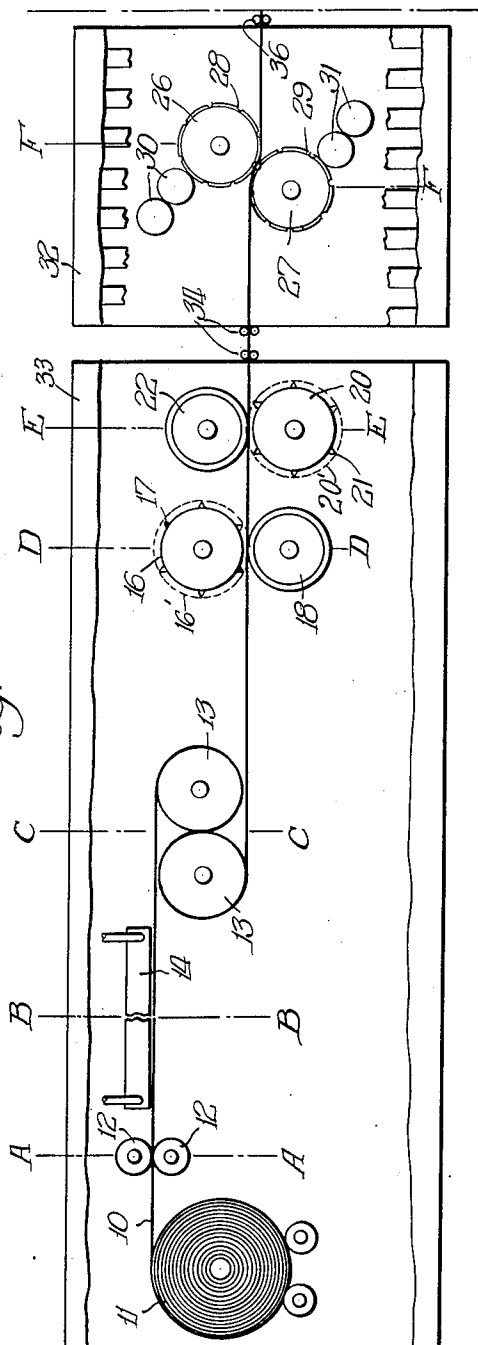
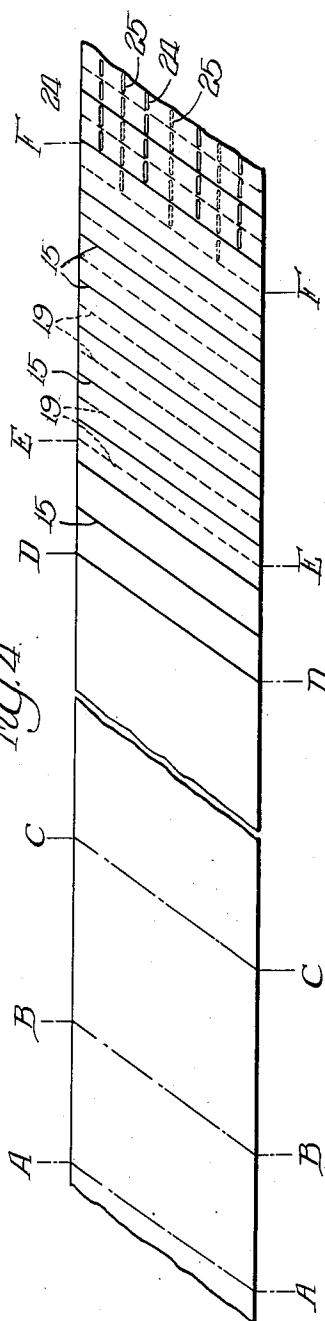


Fig. 4



INVENTORS.

John D. Lincoln,
BY George M. Thomson,
Cromwell, Trist & Warden
attys

May 15, 1951

J. D. LINCOLN ET AL
MACHINE AND METHOD FOR PRODUCING
CONTINUOUS HONEYCOMB STRUCTURES

2,553,054

Filed Jan. 2, 1948

3 Sheets-Sheet 2

Fig. 2

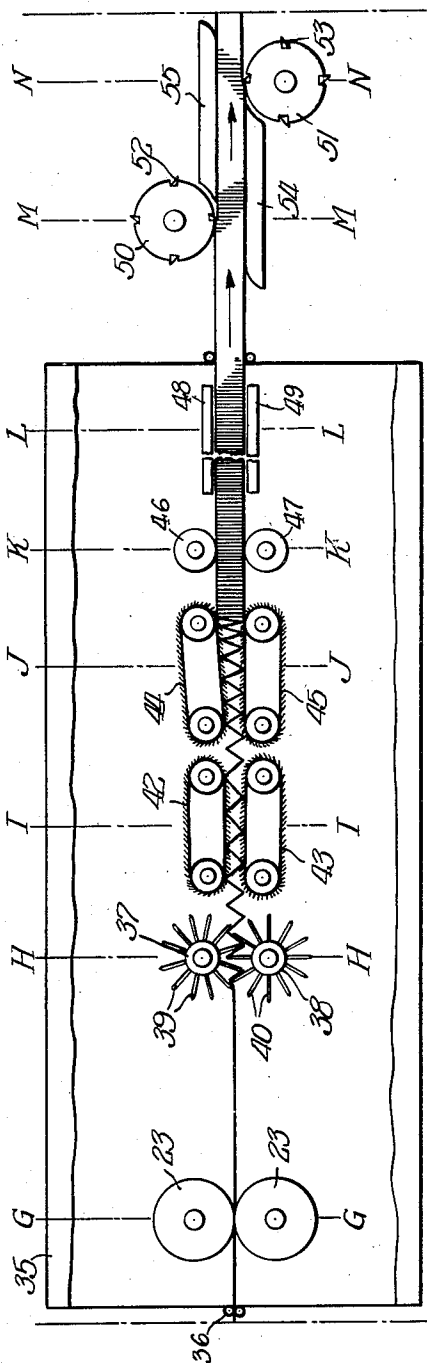
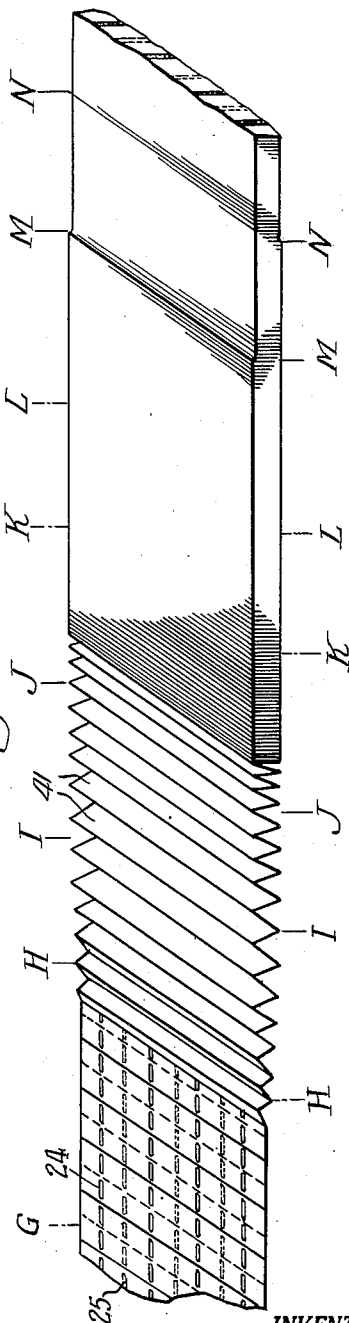


Fig. 5



INVENTORS

Jahr D. Lincoln,

BY George M. Thomson,

Cromwell, Trust & Warden
attys.

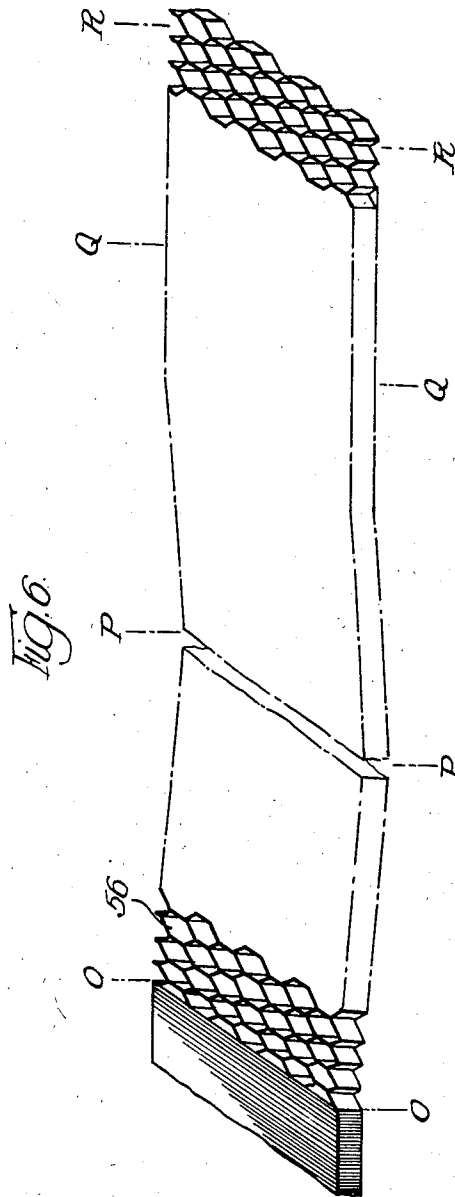
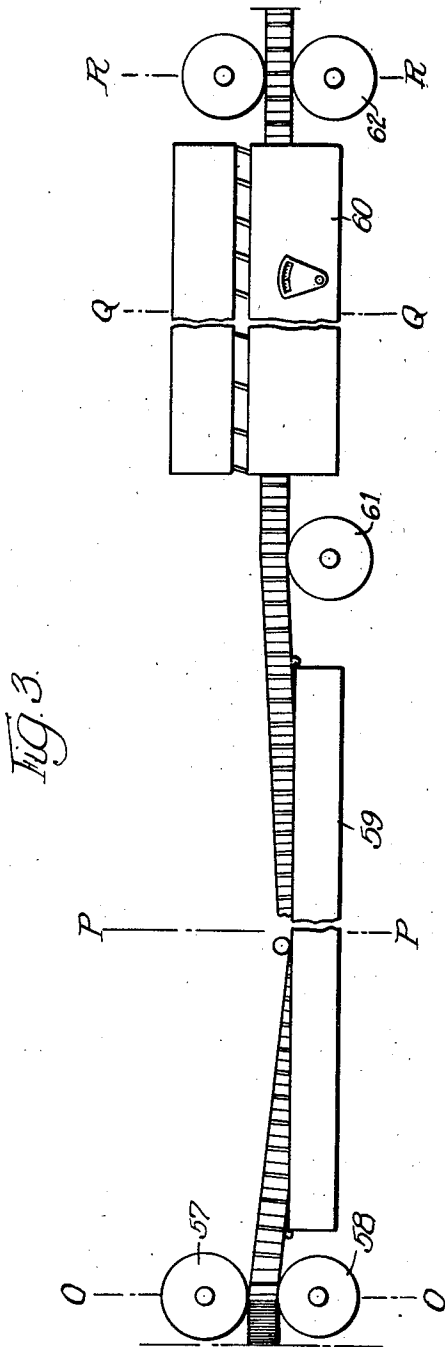
May 15, 1951

J. D. LINCOLN ET AL
MACHINE AND METHOD FOR PRODUCING
A CONTINUOUS HONEYCOMB STRUCTURE

2,553,054

Filed Jan. 2, 1948

3 Sheets-Sheet 3



INVENTORS.
John D. Lincoln,
BY George M. Thomson,
Attorney,
Cromwell, Bristol-Warden.
attys.

UNITED STATES PATENT OFFICE

2,553,054

MACHINE AND METHOD FOR PRODUCING A
CONTINUOUS HONEYCOMB STRUCTUREJohn D. Lincoln, Marion, Va., and George M.
Thomson, Toronto, Ontario, Canada; said
Thomson assignor to said Lincoln

Application January 2, 1948, Serial No. 272

9 Claims. (Cl. 154—1.8)

1

This invention relates to a new and improved machine and method for automatically producing from a strip or web of thin flexible sheet material a relatively thick, rigid honeycomb structure in continuous ribbon-like form.

It is a general object of the invention to provide a machine and method for progressively fabricating a strip or web of relatively thin sheet-like material into a relatively thick rigid honeycomb structure which structure may be used for a great many purposes, as for example the interior framework of building panels, doors, table tops, etc.

It is a specific object of the invention to provide a machine and method for fabricating from a paper-like material a relatively rigid honeycomb core structure wherein a continuously moving web of the material is provided with longitudinally spaced transverse crease lines while maintained in a flat and tensioned condition, longitudinal lines of adhesive are provided in alternate spaced relation on both sides of the material, the material is then contracted longitudinally by folding first in one direction and then in the other about the transverse crease lines to bring the strip portions defined by the crease lines into alternate face to face relation, the adhesive is dried while the material is maintained in contracted or folded condition, the top and bottom surfaces of the contracted material are trimmed to remove the folded edges of the strip portions, and the resulting material after being expanded or opened up into a honeycomb formation is finally subjected to a rigidifying material which when set rigidly maintains the honeycomb formation in its opened up condition.

While the foregoing statements are indicative in a general way of the nature of the invention other more specific objects and advantages will be apparent to those skilled in the art upon a full understanding of the new machine and method.

A preferred embodiment of the invention is presented herein for the purpose of exemplification but it will of course be appreciated that such embodiment is susceptible of modification within the spirit and teaching of this disclosure without departing from the invention as defined in the appended claims.

In the accompanying drawings:

Figs. 1, 2 and 3 together schematically illustrate in side elevation a machine constructed in accordance with the invention for practicing the method of the invention; and

Figs. 4, 5 and 6 together illustrate in perspective a strip of thin flexible sheet material as it

2

passes through the machine and is progressively fabricated into a relatively thick rigid honeycomb structure.

The machine and method of the present invention have to do in a general way with the subject matter of Thomson Patent No. 1,924,472 which involves the fabrication of a similar core structure in the manufacture of sound absorbing material.

Referring to the drawings there is illustrated somewhat schematically, a machine, embodying the principles of the invention, and by means of which the steps constituting the method of the invention may be conveniently carried out. The stations at which the various operations are performed are indicated by the lettered lines A, B, C, etc., in the order of the sequence of operations.

The web 10 of paper or other suitable material is supplied from the roll 11 and passed between a pair of constant tension rolls 12 (Figs. 1 and 4, station A) which feed the paper to a pair of position control rolls 13 (station C) by means of which the speed of the paper through the machine is controlled. The pairs of rolls 12 and 13 are spaced longitudinally and a hot plate 14 (station B) or other conditioning means is positioned between them to equalize the moisture content of the paper. If desirable the paper rolls may be preconditioned by subjecting them to a preliminary drying operation to remove excess moisture before they are placed in the machine.

The web 10 is next provided on its top surface with longitudinally spaced transverse crease lines 15 by the top crimping or creasing roll 16 (station D), which is supplied with a plurality of creasing rules 17, arranged in spaced relation on its peripheral surface, and a cooperating yieldable platen roll 18. Alternately spaced crease lines 19 are provided on the opposite side or bottom surface of the moving web 10 by means of the bottom creasing roll 20 (station E), having peripherally spaced creasing rules 21 and the cooperating anvil roll 22. The creasing rolls 16 and 20 are provided with fly wheels 16' and 20' to insure uniform and smooth operation.

The web 10 is maintained in taut condition while the transverse crease lines 15 and 19 are applied by means of a pair of driven rolls 23 (station G), which cooperate with the position control rolls 13. The rolls 23 are yieldably driven through a slip clutch, or the like, whereby they move the web at the same surface speed as the speed of the control rolls 13 but under a constant tension or in taut condition due to the slipping action between the rolls and the drive, the latter

3

operating it at a predetermined greater rate of speed than the control rolls 13.

The web 10, while maintained in taut condition, is also provided with alternate spaced longitudinal lines of adhesive 24 and 25 on the top and bottom sides, respectively, by means of top and bottom applicator rolls 26 and 27 (station F), located between the creasing roll 20 and the tension applying driven rolls 23. The applicator rolls 26 and 27 are provided with a plurality of peripherally spaced transverse grooves 28 and 29 on their surfaces to interrupt the glue lines. The spacing of the grooves 28 and 29 and the timing of the rolls 26 and 27 is arranged, relative to the movement of the creased web, so that the longitudinal lines of adhesive are interrupted at the transverse crease lines 15 and 19 and applied only between the same. The adhesive is supplied to the rolls 26 and 27 from any conventional supply source by means of delivery rolls 30 and 31.

The adhesive applicator mechanism is preferably inclosed in a cabinet or chamber 32 having means therein for maintaining a reduced temperature so that a pressure sensitive, fast drying, thermosetting adhesive may be used. The web is delivered from the initial chamber or cabinet 33, in which the conditioning and creasing mechanism are preferably housed, to the adhesive applying chamber 32 by means of guide rolls 34, and from the latter to the adjoining cabinet or chamber 35, in which the web folding and adhesive drying mechanism is housed, by guide rolls 36. By inclosing the mechanisms in the separate chambers 32, 33 and 35 the best temperature conditions can be maintained for the various operations resulting in better control of the process and a more uniform product.

The web 10, after having been provided with the transverse crease lines 15, 19 and longitudinal glue lines 24, 25, is delivered from the rolls 23 to rotatable folding devices or wheels 37 and 38 (station H) by means of which the material is initially folded first in one direction and then in the other about the crease lines 15 and 19 to impart thereto a pleated or accordion like formation. The folding devices 37 and 38, which are provided with a plurality of peripherally spaced radially projecting vanes or blades 39 and 40, respectively, are mounted on opposite sides of the path of travel of the web of material and operated relative to each other so that the ends of the blades on the one device move into the space between adjacent pairs of blades on the other device during rotation to thereby fold or pleat the material. The folding devices 37 and 38 are movable as a unit relative to the path of movement of the material so that the ends of the blades 39 and 40 may be adjusted to engage the material approximately along the transverse crease lines 15 and 19 to fold the material in alternate directions about the crease lines. Due to the contracting effect of the folding operation the movement of the partially folded material is slower at this point in the operation than the initial speed of the web 10.

The feeding rolls 23 and the folding devices 37 and 38 are provided with transversely interrupted peripheral surfaces so that they contact or engage portions of the surface of the traveling material which are free of the adhesive or glue and avoid contact with the glue lines on the material. In this manner undesirable accumulation of glue on the folding devices is avoided.

The transversely extending fold portions 41

4

defined by the transverse fold lines 15 and 19 are brought into face-to-face relation by spaced pairs of endless belts 42, 43 and 44, 45 (stations I and J) which are provided on their surfaces with fine wire carding teeth. The belts are arranged on opposite sides of the path of travel of the material so that the opposite edge portions of the folds in the material are brushed by the carding teeth to progressively decrease the space between the fold portions 41 and to complete the folding of the material into a relatively thick compacted strip formation. The top and bottom belts of the respective pairs are arranged in diverging relation to accommodate the increase in thickness as the material is folded.

The completely folded material is further compacted and the folds are maintained in compacted relation by a pair of relatively slowly traveling pack rolls 46, 47 (station K). While maintained in compacted condition the material is moved between a pair of hot plates 48, 49 (station L) to dry or set the adhesive in the lines 24, 25.

After the glue is set the top and bottom edges of the material are removed by top and bottom planer rolls 50 and 51, respectively (stations M and N). These rolls are provided with suitable peripheral cutting knives 52, 53, respectively. Platen members 54 and 55 are located on the opposite sides of the material for cooperation with the planer rolls 50 and 51, respectively. The removal of the folded edges disconnects the fold portions 41 of the material at the edges leaving the fold portions connected only at the glue lines 24, 25 thereby permitting the material to be stretched out or expanded in the longitudinal direction into a honeycomb structure 56 (Fig. 6, station O).

In order to expand the material into the honeycomb structure it is passed between a pair of rolls 57 and 58 (Fig. 3, station O) which are operated at a substantially greater rate of speed. The honeycomb structure 56 is thereafter impregnated or treated with a rigidifying material by passing it through a tank or other vessel or chamber 59 (station P) which contains a quantity of a material, in liquid form, which is suitable for this purpose, such as, a thermosetting synthetic resin.

The impregnated core structure is then passed through a heating oven 60 (station Q) to set the rigidifying material by curing or drying the same. The core structure is passed into the oven over a guide roll 61 and is received between a pair of feed rolls 62 as it emerges from the oven 60, to be thereafter delivered to other mechanism for further operations depending upon the type of structure for which it is being fabricated.

The various elements of the machine will, of course, be provided with appropriate driving connections, arranged to operate the elements in the proper timed relation, to perform the functions described. The respective steps in the process of the invention have been described with relation to the structure and operation of the illustrated machine which is particularly adapted to carry out the process in a satisfactory and efficient manner.

The heating member 14 for conditioning the paper may be eliminated where the material does not require any preconditioning, or any other suitable conditioning apparatus may be substituted depending upon the nature of the web material and other conditions which may vary. Likewise the hot plates 48 and 49 may be replaced

5

by any other suitable means for drying or setting the adhesive.

The dipping tank 59 is suitable for applying most rigidifying material but a spray or any other suitable apparatus for applying the rigidifying material to the honeycomb structure is contemplated by the invention.

The heating or drying oven 60 has been provided for curing rigidifying material, such as a thermosetting resin, of the type which is most readily polymerized by heat. When other rigidifying materials are used it may be desirable to cure or dry them by other means which are more suitable for the particular materials used.

While specific details of construction and materials have been referred to in describing the machine and method illustrated it will be understood that other details of construction and other materials may be resorted to within the spirit of the invention.

We claim:

1. Apparatus for producing a relatively thick core structure which core structure is characterized by a plurality of strips of relatively thin material arranged in edgewise face-to-face interconnected honeycomb forming relation, said apparatus comprising pairs of longitudinally spaced cooperating feed rollers for feeding a web of the strip forming material continuously and in taut condition, creasing rules arranged between said feed rollers for providing longitudinally spaced transverse crease lines alternately on opposite faces of the material, glue applicators for applying transversely spaced longitudinal lines of glue in alternate spaced relation on opposite faces of the material, oppositely disposed movable folder members for engaging the material along the transverse crease lines to bring the strips defined by the crease lines into face-to-face compacted relation, oppositely spaced continuously moving carding fingers for maintaining the material in compacted relation until the glue sets, oppositely spaced trimming elements for removing the top and bottom surfaces of the compacted material to disconnect the strips at their top and bottom edges, cooperating feed means to expand the resulting face-to-face interconnected strips into a honeycomb structure, and means for providing the honeycomb structure with a rigidifying substance.

2. Apparatus as defined in claim 1 and means for initially subjecting the strip forming material to a heating agent for equalizing the moisture content thereof.

3. Apparatus for producing a relatively thick core structure which core structure is characterized by a plurality of strips of relatively thin material arranged in edgewise face-to-face interconnected honeycomb forming relation, said apparatus comprising longitudinally spaced pairs of rollers for feeding a web of the strip forming material continuously, means for rotating said pairs of rollers at different speeds to control the movement of the material and to tension it during movement, longitudinally spaced creasing rules for providing transverse crease lines alternately on opposite faces of the material while the material is under tension, transversely spaced glue applicators for applying longitudinal lines of glue in alternate spaced relation on opposite faces of the material, movable folders for engaging the material along the transverse crease lines to bring the strips defined by the crease lines into face-to-face compacted relation, cutters above

6

and below the path of movement of the compacted material for removing portions of the compacted material to disconnect the strips at their top and bottom edges, longitudinally spaced means for expanding the resulting honeycomb structure, and means for providing the honeycomb structure with a rigidifying substance.

4. A method of fabricating from a thin, flexible, paper-like material a relatively rigid honeycomb core structure comprising continuously feeding a web of the material, applying longitudinally spaced transverse crease lines on the material while maintaining the material in a flat and tensioned condition, applying longitudinal lines of adhesive in alternate transversely spaced relation on both sides of the material, contracting the material longitudinally by folding first in one direction and then in the other about the transverse crease lines to bring the strip portions defined by the crease lines in alternate face-to-face relation, compacting the folded material and maintaining it in compacted condition while the adhesive sets, trimming the top and bottom edges of the compacted material to remove the folded edges of the strip portions, expanding the resulting material into a honeycomb formation, subjecting the honeycomb formation to a rigidifying material and maintaining the material in expanded honeycomb formation while the rigidifying material sets.

5. A method of producing from a strip of thin flexible material a relatively thick rigid honeycomb structure in continuous ribbon-like form which method comprises continuously feeding the strip of material, maintaining the moving strip in substantially taut condition during the feeding operation, applying longitudinally spaced transverse crease lines to the opposite surfaces of the moving strip with the crease lines on one surface staggered with respect to those on the other surface while the strip is maintained in taut condition, applying transversely spaced longitudinal lines of an adhesive material to the opposite surfaces of the moving strip with the lines of adhesive on one surface staggered with respect to those on the other surface while the strip is maintained in taut condition, thereafter folding the moving strip first in one direction and then in the other along the crease lines, to bring the folds of the strip into solidly compacted face-to-face relation to thereby provide a relatively thick strip formation, maintaining the strip formation in solidly compacted condition while allowing the adhesive to set, trimming off opposite faces of the strip formation to disconnect the folds adjacent the crease lines while maintaining the strip formation in solidly compacted condition, opening up the relatively thick strip formation longitudinally into a continuous honeycomb formation, applying a rigidifying material to the interior surfaces of the opened up honeycomb formation and setting the rigidifying material while continuously moving the honeycomb formation and maintaining it in its opened up condition.

6. A method of producing from a strip of thin flexible material a relatively thick rigid honeycomb structure in continuous ribbon-like form which method comprises feeding the strip of material at a relatively high rate of speed, maintaining the moving strip in substantially taut condition during the feeding operation, applying longitudinally spaced transverse crease lines to the opposite surfaces of the moving strip with the crease lines on one surface staggered with

respect to those on the other surface while the strip is maintained in taut condition, applying transversely spaced longitudinal lines of an adhesive material to the opposite surfaces of the moving strip with the lines of adhesive on one surface staggered with respect to those on the other surface while the strip is maintained in taut condition, thereafter initiating a partial folding of the moving strip first in one direction and then in the other along the crease lines, substantially completely folding the partially folded moving strip along the transverse crease lines, retarding the forward movement of the strip while permitting it to continue to move forwardly at a relatively slow speed to thereby cause the folds of the strip to become solidly compacted face to face in a relatively thick strip formation, maintaining the slowly moving strip in solidly compacted condition while allowing the adhesive to set, trimming off opposite faces of the slowly moving strip formation to disconnect the folds adjacent the crease lines while maintaining the strip in solidly compacted condition, feeding the strip forwardly at a higher rate of speed and opening up the relatively thick strip formation longitudinally into a more rapidly moving continuous honeycomb formation having spaced cellular walls disposed at right angles to the faces of the formation, applying a rigidifying material to the interior surfaces of the opened up honeycomb formation and setting the rigidifying material while continuously moving the honeycomb formation and maintaining it in its opened up condition.

7. Apparatus as defined in claim 1 wherein the movable folder members include a pair of folding wheels having cooperating radial vanes which initiate the folding of the material about the

transverse crease lines and a pair of endless belts arranged in opposed diverging relation on opposite sides of the travel of the partially folded material which engage the edges of the initial folds and progressively gather the material together to complete the folding thereof.

8. A machine of the character described in claim 1 wherein the creasing rules for applying transverse crease lines to each surface of the strip forming material are mounted on one of a pair of rolls between which the material moves, the other roll of said pair having a yieldable platen of cylindrical formation on the surface thereof and a flywheel mounted on said first mentioned one of said pair of rolls to provide smooth and uniform operation thereof.

9. Apparatus as defined in claim 1 wherein the applicators for applying longitudinal lines of glue to the opposite faces of the material include a pair of rolls between which the strip moves, said rolls having axially spaced glue line applying formations which are interrupted circumferentially whereby longitudinal lines of glue are applied which extend between the transverse crease lines and which are interrupted at the crease lines.

JOHN D. LINCOLN.

GEORGE M. THOMSON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,103,033	Clark	July 14, 1914
1,182,296	Morden	May 9, 1916
1,924,472	Thomson	Aug. 29, 1933
2,428,979	May	Oct. 14, 1947