

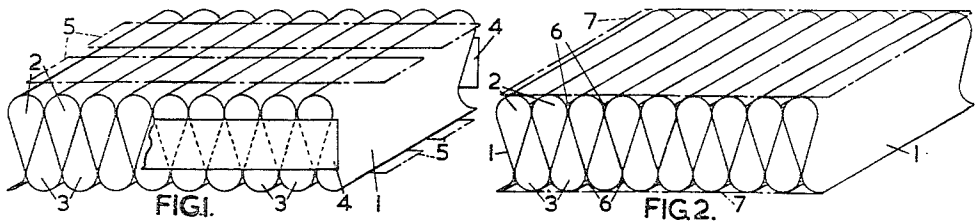
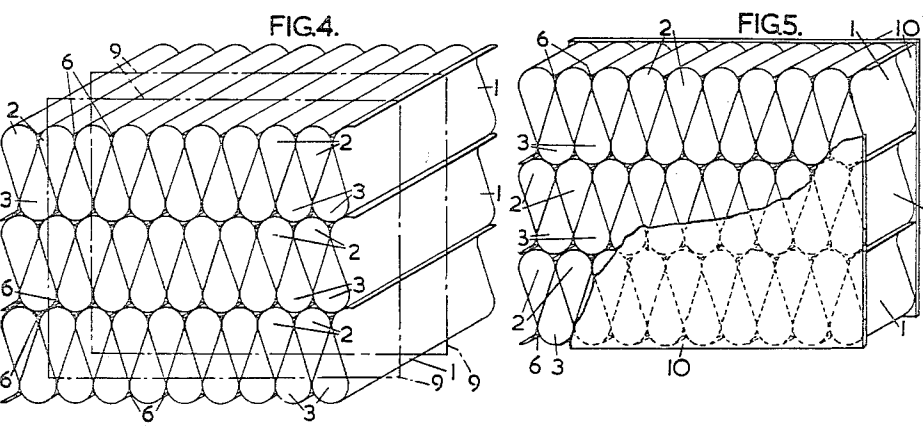
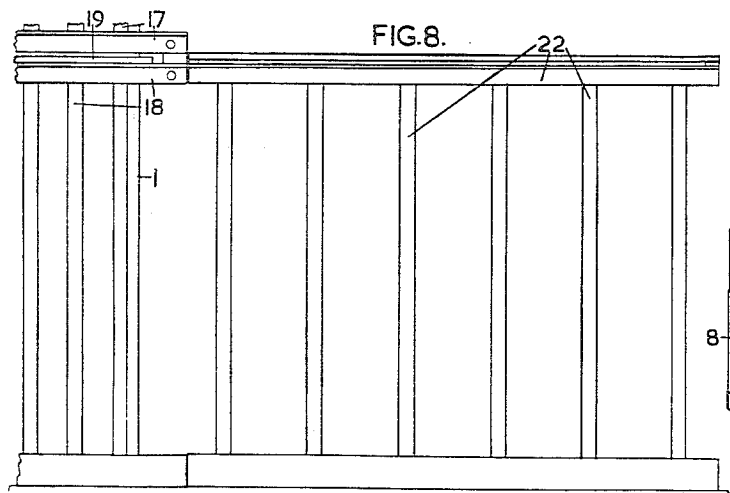
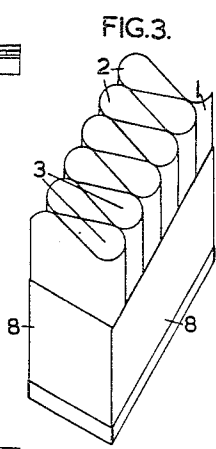
May 31, 1960

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MACHINE AND METHOD FOR PRODUCING PREFABRICATED
MATERIAL OF CELLULAR CONSTRUCTION

2,938,567

Filed May 15, 1956

2 Sheets-Sheet 1



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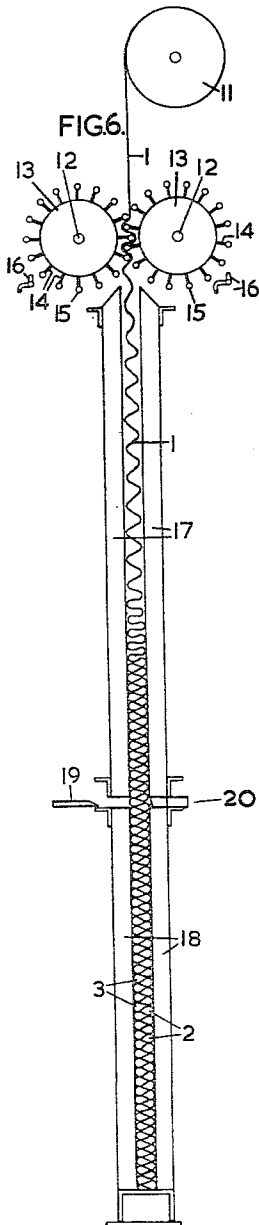
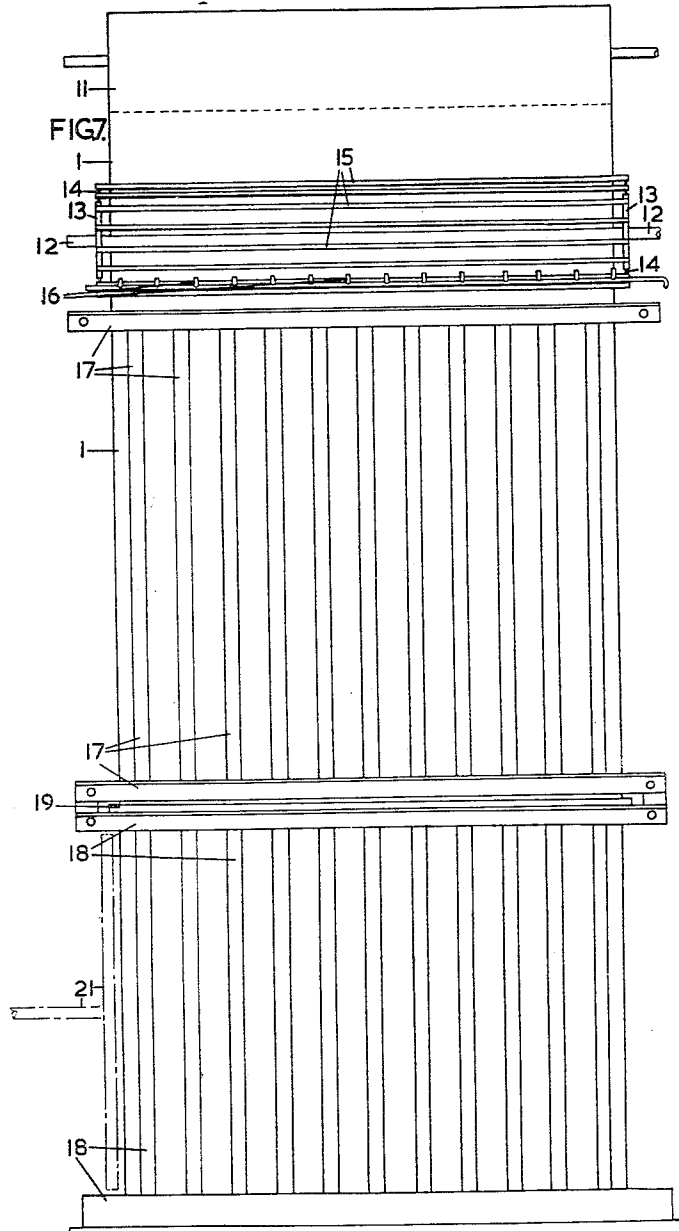
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MACHINE AND METHOD FOR PRODUCING PREFABRICATED MATERIAL OF CELLULAR CONSTRUCTION

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9 Claims. (Cl. 154—30)

This invention relates to prefabricated material of cellular construction, the chief object being to provide a new or improved cellular material, made from paper, metal foil, plastic sheet, or any other appropriate flexible sheet material (hereinafter referred to as "paper"), which will be suitable for various applications, for example as a packing material or as a core filling between outer skins in making panels, doors, partitions, walls or the like such as are required in the construction of buildings, aircraft or vehicle bodies, furniture and other structures in which the use of light-weight core filling material with considerable compression resistance and/or heat insulating properties is desirable.

According to the invention, the method of producing from a length of paper a material of cellular construction, which method consists in feeding the latter downwardly between two rolls having deeply intermeshing but non-contacting radially arranged forming members each of which, in turn, by its movement relatively to the paper between two adjacent forming members on the opposite roll, produces a deep transverse corrugation in the paper; allowing the corrugated paper leaving the rolls to collapse lengthwise upon itself under the action of its own weight until its confronting portions are brought into contact and the collapsed length of deeply corrugated paper defines two rows of cells, with the cells of each row close together and staggered in relation to and projecting partly between those in the other row, and the application to the length of paper of means for retaining it in its collapsed cell-defining state.

The means for retaining the length of paper in cell-defining state may be an adhesive applied so that it will enter the spaces between the adjacent cells in each row.

Alternatively said retaining means may comprise strips or sheets of paper applied with adhesive either to the opposite edges or the opposite faces, or both, of the cell-defining length of paper so as to constitute binding strips or outer skins which bridge and hold together the convolutions which enclose the two rows of cells. As a further alternative, the said retaining means may be in the form of a closely confining envelope, sheath or outer casing for the cell-defining length of paper. The particular retaining means employed will, in some measure, depend upon the particular application to which the cellular material is to be put.

According to the invention, prefabricated material of cellular construction and of a more complex form than that above described, comprises a number of lengths of paper all of the same width and each bent or folded upon itself alternately in reverse directions so as to define two rows of approximately uniform and transversely extending cells with the cells of each row close together and staggered in relation to and projecting partly between those in the other row, and means for retaining each of said lengths of paper in cell-defining state, said lengths of paper in cell-defining state being assembled and secured together in parallel face-to-face relationship to form a multi-cellular structure. In such multi-cellular assembly,

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and insofar as the approximate uniformity of its double-row cell-defining components will allow, the cells in a row defined by any length of paper will preferably be staggered in relation to and project partly between those in the immediately adjacent row defined by the next length.

In order to produce such a multi-cellular structure, each length of paper would be brought to cell-defining state as previously described and retained in that state either by adhesive applied in the spaces between adjacent cells in each row or by binding strips applied with adhesive to the opposite edges so as to bridge the ends of the cells. The double-row cell-defining components would then be built up and secured one upon another in face-to-face contact by adhesive until a stack of the desired dimensions has been attained.

The length of the cells will, of course, correspond to the width of the paper by which they are defined. In this connection, where the cellular structure only requires to have a short cell-length or thickness, it may be produced from either one or more lengths of paper of a width corresponding to the cell-length required or from one or more webs or sheets of paper the width of which is greater than and preferably a multiple of the ultimate thickness or cell-length and which, after being brought to cell-defining state and the retaining means applied, is divided in the direction of the length of the webs or sheets, i.e. across the cells, into portions each of which constitutes a cellular-structure of the requisite thickness or cell-length.

The invention will now be more fully described with reference to and by the aid of the accompanying drawings; in which Figs. 1 to 5 are isometric views illustrating various examples of the prefabricated material, Figs. 6 and 7 are end and front elevations respectively of a machine for use in producing the cellular material and Fig. 8 is a front elevation showing an auxiliary piece of apparatus for use in or with the said machine.

Referring to Fig. 1 of the drawings, the cellular material comprises a length of paper 1 bent upon itself alternately in reverse directions so as to define two rows of approximately uniform and transversely extending cells 2, 3 respectively with the cells of each row close together and staggered in relation to and projecting partly between those in the other row, the length of paper 1 being retained in its cell-defining state by strips of paper 4 applied with adhesive to the opposite edges so as to constitute binding strips which bridge the convolutions which define the cells 2, 3. These edge binding strips may be wider than those shown, sufficiently so that they will close the ends of the cells 2, 3 completely, and they may even be wide enough not only to close the cell ends but also to have their longitudinal marginal portions folded over on to the opposite faces of the cellular structure.

Alternatively or in addition to the edge binding strips 4, similar strips 5 may be applied longitudinally upon the opposite faces of the cellular structure as shown in chain lines in Fig. 1, these strips 5 being applied with adhesive to the crests of the situations so as to interconnect them and bridge the intermediate valleys or transverse furrows between said crests.

Preferably, however, the edge binding strips 4 will be used only as temporary retaining means whilst other and more permanent retaining means can be applied, and such permanent retaining means preferably comprises adhesive applied to the opposite faces of the cellular structure so that it will form menisci 6 (see Fig. 2) which adhesive when set, will hold the crests together and thereby permanently retain the cell-defining state of the structure. In this connection the edge binding strips 4 will be applied with a tacky and comparatively slow-drying adhesive so that they can, if desired, be removed once the adhesive menisci 6 have set.

Permanent retaining means alternative to, or in addition to,

tion to, the adhesive menisci 6 may comprise face-binding strips, such as the strips 5 shown in chain lines in Fig. 1, or paper sheets 7 shown in chain lines in Fig. 2, said sheets being applied with adhesive to the opposite faces of the cellular structure so as to interconnect the crests and bridge the intermediate cusp-shaped valleys or transverse furrows and constitute outer skins which cover the whole of the said opposite faces. The sheets 7 may be of such a width that their marginal portions can be folded over the edges of the cellular structure and stuck together or in overlapping relation so as to close the ends of the cells 2, 3. Such sheets 7 may, of course, be applied similarly to the cellular structure shown in Fig. 1, instead of the face binding strips 5, whereupon the edge binding strips 4 could be removed.

Further alternative retaining means may comprise a closely confining envelope, sheath or outer casing of appropriate cross section into which the sinuously bent length of paper 1, whilst temporarily held in its cell-defining state can be transferred in the direction of the length of the cells. Such an arrangement is shown in Fig. 3 in which the envelope, sheath or outer casing bears the reference 8. In this view the cellular structure extends from the open end or mouth of the outer casing 8 and may be covered by a cap-fitted lid (not shown).

The prefabricated material affording two rows of cells 2, 3, and constructed as described with reference to Figs. 1 and 2 will be light in weight and comparatively strong for its weight, and it will have good heat insulating properties and exhibit considerable resilient resistance to lateral compression and, consequently, is eminently suitable for various applications as a general packing material. Also said material will have a degree of flexibility in the lengthwise direction so that it can be made to conform to curved surfaces without breaking the bond or inter-connection between adjacent cells in either row. The embodiment shown in Fig. 3 may be used as a pack for protection of rod-like articles, such for example as cigarettes, inserted endwise one in each cell; it is, however, conceivable that it may be possible to introduce such rod-like articles laterally into the sinuations of the length of paper 1, before said sinuations are closed upon one another into the cell-defining state, and that, whilst temporarily held in that state, the cell-defining structure with a rod-like article embraced in each cell may be transferred to a retaining envelope, sheath, or outer casing 8.

Referring now to Fig. 4 of the drawings, this shows a multi-cellular structure the components of which each comprise a two-row cell-defining length of paper 1 as shown in Fig. 2 (without the outer skin sheets 7), said components being assembled or built up one upon another and secured together in parallel face-to-face relationship by adhesive. Preferably and insofar as the approximate uniformity of the components will allow, the cells in either row defined by one component will be staggered in relation to and project partly between those in the immediately adjacent row defined by the next component, as shown. It will be appreciated that this multi-cellular structure, which is particularly suitable as a core filling material, may be built up to various sizes depending upon the dimensions and number of the components employed. For expeditious and economical production the cell-length of the components will preferably be a multiple of the cell-length required for the core filling and, after assembly, the multi-cellular structure will be divided, say by the use of rapidly moving circular or band saws, indicated by chain lines 9, into a number of multi-cellular structures of the requisite cell-length, one of which is shown in Fig. 5. The cells in the multi-cellular structure or core filling material may be closed by side skins 10 of paper, cardboard, plywood or other appropriate sheet material, applied with adhesive to the end edges of the cells, as illustrated in Fig. 5.

Referring now to Figs. 6 and 7 of the drawings, the

machine for producing the basic or two-row cell-defining material comprises a pair of co-acting corrugating rolls between which a web of paper 1 of appropriate width is fed downwardly from a supply roll 11. Each corrugating roll comprises an axle or shaft 12, end flanges or discs 13, radial spokes 14 and a circumferential series of axially disposed metal rods 15 carried by and between the spokes 14 on the two end flanges or discs 13. The two corrugating rolls are driven and inter-gear (not shown) to ensure that the rods 15 intermesh without contacting each other so that when one rod of one roll passes in deep intermeshing relationship between two adjacent rods of the second roll, the relative movement of the one rod with respect to the paper between the two rods of the opposite roll has a corrugating effect on the paper which is substantially independent of the rod diameter. A study of Fig. 6 will show that when the paper initially enters the roll over a single rod of the right hand roll, the bight or loop is nearer the upper of the two meshing rods on the left hand roll and that by virtue of the relative motion of these rods, said single rod has a stroking or ironing action on the said bight or loop in moving it nearer the lower of the two meshing rods on the left hand roll. This stroking or ironing action is repeated by the single rods of the two rolls intermeshing alternately with the rods of the opposite roll with the result that a continuous series of corrugations is formed in the paper and each of these corrugations exceeds a half circle by a substantial amount. From the foregoing, it should be apparent that the size of the corrugations is substantially independent of the rod diameter since the corrugations are formed by the described stroking or ironing action of a single rod on one side in moving the paper looped thereover relative to two meshing rods on the opposite side. This effect could not be achieved if the paper were at any time clamped between any intermeshing rods and thus the rods as shown in Fig. 6 must not contact each other at any time.

The rods 15 are heated by rows of gas jets 16 so that, in forming the corrugations in the paper 1 passing through the roll gap, the heated rods 15 will "set" the curvature imparted to those portions of the paper which are subjected to the stroking or ironing action of said rods 15.

On leaving the roll gap the corrugated paper passes vertically down between confining and guiding surfaces constituted by the vertically slatted sides of an upper frame or cage 17 and then further down through the open base of the upper cage 17 into a similar and vertically aligned lower cage 18 in which it is collected in cell-defining state. Between the upper cage 17 and the lower cage 18 is a gap for the entry of means for severing the cell-defining length of paper 1 collected in the lower cage 18 from the remainder of the web from time to time, such means being shown as a knife 19 co-operating with a wooden bar 20 fixed in the opposite side of said gap to support the material being severed.

As the paper 1 leaves the rolls in corrugated form it will pass straight down to the bottom of the lower cage 18, the gravitational pull acting to draw the paper into the upper cage and also to open out the corrugations to a shallow wavy form and so permit such entry the more permanent "set" or curvature imparted to the crests acting to prevent complete opening out or straightening, so that upon reaching the bottom of the lower cage, the paper 1 will commence to pile up upon itself, and under the weight of the accumulation, progressively be caused to assume the full cell-defining state. This accumulation is allowed to continue until the paper throughout the lower cage 18 and the lower portion of the upper cage 17 has assumed the cell-defining state, whereupon the knife 19 is operated to sever the length of paper in the lower cage 18 from the remainder. The knife 19 is allowed to remain in the closed or severing position until the severed cell-defining length of paper is removed edgewise from the lower cage 18, and, during this period the

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paper will continue to accumulate in cell-defining state in the upper cage 17, to which latter the knife 19 temporarily constitutes a closed bottom and a closed top to the lower cage 18. After the severing operation and before removing the cell-defining length of paper from the lower cage 18, binding strips, such as the strips 4 in Fig. 1, may be applied to the edges of said length of paper either as temporary or permanent retaining means. If the rate of feed of the paper is such as not to allow for such edge-binding strips to be applied whilst the cell-defining length of paper is still in the lower cage 18, said length of paper may, immediately after the severing operation, be transferred edgewise, say by a pusher 21 (see Fig. 7) into an auxiliary cage 22, which may be one of a number of such auxiliary cages and part of the machine or separate therefrom, said cage 22 being transversely aligned with the lower cage 18 ready to receive its charge. This auxiliary cage 22 is similar to the lower or collecting cage 18 except that it has also a closed top, and whilst in this cage 22 the cell-defining length of paper can have the edge-binding strips 4 applied either as a permanent or temporary retaining means as previously described.

When the cell-defining length of paper has been removed from the lower cage 18, the knife 19 will be moved out of the gap and the accumulation of paper in the upper cage will immediately fall down in somewhat open condition into the lower cage 18 where it will commence to pile up again and reassume the complete cell-defining state as the feed of corrugated paper into the upper cage 17 proceeds.

Upon removal from the lower cage 18, or the auxiliary cage 22 if used, the basic two-row cell-defining material with its edge-binding strips may have applied thereto further retaining means, such as the adhesive 6 (Fig. 2) in the transverse furrows or valleys between the crests, the binding strips 5 (Fig. 1), the paper sheets 7 (Fig. 1) or the envelope 8 (Fig. 3). Combinations of these permanent retaining means may be used.

In building up a multi-cellular structure from two-row cell-defining components, it may be sufficient to apply adhesive to the crests on one face only of each component and to rely on this, with or without the menisci 6, to hold together such crests and also to hold in position the adjacent crests of the next component.

Reverting to the method of and machine for producing the basic or two-row cell-defining material, it will be appreciated that, in order to ensure that the paper will collect or accumulate in the cell-defining state, it is necessary that it should be deeply corrugated by the rolls. In this connection, the rolls with peripheral parallel rods carried by comparatively thin spokes, as shown in Figs. 6 and 7 of the drawings, provide a simple and cheap construction whereby the requisite deep intermeshing can be obtained. Moreover, the vertical collection of the deeply corrugated paper between laterally confronting and appropriately spaced confining and guiding surfaces, whereby the weight of the accumulation operates to collapse said paper upon itself into the cell-defining state, is a simple provision to this end and avoids the use of intricate and delicately adjusted apparatus which would be necessary if the collection and collapsing to cell-defining state were effected in a horizontal plane.

Whereas the invention has been described more particularly with reference to a material in which each cell has a curved wall portion it will be appreciated that the bending or folding of the paper may be to angular forms so as to result in two rows of cells of wholly straight-sided cross-section, for example, triangular or diamond shaped.

Having fully described my invention, what I claim and desire to secure by Letters Patent is:

1. The method of producing from a length of paper a prefabricated material of cellular construction, which method consists in forming reverse bends in said paper by feeding the same between two rolls having deeply

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intermeshing but non-contacting radially arranged forming members thereon which form said bends by the relative movement of one forming member on one roll between two adjacent forming members on the second roll, allowing said paper after bending to collapse lengthwise upon itself under the action of its own weight until confronting portions are brought into contact and the collapsed length of paper defines two rows of cells, with the cells of each row close together and staggered in relation to and projecting partly between those in the other row, and applying to the length of paper, means for retaining it in its cell-defining state.

2. The method of producing from a number of lengths of paper all of the same width a prefabricated material of multi-cellular construction, which method consists in bringing each such length of paper to retained cell-defining state as claimed in claim 1 and then assembling and securing them together in parallel face-to-face relationship.

3. The method of producing material of prefabricated cellular construction which comprises passing a web of paper downwardly between rolls having deeply intermeshing but non-contacting radially arranged forming members thereon, forming deep transverse corrugations in said paper by the relative movement of one forming member on one roll between two adjacent forming members on the opposite roller as said rolls operate to move said paper downwardly between said intermeshing forming members, collecting said corrugated web between laterally confronting and appropriately spaced confining and guiding surfaces upon a base so that under the action of its own weight said corrugated web will accumulate and collapse upon itself and thereby assume a state in which it defines two rows of cells, with the cells of each row close together and staggered in relation to and projecting partly between those in the other row, from time to time severing a predetermined length of the paper in cell-defining state from the remainder of the web, and applying to the severed-off length means for retaining it in that state.

4. A machine for producing material of prefabricated construction, comprising a pair of corrugating rolls, radially arranged deeply intermeshing but non-contacting corrugating members carried by said rolls for acting on said paper to form deep transverse corrugations therein as said paper is fed between said rolls, upper and lower cages vertically disposed and aligned with one another below the roll gap, which cages afford laterally confronting and appropriately spaced confining and guiding surfaces between which the web of paper corrugated by the said rolls descends to the base of the lower cage and accumulates as it collapses upon itself into cell-defining state, and means operable in a gap between said cages for severing from the remainder of said web the predetermined length of paper which has accumulated in cell-defining state to fill the lower cage.

5. A machine as claimed in claim 4, wherein the forming members comprise peripheral series of rods parallel with the axis of rotation and carried by relatively thin spokes so as to permit deep intermeshing.

6. A machine as claimed in claim 4, wherein means are provided for heating the corrugating members so that they will impart a more permanent set or curvature to the parts of the paper which they engage in corrugating it.

7. A machine as claimed in claim 4, wherein the severing means when in its operative position constitutes a temporary base to the upper cage and upon which the web of corrugated paper can continue to accumulate in said upper cage until such time as the severed-off length of paper, in cell-defining state, has been removed from the lower cage and said severing means has been moved to its inoperative position.

8. A machine as claimed in claim 4, wherein the lower

cage is open-ended so that the severed-off cell-defining length of paper can be removed edgewise therefrom.

9. For use with or in a machine as claimed in claim 4, an auxiliary cage into which the severed-off cell-defining length of paper can be transferred edgewise from the lower of the two main cages. 5

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