Oct. 7, 1969 D. E. CHUPKA 3,471,367

APPARATUS FOR MAKING MULTI-PLY PAPER

Filed Feb. 21, 1966

FIG-1

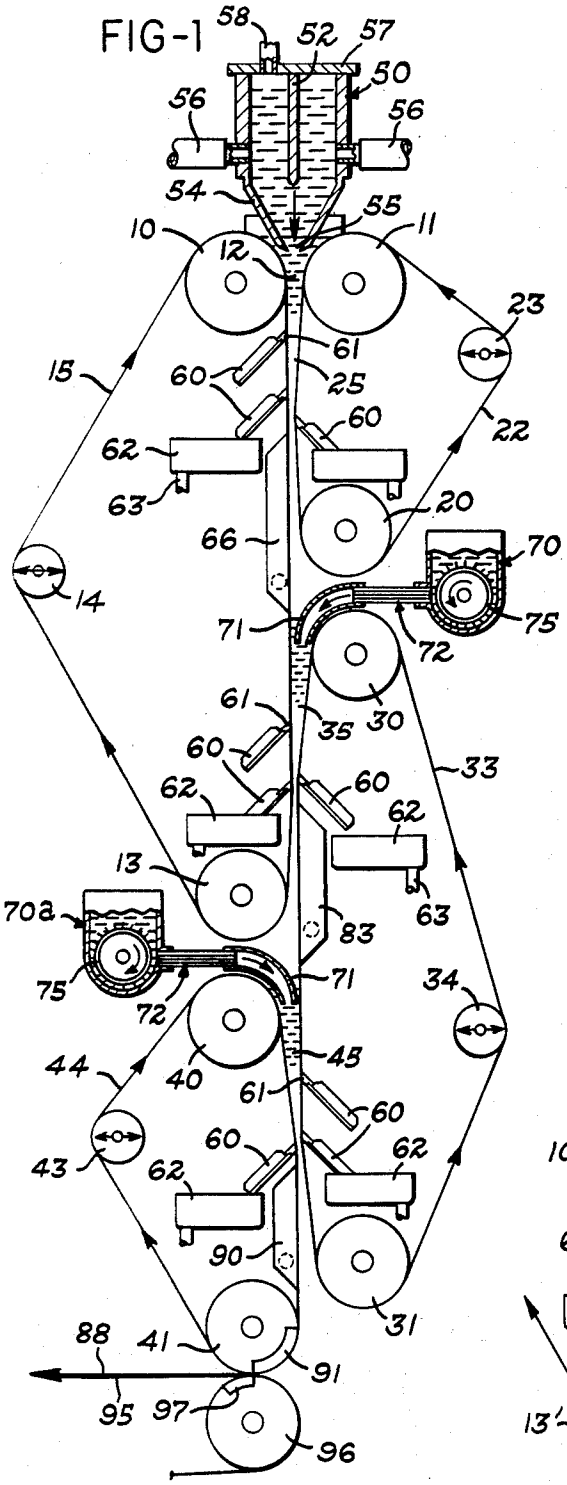


FIG-2

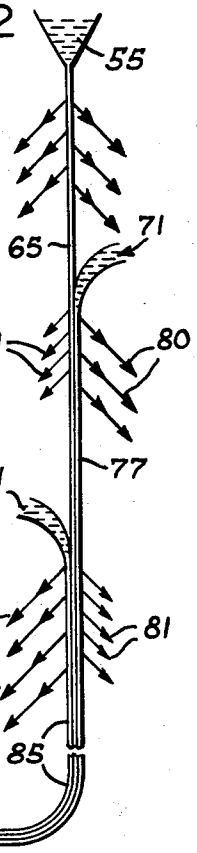


FIG-3

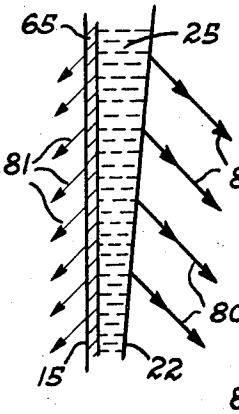
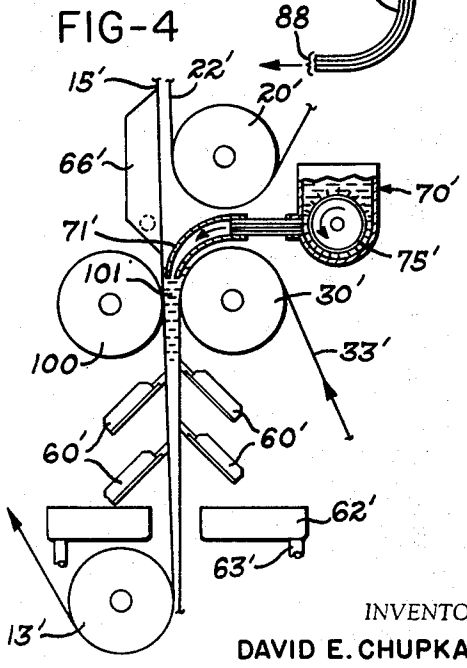


FIG-4



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APPARATUS FOR MAKING MULTI-PLY PAPER

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U.S. Cl. 162—303 9 Claims

ABSTRACT OF THE DISCLOSURE

A multi-ply paper web is formed by directing separate flows of stock into the upper ends of a plurality of generally vertically extending forming zones each defined by closely spaced converging runs of a plurality of forming wires, carrying the ply formed in each zone to the next successive zone by a common wire and combining the plies by intermeshing the fibers of adjacent webs.

This invention relates to apparatus for making a multi-ply web of paper or paperboard from paper making stock, and more particularly to a generally vertically arranged apparatus which successively forms and combines layers of fiber while the stock is traveling in a downward direction.

The present invention has special relation to apparatus of the general construction disclosed in U.S. Patents Nos. Re. 25,333 and No. 3,215,594, both of which issued to the assignee of this invention. More specifically the invention is directed to apparatus for forming a multi-ply paper web or board in a downward direction whereas the apparatus shown in the above patents each forms a single ply web of paper in a downward direction. Thus the desirable feature of minimizing the floor space required for the apparatus shown in the above patents is also a feature of the apparatus of the present invention.

It is a primary object of the present invention to provide improved method and apparatus for forming a multi-ply paper web or board whereby a plurality of layers of liquid fibrous stock are successively formed into plies and combined together while traveling in a downward direction.

As another object, the present invention provides apparatus as outlined above including means for removing liquid from each layer of stock simultaneously through both sides of the layer to promote commingling of the fibers of adjacent layers and thereby to produce a multi-ply board having a strong bond between adjacent plies.

In accordance with a more specific object, the present invention provides apparatus as outlined above wherein a plurality of endless forming wires are supported and arranged to establish a plurality of generally vertically extending and overlapping wire runs which are guided in closely spaced opposed overlapping relationship to define a plurality of downwardly extending forming zones disposed in generally vertical alignment whereby the web plies are formed and combined successively into a multi-ply board while traveling in a downward direction.

It is also an object of the invention to provide a new method of making multi-ply paper webs having outstanding advantages of convenience as well as of improved properties in the product thereof.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawing and the appended claims.

In the drawing:

FIG. 1 is a schematic view generally in side elevation of apparatus for making three-ply board in accordance with the invention;

FIG. 2 is a diagrammatic view illustrating the forming of three-ply board with the apparatus shown in FIG. 1;

FIG. 3 is an enlarged diagrammatic view of a fragment of the second forming zone in the apparatus of FIG. 1; and

FIG. 4 is a fragmentary diagrammatic view of a modified form of the apparatus shown in FIG. 1.

Referring to the drawing, which illustrates preferred embodiments of the invention, the apparatus in FIG. 1 includes a pair of parallel breast rolls **10** and **11** which are rotatably supported by a frame (not shown) and spaced to define a vertical nip **12** therebetween. Spaced below the breast roll **10** is a couch roll **13**, and directed around the rolls **10** and **13** and a guide and stretch roll **14** is an endless forming wire **15** having a generally vertically extending downward run. A second couch roll **20** is spaced below the breast roll **11** and positioned opposite the central portion of the downward run of wire **15**, and a second endless forming wire **22** is directed around the breast roll **11**, couch roll **20** and a guide and stretch roll **23** to provide a generally vertically extending downward wire run which is located in closely spaced opposed relationship with the downward run of wire **15** to define a first forming zone **25** but is of only approximately one-half the vertical extent of the downward run of wire **15**.

A third breast roll **30** is spaced closely below the couch roll **20** and also opposite the central portion of the downward run of wire **15**, and having a complementary third couch roll **31** spaced below breast roll **30**. A third endless forming wire **33** is directed around the breast roll **30**, couch roll **31** and guide and stretch roll **34** to provide a third generally vertically extending downward wire run, the upper portion of which overlaps the lower portion of the downward run of wire **15** and is in closely spaced opposed relationship therewith to define a second forming zone **35**.

A fourth breast **40** is spaced closely below the couch roll **13** and adjacent the central portion of the downward run of wire **33**, and a fourth couch roll **41** is spaced below the breast roll **40** at a level slightly below that of the third couch roll **31**. A fourth endless forming wire **44** is directed around the breast roll **40**, couch roll **41** and a guide and stretch roll **43** and provides a fourth generally vertically extending downward wire run which is in closely spaced opposed relationship with the lower portion of the downward run of wire **33** to define a third forming zone **45**. While only three forming zones are shown in FIG. 1, it is to be understood that additional forming zones may be provided simply by providing additional forming wires having closely spaced vertically extending downward runs which overlap as the wire **15** overlaps the downward runs of wires **22** and **33**, and the downward run of wire **33** overlaps the downward runs of wires **15** and **44**.

A headbox **50** is positioned above the breast rolls **10** and **11** to discharge stock into the nip **12**, and the headbox **50** is shown as of the construction disclosed in copending application Ser. No. 434,051 filed Feb. 19, 1965 and assigned to the assignee of the present invention. Thus headbox **50** includes a central baffle **52** and converging bottom walls **54** defining a discharge outlet slot **55**. Stock is supplied to the interior of the headbox **50** from a suitable header, not shown, by way of a plurality of inlet tubes **56** spaced along opposite sides of the headbox, and the headbox is shown as having a top wall **57** provided with a connecting pipe **58** to a suitable source of positive or negative gas pressure.

To form multi-ply paper web or board, filler stock is supplied to the headbox **50** and is directed downwardly through the discharge outlet **55** into the first forming

zone 25 defined by the wires 15 and 22. A series of angularly disposed and parallel spaced deflectors 60 are positioned adjacent the back side of the downward runs of wires 15 and 22, and each deflector includes a nose portion 61 which preferably is formed from a wear resistant plastic material for slidably engaging the back side of the corresponding wire run. As described in the above mentioned patents, the deflectors 60 cooperate to direct the wires 15 and 22 so that they converge downwardly and thereby squeeze liquid from the layer of filler stock within the forming zone 25. This liquid drains down the deflectors 60 from each side of the layer of filler stock through each of the wires 15 and 22 and is collected within suitable containers 62 having drain outlets 63.

The filler web or ply 65 (FIG. 2) which is thus formed within and discharged downwardly from the forming zone 25 is carried by the wire 15 downwardly into the second forming zone 35. However, to insure that the web 65 does not separate from the wire 15 within the space between the couch roll 20 and breast roll 30, a suction box 66 is positioned adjacent the back side of the wire 15 generally opposite the couch roll 20 and the area where the wire 22 diverges from wire 15 to wrap roll 20.

A second headbox 70 is positioned adjacent the couch roll 20 and breast roll 30 for supplying stock to the nip between breast roll 30 and wire 15, and a third headbox 70*a* is similarly positioned adjacent the couch roll 13 and breast roll 40 to supply stock to the nip between breast roll 40 and wire 33. The headboxes 70 and 70*a* are shown as constructed in accordance with copending application Ser. No. 384,640 now Patent No. 3,328,237 filed July 13, 1964 and assigned to the same assignee as the present invention. Thus each headbox 70 and 70*a* is connected with its associated slice lip assembly 71 by a plurality of parallel tubes 72 of relatively small diameter. A rotor 75 is mounted within each headbox 70 for agitating the stock within the headbox and maintaining uniform pressure and flow conditions through the multiple tubes 72.

In making three-ply paperboard, the upper headbox 70 is preferably supplied with bottom liner stock which is directed into the second forming zone 35 to form a layer of stock adjacent the web 65. Liquid drained from this layer of liner stock flows over the deflectors 60 positioned adjacent the back side of the portions of wires 15 and 33 which define the second forming zone 35, and this liquid is collected within the corresponding containers. Thus the layer of bottom liner stock supplied to the upper headbox 70 is formed into a bottom liner ply 77 overlying the filler ply 65.

FIG. 3 illustrates diagrammatically the conditions within the upper portion of the forming zone 35. The web 65 travels downwardly into the zone on the wire 15 and thus effectively forms one side of the zone, the other side being formed by the wire 22. The space between the web 65 and the wire 22 is initially filled with essentially liquid stock, but the water drains away rapidly as the stock travels downwardly with the wires. During this interval, since the wire 22 offers less resistance to water drainage than the combined web 65 and wire 15, the water drainage through wire 22 will be at a substantially greater rate than in the opposite direction, as is indicated in FIG. 3 and FIG. 2 by relatively heavy and light arrows 80 and 81. Since, however, there is substantial drainage through the web 65, there will be a high degree of commingling of the newly added fibers with the fibers on the surface of web 65, causing these fibers to mesh as the combined web dewaters and thus establishing a strong bond at the interface of the two plies 65 and 77.

A second suction box 83 is positioned adjacent the back side of the wire 33 and opposite the couch roll 13 which causes the combined web plies 65 and 77 to transfer from wire 15 to wire 33 as the wire 15 diverges to wrap roll 13 and to be retained on wire 33 during travel from the second forming zone 35 downwardly into the third forming zone 45. Top liner stock is supplied to the headbox 70*a* and is discharged as a layer from the lower slice assembly 71 downwardly into the top of the third forming zone 45, which is now bounded by the wire 44 on one side and by the combined webs 65 and 77 with wire 33 on the other side.

A series of deflectors 60 are positioned adjacent the back sides of the wires 33 and 44 defining the forming zone 45 to direct the liquid which drains from both sides of the third forming zone 45 in generally the same manner as described in connection with FIG. 3, as is similarly indicated by heavy and light arrows 80 and 81 in FIG. 2. This liquid is collected within the containers 62 in the same manner as described above for the forming zones 25 and 35. As the liquid drains from the layer of back liner stock within the forming zone 45, a top liner ply 85 is formed, and some of the fibers are drawn toward the interface of the plies 65 and 85 where they commingle and mesh with a portion of the fibers of the filler ply 65. As a result, a strong bond is also produced between the back liner ply 85 and the filler ply 65, and the resulting board is designated as 88.

The three-ply board 88 is separated from the wire 33 and retained on wire 44 by a suction box 90 and a suction chamber 91 provided within the couch roll 41. The board 88 is then transferred from the forming wire 44 to a felt 95 which is shown as wrapping a transfer roll 96 having a suction chamber 97 therein. The three-ply board 88 may then be directed through suitable press and dryer sections (not shown) in accordance with conventional practice.

A modified form of the apparatus is shown in FIG. 4. This modification is of essentially the same construction as that of FIG. 1 with the exception that a backup roll 100 is added behind each of the downward runs of the several forming wires 15', 22', 33', opposite the respective breast rolls represented by the breast roll 30'. The backup roll 100 may be desirable to define a precise nip 101 similar to the nip 12 at the top of each of the lower forming zones which will provide a metering effect on the layer of stock directed downwardly into the corresponding forming chamber.

Multi-ply board forming apparatus constructed in accordance with the invention provides several desirable features and advantages. For example, not only do the generally vertically spaced relationship and alignment of the forming zones 25, 35 and 45 minimize the floor space required for a board forming apparatus, but the overlapping arrangement of the forming wires 15, 22, 33 and 44 minimizes the overall length of the forming wires and thereby provides for a significant cost reduction in the wires. Additional plies can be easily added to the web or board simply by adding corresponding additional endless forming wires and extending the overlapping arrangement.

The apparatus of the invention is capable of utilizing higher consistency stock in the headboxes 50, 70 and 70*a* than is conventionally used, for example 0.8% consistency as compared with the conventional 0.3%, which provides for a significant reduction in power since it is necessary to transport less liquid. Furthermore, the apparatus enables different forming wires to be used to obtain correspondingly different exposed surface textures on the liner plies. Then too, by using the same liner stock in each headbox 70 and by using forming wires 33 and 44 of identical characteristics, a multi-ply board can be formed having the same texture on both exposed sides. In this connection, it should be noted that the term "wire" as used herein is including felts and other fabric and plastic webs of perforate structure.

What is claimed is:

1. Apparatus for progressively forming a multi-ply paper web from paper making stock, comprising a plurality of endless forming wires, roll means supporting said wires to form a plurality of pairs of downwardly extending runs arranged in closely spaced converging re-

lationship with each said pair of runs defining a downwardly extending forming zone, means for directing a flow of stock downwardly into the upper end of each said forming zone, means for draining liquid from the stock simultaneously through each of said downwardly extending pairs of runs to effect formation of a web ply in each said forming zone, and means for directing the web formed in each of said zones into one side of the next successive said zone to combine with the flow of stock received therein so that the drainage of liquid through the corresponding said wire runs causes the fibers of the ply formed therein to intermesh with the fibers of the web directed thereto to produce a multi-ply web in which the plies are firmly bonded together.

2. Apparatus as defined in claim 1 wherein at least one of said downward wire runs is arranged in overlapping relation with at least a portion of each of two other said runs to define one side of two vertically spaced said forming zones, and comprising means for retaining the web formed in the upper of said zones on said overlapping wire run during travel thereof from said upper zone to the lower of said two zones.

3. Apparatus as defined in claim 1 comprising first and second breast rolls supporting the uppermost portions of the first and second said wires in spaced relation defining a nip at the upper end of the uppermost said forming zone, first and second couch rolls associated with said breast rolls and supported therebelow with said first couch roll spaced at a substantially lower level than said second couch roll, a third breast roll positioned below said second couch roll at a level substantially higher than said first couch roll and supporting the uppermost portion of the third said forming wire, said third breast roll being located opposite an intermediate portion of said downward run of said first wire so that said first wire defines one side of each of the first and second said forming zones, suction means positioned on the opposite side of said intermediate wire portion from second couch roll for retaining on said wire the web formed in said uppermost zone during travel of said first wire to said second zone, and a headbox arranged to deliver stock into said second forming zone for downward flow between the web formed in the uppermost said forming zone and said third wire.

4. Apparatus as defined in claim 3 comprising a third couch roll associated with said third breast roll and supported therebelow at a substantially lower level than said first couch roll, a fourth breast roll positioned below said first couch roll at a level substantially above the level of said third couch roll and supporting the uppermost portion of the fourth said forming wire, said fourth breast roll being positioned opposite an intermediate portion of said third wire so that said third wire defines one side of each of said second and third said forming zones, means for retaining the web formed in said second zone on said third wire during travel thereof below the level of said first couch roll, and a second headbox arranged to deliver stock into said third forming zone for downward flow between the web formed in said second forming zone and said fourth wire.

5. Apparatus as defined in claim 1 comprising first and second breast rolls supporting the uppermost portions of the first and second said wires in spaced relation defining a nip at the upper end of the uppermost said forming zone, first and second couch rolls associated with said breast rolls and supported therebelow with said first couch roll spaced at a substantially lower level than said second couch roll, at least one additional pair of breast and couch rolls positioned below each of said first and second couch rolls respectively, each said additional pair of rolls supporting an additional said forming wire, each additional said breast roll being located opposite an intermediate portion of said downward run of one of said wires to define therewith an additional nip at the upper end of an additional said forming zone so that said one wire run overlaps two other said wires and thereby defines one side of two forming zones, and means for retaining the web formed in the upper of each of said two zones on said overlapping wire run during travel from the lower portion of said upper zone to the lower of said two zones.

6. Apparatus as defined in claim 5 comprising a further roll positioned in horizontally aligned relation with at least one said additional breast roll and in backup relation with the associated said intermediate wire portion to establish the effective width of the associated said additional nip.

7. Apparatus fo progressively forming a multi-ply paper web from paper making stock, comprising a plurality of endless forming wires, roll means supporting said wires to form a plurality of downwardly extending runs arranged in closely spaced converging relationship with said pair of runs defining a generally vertically extending forming zone, means for delivering a flow of stock into the upper end of each said forming zone whereby liquid is removed from the stock through each of said wire runs to effect formation of a web ply in each said forming zone, and at least one of said wires including one of said runs of two successive said forming zones for carrying the web formed in the first of said two zones into the second said zone to combine with the flow of stock received therein so that the removal of liquid through said wire runs causes the fibers of the ply formed therein to intermesh with the fibers of the web directed thereto to produce a multi-ply web in which the plies are firmly bonded together.

8. Apparatus as defined in claim 7 wherein said roll means comprises a pair of spaced breast rolls for each said forming zone.

9. Apparatus as defined in claim 7 including suction box means cooperating with the one said wire to aid in directing the web formed in the first said forming zone into the second said forming zone.

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S. LEON BASHORE, Primary Examiner

T. G. FERRIS, Assistant Examiner

U.S. Cl. X.R.

162—123, 203