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(54) Titre : SYSTEME ET PROCEDE DE PRODUCTION D'UN CARTON MULTICOUCHE COMPORTANT UN SUPPORT A STRUCTURE AMELIOREE

(54) Title: SYSTEM AND METHOD FOR PRODUCING A MULTI-LAYERED BOARD HAVING A MEDIUM WITH IMPROVED STRUCTURE

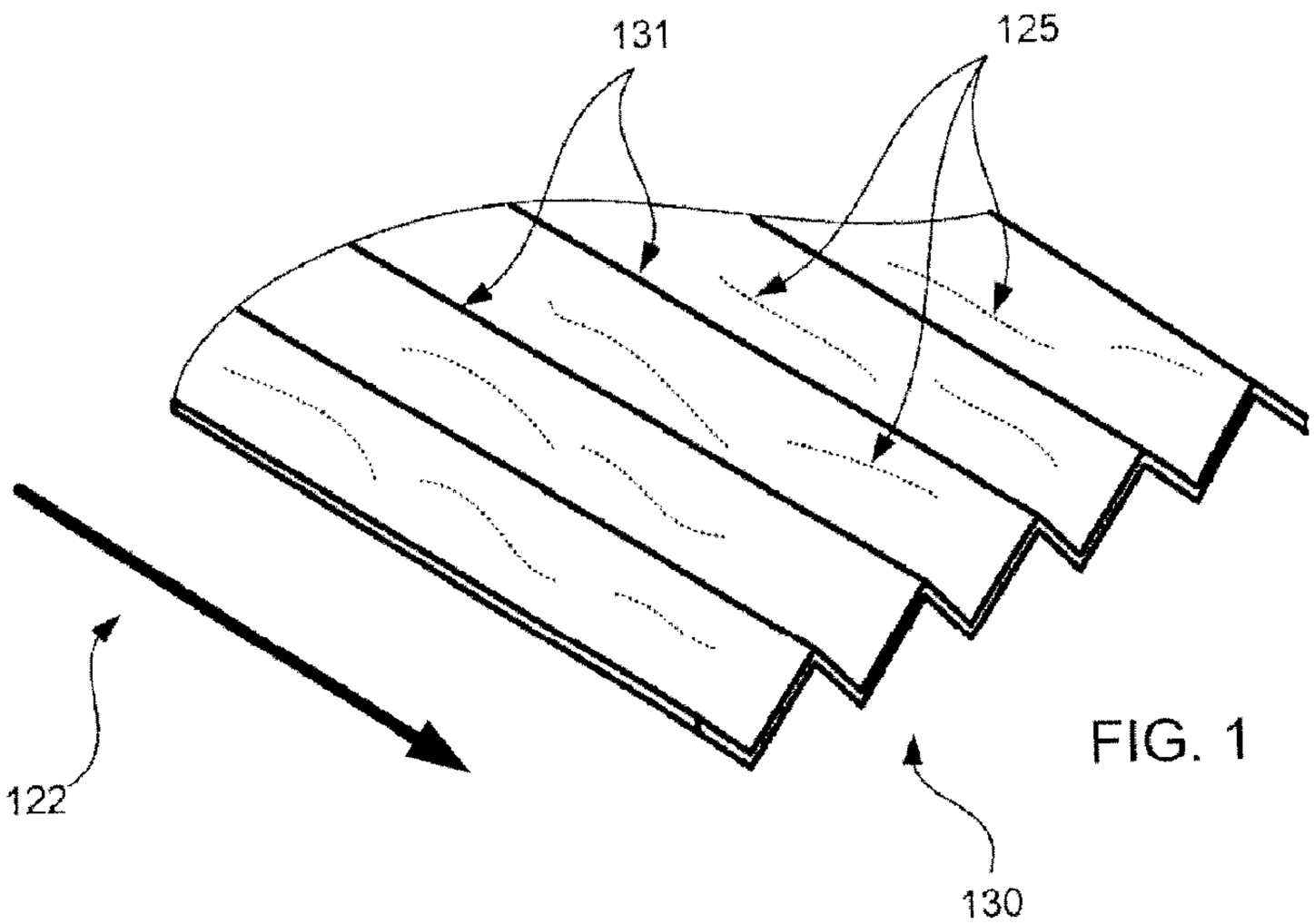

FIG. 1

(57) Abrégé/Abstract:
A system and method for producing a board product made from paper products that have embossed medium that features an improved structural profile. The improved structural profile may include a triangular flute pattern wherein each flute may exhibit a first linear leg support and a second linear leg support that each support a center apex structure. The apex may have a substantially flat portion that is configured to engage a facing. As such, the board product may further include one or more facings that are adhesively coupled to the embossed medium. Further, the apex of each "triangle" may also have a groove or channel for receiving an adhesive in a continuous and uniform manner.

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(54) Title: SYSTEM AND METHOD FOR PRODUCING A MULTI-LAYERED BOARD HAVING A MEDIUM WITH IMPROVED STRUCTURE

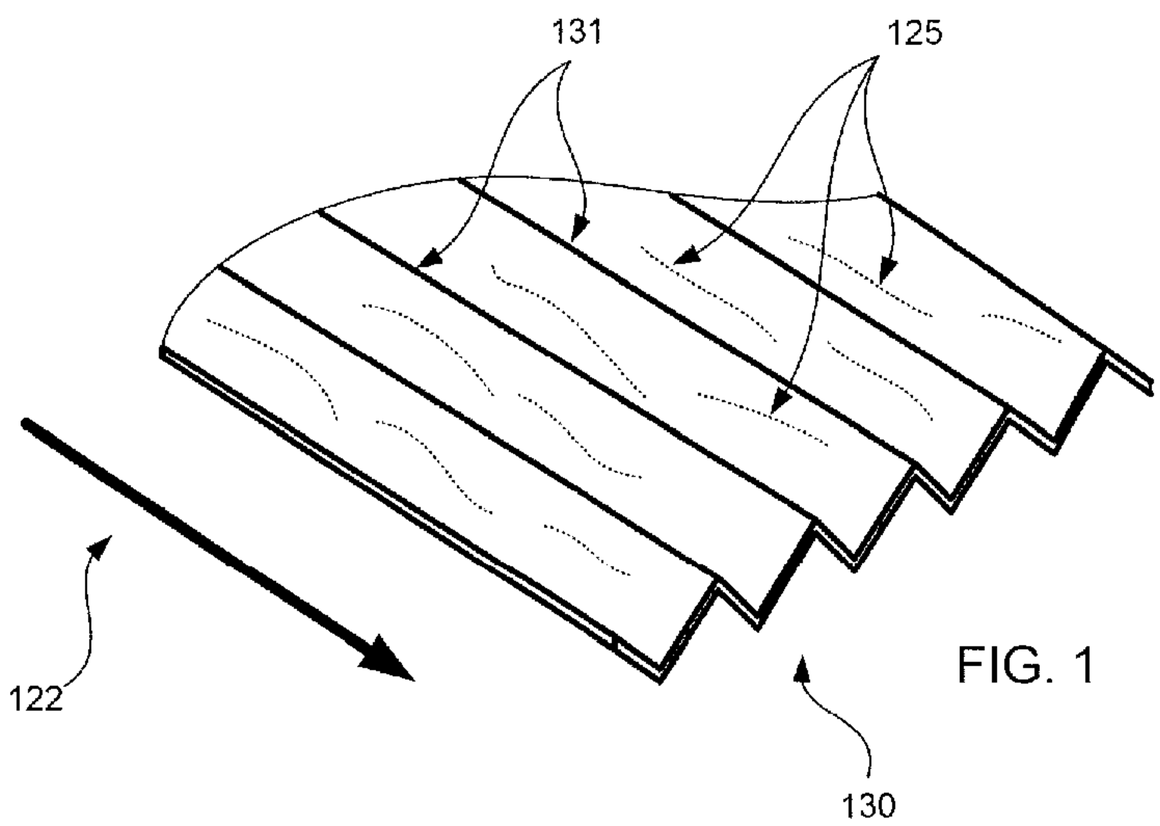

FIG. 1

(57) Abstract: A system and method for producing a board product made from paper products that have embossed medium that features an improved structural profile. The improved structural profile may include a triangular flute pattern wherein each flute may exhibit a first linear leg support and a second linear leg support that each support a center apex structure. The apex may have a substantially flat portion that is configured to engage a facing. As such, the board product may further include one or more facings that are adhesively coupled to the embossed medium. Further, the apex of each "triangle" may also have a groove or channel for receiving an adhesive in a continuous and uniform manner.

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SYSTEM AND METHOD FOR PRODUCING A MULTI-LAYERED BOARD HAVING A MEDIUM WITH IMPROVED STRUCTURE

BACKGROUND

[1] Modern paper-making techniques use paper machines at paper mills to produce rolls of paper that, in turn, can be used by board makers to produce board products (*i.e.*, corrugated board). As a result, rolls of paper may be produced from machines that operate continuously. Modern paper machines typically produce paper from a number of substances including wood pulp that comprise wood fibers (although other fibers may also be used). These fibers tend to be elongated and suitable to be aligned next to one another. The fiber starts as a slurry that can be fed onto a moving screen from a head box of the paper machine. In modern paper machines, the fibers tend to align with each other and align with a direction in which the screen is moving. This alignment direction of underlying fibers is called the major direction of the paper and is in line with the machine direction. Thus, the major direction is often simply called the machine direction (MD) and the paper that is produced has an associated MD value.

[2] When paper is used to make a board product, portions or layers of the board product may be corrugated. Conventional corrugating machines will corrugate the underlying paper product in the cross direction (CD) of the paper thereby failing to take advantage of the natural strength bias of the paper in the machine direction. Further, the greater natural strength qualities of paper in the machine direction are left unharnessed by cross corrugation techniques in board making solutions. Further yet, conventional corrugated medium includes flutes that take on a sinusoidal shape because of the shape of the protrusions in a conventional pair of corrugating rolls. As a result, companies that

produce conventional board products remain entrenched in old production processes that limit the strength of the board product.

BRIEF DESCRIPTION OF THE DRAWINGS

[3] Aspects and many of the attendant advantages of the claims will become more readily appreciated as the same become better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

[4] **FIG. 1** is an isometric cutaway view of an embossed medium that may be part of one or more board products according to one or more embodiments of the subject matter disclosed herein.

[5] **FIG. 2** is an isometric cutaway view of an embossed medium having an adhesive applied to tips of medium support structure that may be part of one or more board products according to one or more embodiments of the subject matter disclosed herein.

[6] **FIGs. 3A-C** are profile views of various flute profiles of medium having improved structure according to embodiments of the subject matter disclosed herein.

[7] **FIG. 4** is an isometric cutaway views of a board product having the embossed medium of **FIG. 1** according to an embodiment of the subject matter disclosed herein.

[8] **FIG. 5** is a diagram of aspects of a machine configured to produce the board product of **FIG. 4** according to an embodiment of the subject matter disclosed herein.

DETAILED DESCRIPTION

[9] The following discussion is presented to enable a person skilled in the art to make and use the subject matter disclosed herein. The general principles described herein may be applied to embodiments and applications other than those detailed above without departing from the spirit and scope of the present detailed description. The present disclosure is not intended to be limited to the embodiments shown, but is to be accorded the widest scope consistent with the principles and features disclosed or suggested herein.

[10] By way of overview, the subject matter disclosed herein may be directed to a system and method for producing a board product made from paper products that have embossed medium (sometimes called embossed fluting) that features an improved structural profile. The improved structural profile may include a triangular flute pattern wherein each flute may exhibit a first linear leg support and a second linear leg support that each support a center apex structure. The apex may have a substantially flat portion that is configured to engage a facing. As such, the board product may further include one or more facings (sometimes called liners or walls) that are adhesively coupled to the embossed medium. Further, the apex of each "triangle" may also have a groove or channel for receiving an adhesive in a continuous and uniform manner.

[11] When a board product is produced such that an embossed medium includes a flute profile with linear leg structures flanked by substantially flat apexes, the resulting board strength and overall structure is improved with respect to conventionally produced board having corrugated medium. Further, the embossed medium may be produced using a linear embossing process that takes advantage of the natural strength of the machine direction of the paper product. Additional permutations of the underlying concept of

having a cross-corrugated medium and a linearly embossed medium in the same board product are possible, including disposing a facing between the corrugated medium and the embossed medium and having facings on one or both outer walls of the board product. These advantages and additional aspects of various embodiments of the subject matter disclosed herein are discussed below with respect to **FIGs. 1-5**.

[12] Prior to discussing the various embodiments, a brief discussion about cross corrugating and linear embossing is presented. As has been briefly stated above, conventional board products include a conventionally produced corrugated medium (sometimes called a corrugated fluting), *e.g.,* a cross-corrugated medium. A cross-corrugated medium has flutes formed perpendicular to most underlying fibers of the paper product. This results in flutes that are not aligned with the majority of underlying fibers and, therefore, do not take advantage of the natural strength of the MD value of the paper (when compared to the CD value). Such a failure to harness the MD value of the paper leads to loss of opportunity in the manufacturing of board products when specific board strength is to be realized. That is, it will necessarily take more paper (heavier paper, larger flutes, and the like) to realize the required board strength.

[13] A linearly-embossed medium is different from a cross-corrugated medium in that the induced flutes are aligned with the MD value of the paper product. This results in flutes that are aligned with the majority of underlying fibers and, therefore, take advantage of the natural strength of the MD value of the paper (when compared to the CD value). Harnessing the MD value of the paper leads to efficiencies in the manufacturing of board products when specific board strength is to be realized. That is, it will necessarily take less paper (lighter paper, smaller flutes, and the like) to realize the required board

strength. Aspects of making, producing, and using linearly embossed mediums are discussed in greater detail in U.S. Patent Application No. 15/077,250 entitled "SYSTEM AND METHOD FOR INDUCING FLUTING IN A PAPER PRODUCT BY EMBOSSING WITH RESPECT TO MACHINE DIRECTION" and filed on March 22, 2016, which is incorporated herein by reference in its entirety and for all purposes. Thus, the aspects of linearly-embossed mediums will not be discussed further for brevity as the discussion now turns to **FIGs. 1-5**.

[14] **FIG. 1** is an isometric cutaway view of an embossed medium ***130*** that may be part of one or more board products according to one or more embodiments of the subject matter disclosed herein. This diagram shows an isometric view of a portion of an embossed medium ***130*** that may be formed from an embossing process. That is, flutes ***131*** are formed from passing the initial paper product through embossing rolls to form flutes using a linear-embossing technique such that the flutes ***131*** are formed congruent with a majority of underlying fibers ***125*** of the paper. The flutes ***131*** are also formed congruent with the machine direction ***122***. A linearly-embossed medium ***130*** harnesses the natural strength of the paper in the machine direction ***122*** as the flutes ***131*** are formed in the machine direction ***122*** of the paper (*e.g.,* congruent with a majority the underlying fibers ***125***). Therefore, a linearly-embossed medium ***130*** does harness the natural strength of the paper in the machine direction ***122***. Such an embossed medium ***130*** may be a component/layer of a board product as discussed below with respect to **FIG. 4**.

[15] Further, as is shown in **FIG. 1**, the flutes ***131*** may form a triangular pattern when viewed from a cutaway perspective. This flute pattern having a triangular repeating shape is referred to as a flute profile hereinafter. In the embodiments discussed in the remaining

figures, the flute profile provides an improvement in structural integrity of the embossed medium when compared to a flute profile the exhibits a curvilinear or sinusoidal flute profile. Such a curvilinear or sinusoidal flute profile is prevalent in conventional cross-corrugated mediums. Therefore, the triangular flute profile as shown in **FIG. 1** is also superior to corrugated mediums with respect to medium strength and structural integrity. Various reasons why this flute profile and other similar flute profile exhibit superior strength and structural integrity are presented below with respect to **FIGs. 2-3**.

[16] **FIG. 2** is an isometric cutaway view of an embossed medium ***130*** having an adhesive ***201*** applied to the apex structure of the medium support structure that may be part of one or more board products according to one or more embodiments of the subject matter disclosed herein. In **FIG. 2**, a closer look at the embossed medium shows a series of flutes that form an isosceles triangle flute profile. The flute profile may comprise a series of support structures that each include three portions. In this example, the three portions are a first leg support structure ***211***, a second leg support structure ***212***, and an apex structure ***210***. As shown, the apex structure ***210*** is disposed between the first and second leg support structures ***211*** and ***212***. In this example support structure then, each support structure may have an apex facing up (although up is an arbitrary direction simply shown by virtue of the illustration).

[17] By the same token, a second series of support structures may also each include three portions, but from the downward facing perspective. In this respect, the leg support structure ***212*** also forms a leg support structure for a triangle facing downward. Thus, the three portions are a first leg support structure ***214***, a second leg support structure ***212***, and an apex structure ***213*** disposed between the first and second leg support structures

214 and ***212***. Note that the second leg structure ***212*** is the same second leg support structure with respect to the upward facing apex ***210*** and the downward facing apex ***213***. The flute profile can then be thought of as series of alternating upward ***210*** and downward ***213*** facing apexes with alternating linear leg support structures (*e.g.*, ***211***, ***212***, and ***214***) disposed there between.

[18] Each apex ***210*** and ***213*** may be formed to be substantially flat so as to provide a uniform surface to receive the adhesive ***201*** from a machine for locating an apex and applying a continuous line of adhesive to each apex. Then, the embossed medium ***130*** may be affixed to a facing ***140*** at the apexes that have adhesive ***201*** at the ready. In other embodiments, each apex ***210*** and ***213*** may have a groove for facilitating the receiving of the adhesive. With a groove, the adhesive will tend to remain in place while the embossed medium ***130*** is moving through a board-making machine. Such a grooved apex embodiment is discussed below with respect to **FIG. 3C**.

[19] The embodiments as discussed with respect to **FIGs. 1-2** have an embossed medium ***130*** that exhibits an isosceles triangular flute profile having superior strength and improved support structure. One reason that this embodiment provides superior strength is that the leg support structures ***211***, ***212***, and ***214*** are linear. That is, the leg support structures are not curved and therefore tend to remain fixed and rigid when various forces are applied from various directions. In a sinusoidal corrugated medium, the "legs" are more like a continuous curve of a sinusoidal pattern. Thus, the "apex" of each flute may be the top side of the sinusoidal curve that exhibits a curved, smooth transition to any portion oif the medium that eventually forms a quasi-flat apex. Because of the curved, smooth transition on either side of the apex of conventional corrugated medium, the apex

may translate forward and backward in an undesired manner. With linear leg support structures ***211***, ***212***, and ***214***, a more defined structure is provided that resists unpredictable movement and failure points.

[20] Further, as the well-known maxim goes, the shortest distance between two points is a straight line. As applied here, the shortest distance between each top-side facing apex and each bottom side facing apex is a linear leg support structure. Thus, having a triangular flute profile necessarily uses less overall paper to produce the embossed medium (as compared to a sinusoidal corrugated medium). Other embodiments may include different shapes for a flute profile including saw-tooth, trapezoidal, or any manner of a geometric shape that exhibits linear leg support structures flanked by alternating top-side and bottom-side apexes. Three such embodiments are shown in **FIGs. 3A-C** and discussed next.

[21] **FIGs. 3A-C** are profile views of various flute profiles of medium having improved structure according to embodiments of the subject matter disclosed herein. In **FIG. 3A**, a first isosceles triangle flute profile ***300*** is shown. This flute profile ***300*** is also shown in **FIGs. 1** and **2**, but this view provides a cross-section view of the actual flute profile. In this embodiment, each flute includes a first linear leg support structure ***301*** and a second linear leg support structure ***302*** that are each coupled to one apex ***303*** disposed there between. The apex ***303*** is disposed substantially flat and in a plane that is parallel to an eventual facing that may be coupled (via adhesive, or other means – not shown). Further, the width of the apex ***303*** in this embodiment is approximately one tenth of the length of each linear leg support structure ***301*** and ***302***. Thus, this embodiment may be referred to as a narrow apex flute profile ***300***.

[22] In this embodiment, the angle of each leg ***301*** and ***302*** with respect to each apex ***303*** may be approximately 60 degrees. However, any number of leg angles may be realized. Thus, the first linear leg structure ***301*** and the second linear leg structure ***302*** may be affixed with respect to the apex ***303*** plane at an angle between approximately 30 degrees and 60 degrees.

[23] In **FIG. 3B**, a second isosceles triangle flute profile ***320*** is shown. This flute profile ***320*** view provides a cross-section view of the actual flute profile exhibiting a first linear leg support structure ***321*** and a second linear leg support structure ***322*** that are each coupled to one apex ***323*** disposed there between. Further, the apex ***323*** is disposed substantially flat and in a plane that is parallel to an eventual facing that may be coupled. Different from **FIG. 3A**, the width of the apex ***323*** in this embodiment is approximately one fifth of the length of each linear leg support structure ***321*** and ***322***. Thus, this embodiment may be referred to as a wide apex flute profile ***320***.

[24] In **FIG. 3C**, a third isosceles triangle flute profile ***340*** is shown. This flute profile ***340*** view provides a cross-section view a flute profile exhibiting a first linear leg support structure ***341*** and a second linear leg support structure ***342*** that are each coupled to one apex ***343*** disposed there between. As before, the apex ***343*** is disposed substantially flat and in a plane that is parallel to an eventual facing that may be coupled. Different from **FIGs. 3A** and **3B**, the apex ***343*** includes a groove or channel for receiving an adhesive prior to being coupled to a facing (not shown). In this embodiment, the width of the apex ***343*** is approximately one fifth of the length of each linear leg support structure ***321*** and ***342***. Thus, this embodiment may be referred to as a wide grooved apex flute profile ***340***. Other flute profiles are contemplated but not discussed further for brevity.

[25] **FIG. 4** is an isometric cutaway view of a board product ***400*** having an embossed medium ***130*** with improved flute structure according to an embodiment of the subject matter disclosed herein. In this embodiment, the board product includes four layers: a first facing ***110***, a corrugated medium ***120***, an embossed medium ***130,*** and a second facing ***140***. As is shown, the first facing ***110*** may form a top-side outer wall (although the top/bottom direction reference to alignment of the board product ***100*** is arbitrary) that is coupled to one side of the corrugated medium ***120***. The coupling may be through an adhesive applied to the apex of each flute on the top-side of the corrugated medium ***120*** such that the facing ***110*** is glued to the corrugated medium ***120*** where adhesive is applied. In other embodiments, glue may be applied to the entirety of the facing ***110*** prior to being coupled to the corrugated medium ***120***.

[26] Likewise, a second facing ***140*** may form a bottom-side outer wall (again, the top/bottom direction reference is arbitrary) that is coupled to one side of the embossed medium ***130***. The coupling may be through an adhesive applied to the apex of each flute on the bottom-side of the embossed medium ***130*** such that the facing ***140*** is glued to the embossed medium ***140*** where adhesive is applied. In other embodiments, glue may be applied to the entirety of the facing ***140*** prior to being coupled to the embossed medium ***130***.

[27] Further, the corrugated medium ***120*** and the embossed medium ***130*** may also be glued to each other using adhesive. Because the flutes of the corrugated medium ***120*** are aligned in the cross direction and the flutes of the embossed medium ***130*** are aligned in the machine direction, the contact points between these two mediums will be at the crossings of the apexes of the respective flutes. In this manner, the corrugated medium

120 and the embossed medium ***130*** are affixed with respect to one another because of the adhesive holding one medium directly to the other.

[28] When all four layers are assembled and affixed, the resultant board product ***400*** is stronger than conventional board product because the linearly embossed medium ***130*** includes a flute profile that exhibits superior strength because of the linear leg structures of each flute. Further, adhesive may be continuously and uniformly applied to each apex in a predictable and repeatable manner with greater precision as portions of the adhesive will not spill over to the legs as may be the case with sinusoidal apexes having no flat receiving area. As shown in **FIG. 4**, the board product ***400*** includes a corrugated medium ***120***. In other embodiments, the corrugated medium ***120*** may not be present such that the top-side facing ***110*** is glued to each top-side apex of the embossed medium and the bottom-side facing ***140*** is glued to each bottom side apex of the embossed medium ***130***. Additional aspects of the board product ***400*** of **FIG. 4** are discussed next with respect to the machine of **FIG. 5**.

[29] **FIG. 5** is a diagram of aspects of a machine ***500*** configured to produce the board product of **FIG. 4** according to an embodiment of the subject matter disclosed herein. In this embodiment, the machine includes four feed rolls ***510, 520, 530,*** and ***540*** of paper that are used to produce a board product. These feed rolls include a first facing feed roll ***510***, a corrugated medium feed roll ***520***, an embossed medium feed roll ***530***, and a second facing feed roll ***540***. Note that the paper that is wound on the corrugated medium feed roll ***520*** is prior to corrugating and the paper that is wound on the embossed medium feed roll ***530*** is prior to embossing. The weights and composition of the paper for each respective feed roll may be different and designed specifically for the respective purpose.

[30] The paper from each roll may be unwound from each respective roll and fed toward a combiner ***550*** that is configured to combine the various layers of paper together to form a resultant board product. Prior to entering the combiner ***550***, at least some of the paper from the feed rolls may be passed through a stage for forming the paper into a medium. As used herein and in the industry, a medium may refer to a paper product that has been formed into paper having flutes. Thus, the corrugated medium feed roll ***520*** may feed paper into first and second corrugating rolls ***521a*** and ***521b*** that are aligned with respect to each other. As the paper exits the corrugating stage (*e.g.,* corrugating rolls ***521a*** and ***521b***), it becomes the corrugated medium ***120***. The corrugated medium ***120*** is then fed into the combiner ***550*** to be combined with other materials. Similarly, the embossed medium feed roll ***530*** may feed paper into first and second embossing rolls ***531a*** and ***531b*** that are aligned with respect to each other. As the paper exits the embossing stage (*e.g.,* embossing rolls ***531a*** and ***531b***), it becomes the embossed medium ***130*** as discussed above with respect to **FIG. 1**. The embossed medium ***130*** is then fed into the combiner ***550*** to be combined with other materials.

[31] Further, the embossed medium paper feed 530 may be first fed into a conditioner 560 that may condition the paper prior to embossing. Such conditioning may include wetting the paper, heating the paper, cooling the paper, applying chemicals to the paper and various other forms of changing the underlying condition of the paper to be better prepared for embossing. In this sense, one may think of the conditioning stage as "relaxing" underlying fibers of the paper such that the paper may be in a more compliant state to be manipulated easier so as to avoid tearing and ripping. Such condition may remove or modify inherent stiffness in the paper and reduce the degree of possible fiber

damage that will occur in the stretching process during embossing. In one embodiment, the conditioner may immerse (entirely or partially) the paper web in process in a liquid (*e.g.*, water, recoverable solvent, and the like). The liquid may be heated or not so as to achieve the desired paper condition of compliance/plasticity.

[32] Once passed through the embossing rolls ***531a*** and ***531b***, the embossed medium ***130*** may be passed to an applicator ***570*** for applying adhesive to the newly formed apexes. The applicator may include a device for identifying the locations of each apex and then aligning a series of adhesive dispensers with the identified apexes. In other embodiments, adhesive may be transferred to the flute tips with a glue roll or rolls where the paper contacts a glue film and adheres to the flute tips. In this manner, adhesive may be applied with precision in a continuous and uniform manner. Then, the first facing ***110***, the corrugated medium ***120***, the embossed medium ***130***, and the second facing ***140*** are combined in the combiner ***550*** using various techniques such as adhesion, curing, wetting, drying, heating, and chemical treatment. The resultant board product ***400*** features at least one cross-corrugated medium ***120*** and at least one linearly-embossed medium ***130*** wherein the linearly embossed medium includes a flute profile with improved structure.

[33] While the subject matter discussed herein is susceptible to various modifications and alternative constructions, certain illustrated embodiments thereof are shown in the drawings and have been described above in detail. It should be understood, however, that there is no intention to limit the claims to the specific forms disclosed, but on the contrary, the intention is to cover all modifications, alternative constructions, and equivalents falling within the spirit and scope of the claims.

What is claimed is:

1. A board product, comprising:

a paper medium having a plurality of flutes, wherein at least a set of the plurality of flutes each comprise a first linear leg support structure, a second linear leg support structure and an apex structure; and

a paper facing coupled to the tip support structure.

2. The board product of claim 1, further comprising a second facing affixed with respect to the paper medium.

3. The board product of claim 1, further comprising a second paper medium affixed with respect to the paper facing.

4. The board product of claim 1, wherein the first linear leg structure and the second linear leg structure are affixed with respect to the paper facing at an angle between approximately 30 degrees and 60 degrees.

5. The board product of claim 1, wherein each apex structure comprises a flat portion parallel to the paper facing.

6. The board product of claim 1, wherein each apex structure further comprises a flat portion having a groove configured to channel an adhesive for coupling each apex structure to the paper facing.

7. The board product of claim 1, further comprising a continuous adhesive line coupled between each apex structure and the paper facing.

8. The board product of claim 1, wherein the plurality of flutes further comprise:

a first plurality of flutes each having an apex structure coupled to the paper facing such that the paper facing is affixed to the paper medium on a first side; and

a second plurality of flutes each having an apex structure coupled to a second paper facing such that the second paper facing is affixed to the paper medium on a side opposite the first side.

9. A board-making method, comprising:

embossing a paper product to include a plurality of flutes, wherein at least a second plurality of the plurality of flutes each comprise a first linear leg support structure, a second linear leg support structure and an apex structure; and

coupling a paper facing to at least a third plurality of the apex structures of the second plurality of flutes.

10. The board-making method of claim 9, further comprising embossing a groove in each apex structure.

11. The board-making method of claim 9, further comprising heating the paper medium prior to embossing.

12. The board-making method of claim 9, further comprising wetting the paper medium prior to embossing.

13. The board-making method of claim 12, further comprising drying the paper medium after embossing.

14. The board-making method of claim 9, further comprising curing the paper medium after embossing.

15. The board-making method of claim 9, further comprising gluing the paper medium to the paper facing.

16. The board-making method of claim 9, further comprising affixing a second facing with respect to the paper medium.

17. The board-making method of claim 9, wherein the embossing further comprises embossing a first set of apex structures facing a first direction and second set of apex structures facing second direction that is opposite the first direction.

18. A board-making machine, comprising:

an embosser configured to emboss a paper product to include a plurality of flutes, wherein at least a second plurality of the plurality of flutes each comprise a first linear leg support structure, a second linear leg support structure and an apex structure; and

a combiner configured to couple a paper facing to at least a third plurality of the linear tip support structures of the second plurality of flutes.

19. The board-making machine of claim 18, further comprising a conditioner configured to condition the paper medium prior to embossing.

20. The board-making machine of claim 18, wherein the combiner further comprises an adhesive applicator configured to locate each apex structure and to apply a continuous line of adhesive to each apex structure.

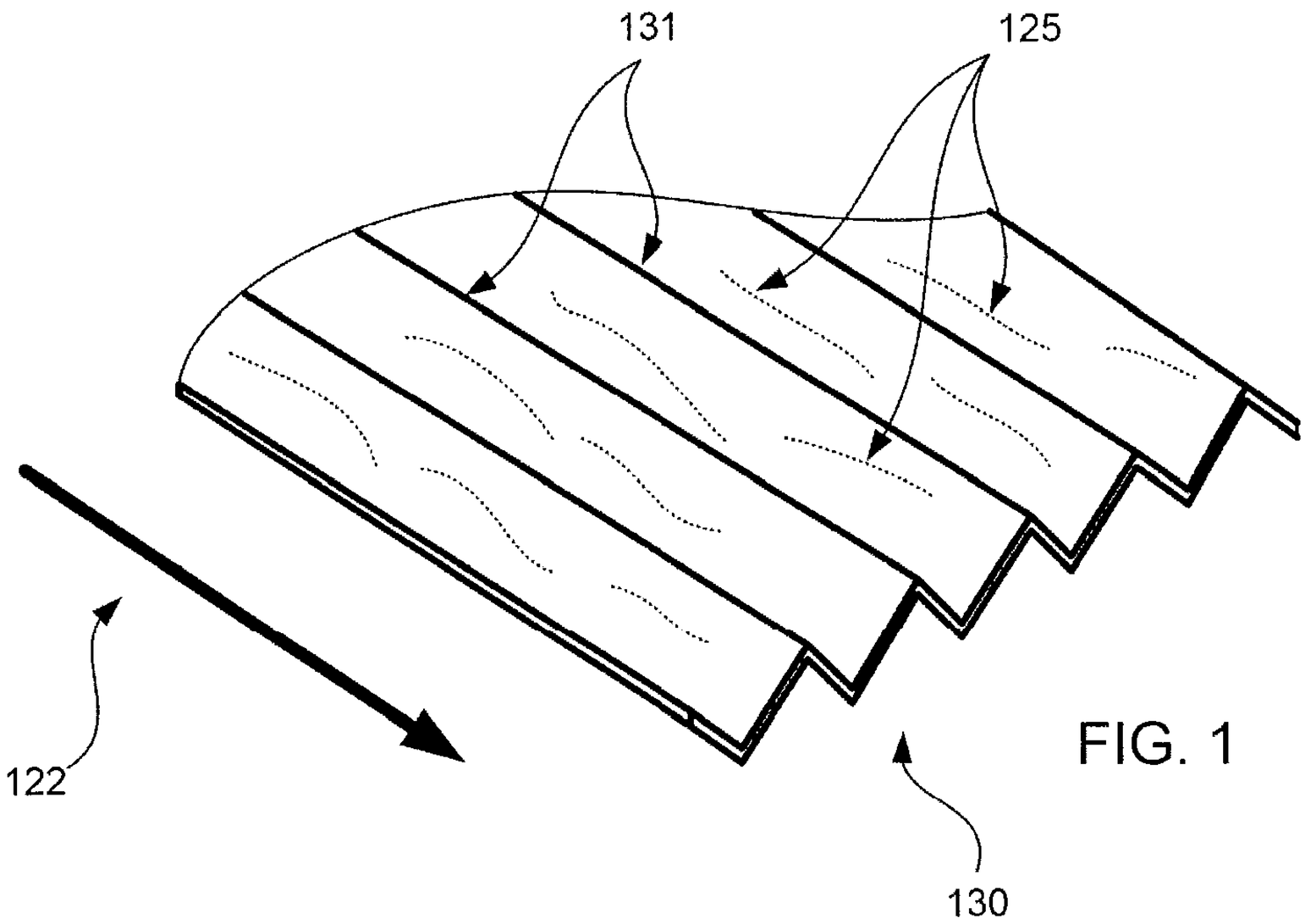

FIG. 1

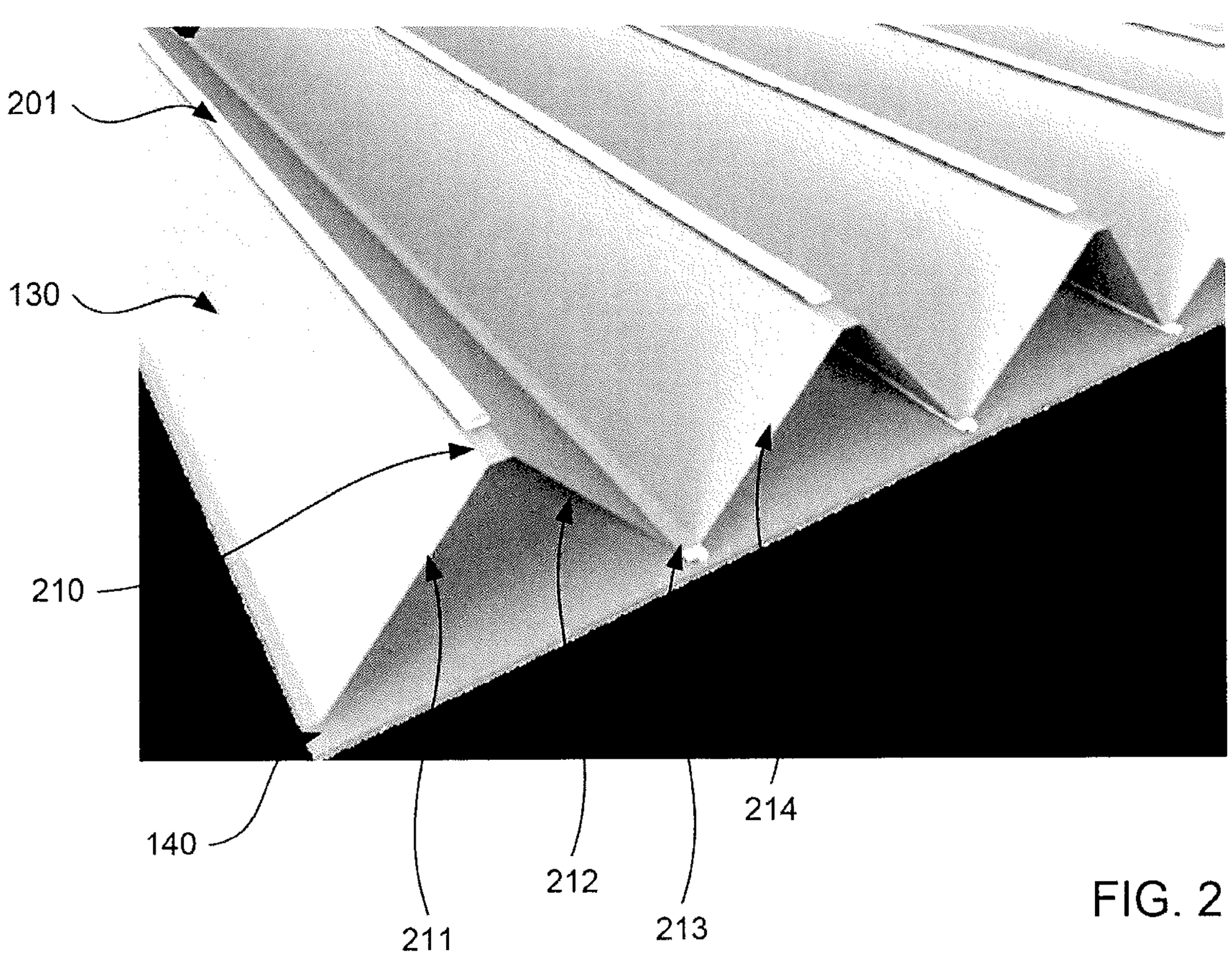

FIG. 2

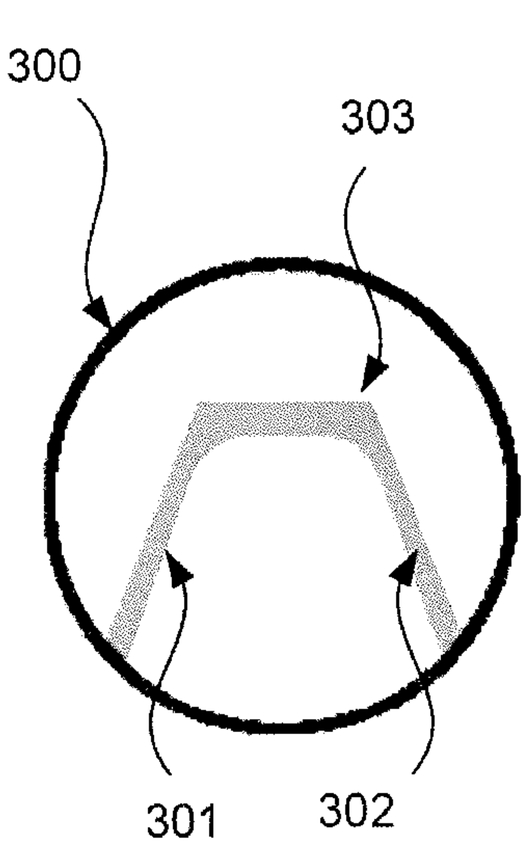

FIG. 3A

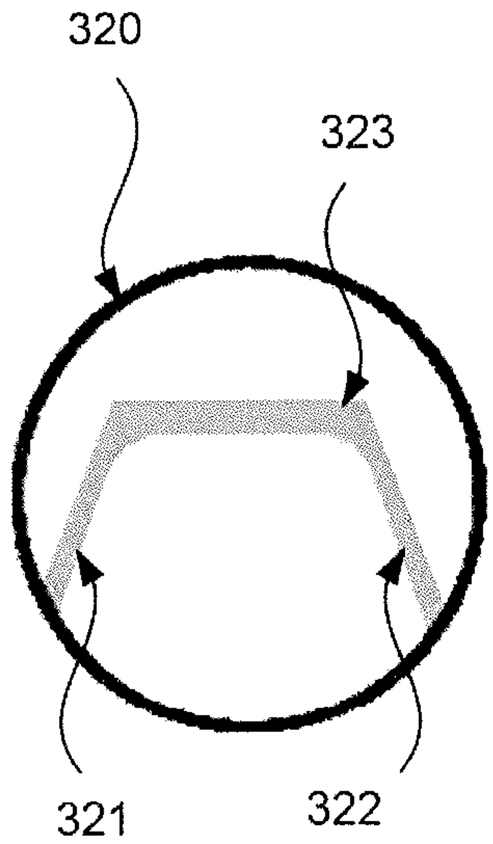

FIG. 3B

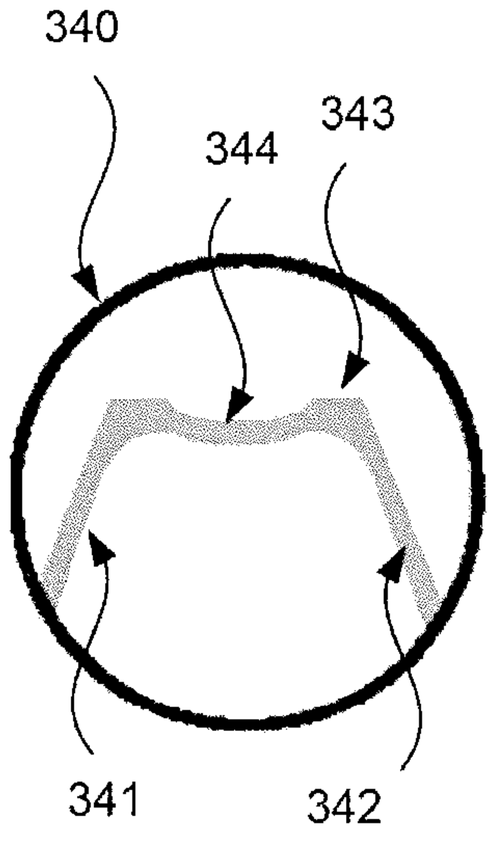

FIG. 3C

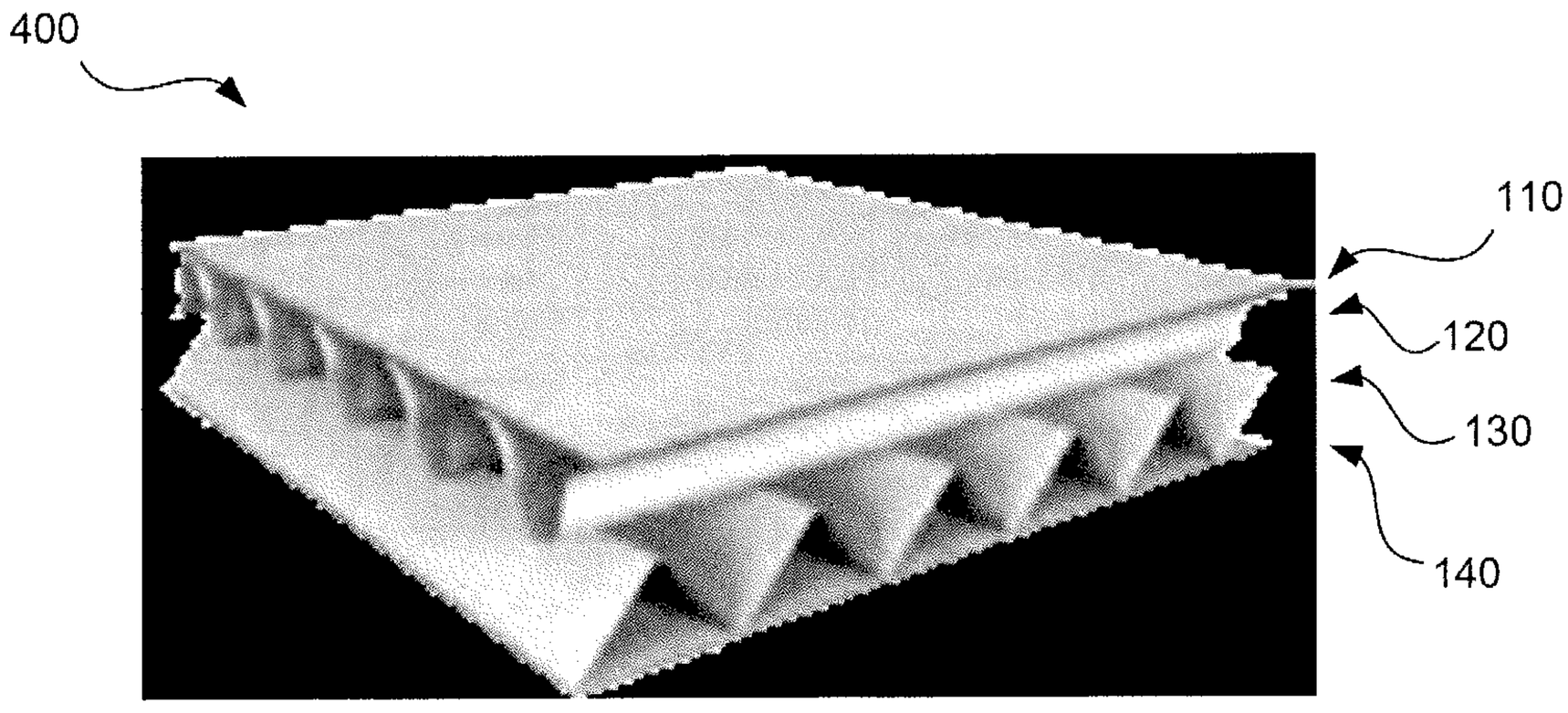

FIG. 4

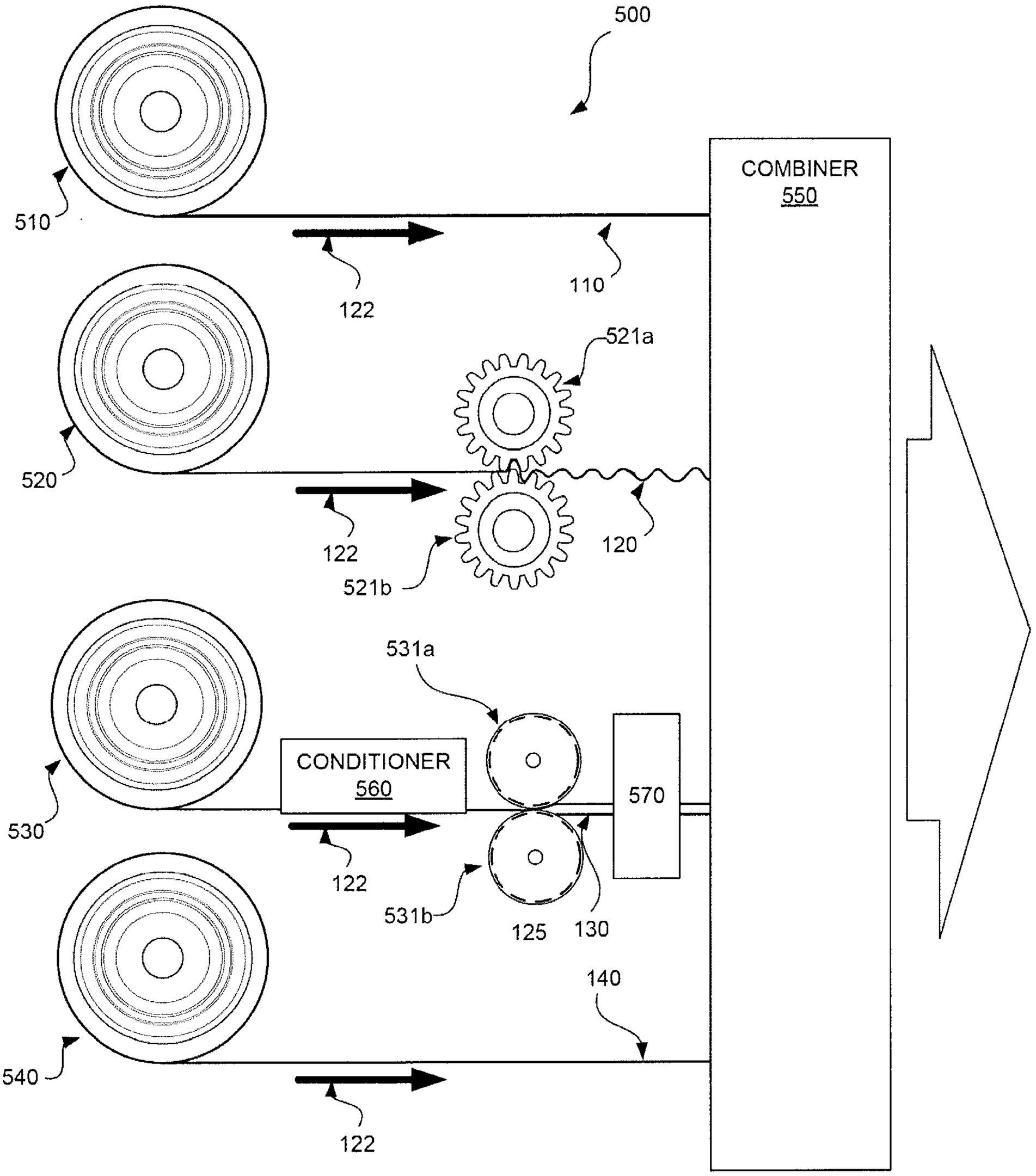
500
COMBINER
550
510
122
110
521a
520
122
120
521b
531a
CONDITIONER
560
570
530
122
531b
125
130
140
540
122

FIG. 5

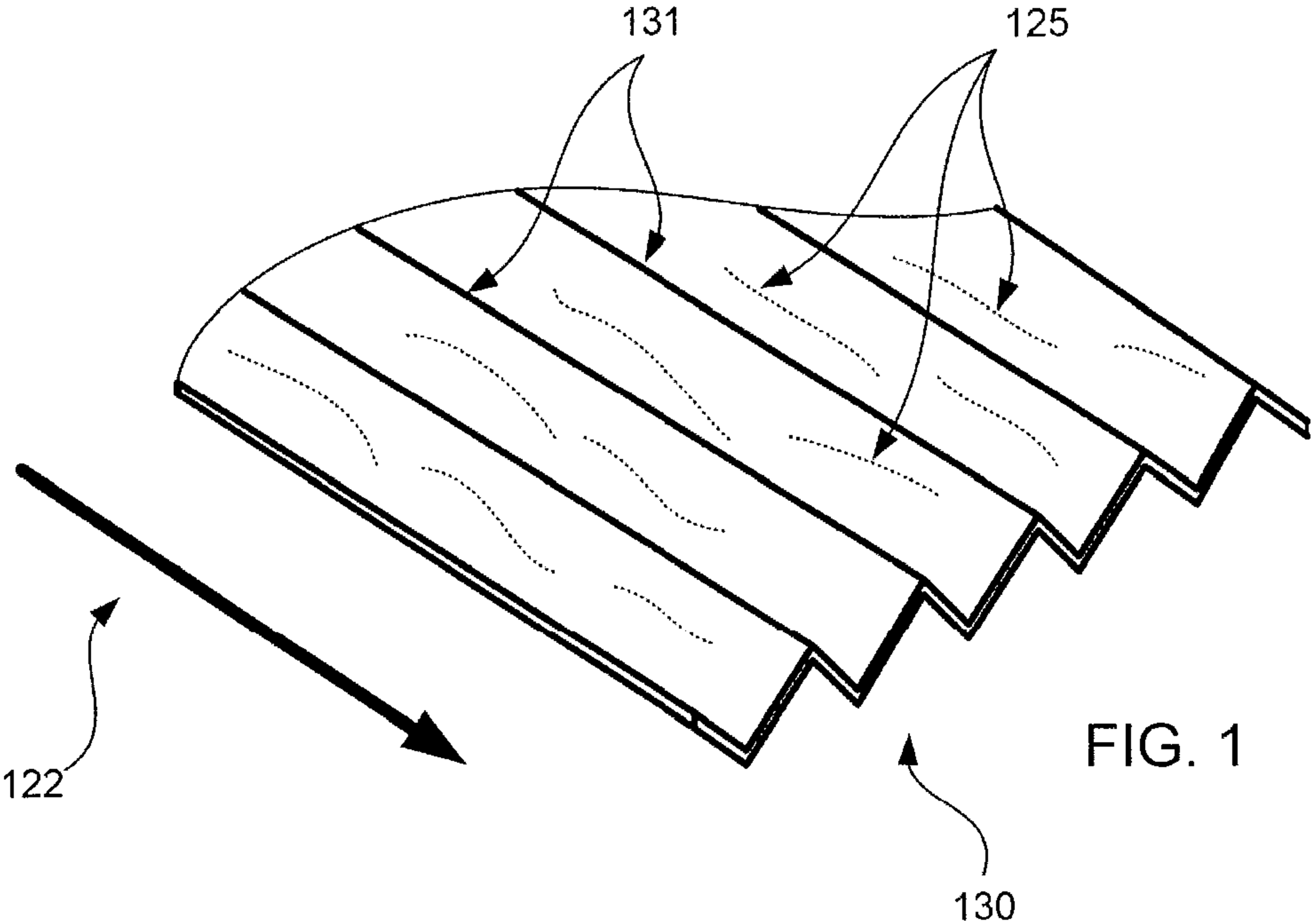

FIG. 1