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(54) **Assembly of forming elements for a paper machine**

Formierelementeanordnung für eine Papiermaschine

Assemblage des lames pour la section de formage d'une machine à papier

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EP 1 479 819 B1

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Description

[0001] The present invention relates to an assembly of forming elements which together define in a papermaking apparatus a discontinuous supporting surface for a papermaking suspension to permit drainage and micro-turbulence to be accurately controlled, and to the papermaking apparatus *per se*.

[0002] In the papermaking industry, various forming elements are deployed to promote the drainage of water from paper stock in its transformation from a papermaking suspension (or slurry) of fibres, water and chemicals (eg fillers) into a self-supporting web of cellulose fibres commonly referred to as a sheet (ie a sheet of paper or board). Dewatering takes place in the forming area at the "wet end" of a papermaking apparatus, a typical one of which is illustrated schematically by way of example in Figure 1. Thus in Figure 1, parallel papermaking wires 1 (or mesh or a belt) move in direction A and are supported from beneath by discrete forming elements which include forming boards 2, spaced apart foils 3 and low vacuum blades 4. Suction box covers 5 together with Uhle box covers 8 constitute dewatering elements.

[0003] Crucial to the formation of the sheet of paper (or board) in the forming area is the drainage of the papermaking suspension and the micro-turbulence generated in the papermaking suspension which serves to eliminate agglomeration thereby enhancing the uniformity of the papermaking suspension. The harmonic pitch of the papermaking apparatus is the spacing on the paper table of the forming board, forming foils and gravity foils which together determine the natural harmonics of the wet end of the papermaking apparatus and which is established at the time that the papermaking apparatus is designed to give the desired drainage and micro-turbulence. It can be a disadvantage of conventional papermaking apparatus that the design is specified in accordance with certain grades of paper (or board) and certain types or quality of pulp.

[0004] Referring again to Figure 1, the papermaking suspension is ejected from a flow box or head box (not shown) onto the papermaking wire 1. Commonly the forming board 2 which is a solid unitary element may do little more than help to direct the papermaking suspension flow onto the moving papermaking wires 1 prior to de-watering. However the forming board 2 may be provided with grooves or slots to generate micro-turbulence. GB-A-2190932 discloses a solid forming board (known commercially as the TURBOFORM™ board) in the surface of which one or more transverse, open-ended slots are provided. The depth of the slots may be varied by an insert to achieve the requisite degree of micro-turbulence in the papermaking suspension whilst permitting limited drainage. However the TURBOFORM™ board is able to take little or no account of the natural harmonic pitch of a papermaking apparatus. Moreover the TURBOFORM™ board is generally of little use in a slow speed papermaking apparatus.

[0005] GB-A-2124669 discloses a papermaking apparatus with a positive pulse preconditioning blade. GB-A-1307980 discloses a vacuum box for a papermaking apparatus.

5 [0006] The present invention seeks to improve the versatility of a papermaking apparatus by introducing into the forming area an assembly of forming elements which together define a discontinuous supporting surface for the papermaking suspension. More particularly, the present invention relates to an assembly of forming elements which takes account of and enhances the natural harmonic pitch of the papermaking apparatus to accurately control in the forming area the drainage of and micro-turbulence in the papermaking suspension thereby satisfying a demand from customers for improved paper quality (eg improved fibre and fines dispersal throughout the sheet).

10 [0007] Thus viewed from one aspect the present invention provides assembly of forming elements including:

a primary blade capable of being positioned adjacent one or more supply means at the wet end of a papermaking apparatus;

25 a first secondary support blade coupled to a leading face of the primary blade by a first drainage deckle; and

30 n consecutive additional secondary support blades and n consecutive additional drainage deckles, wherein a trailing face of the first additional secondary support blade is coupled to a leading face of the first secondary support blade by the first additional drainage deckle and a trailing face of the second to nth additional secondary support blades is coupled respectively to a leading face of the first to n-1th additional secondary support blades by the second to nth additional drainage deckle respectively, wherein n is an integer of one or more, wherein the upper surfaces of at least one of the first drainage deckle and n consecutive additional drainage deckles is angled downwardly from trailing to leading edges of the upper surface.

35 whereby the upper surface of the primary blade, the first secondary support blade, the first drainage deckle, the n additional drainage deckles and the n additional secondary support blades together define a discontinuous surface for supporting a papermaking suspension being carried by a carrier from the wet end to an output end of the papermaking apparatus.

40 [0008] Viewed from a further aspect the present invention provides papermaking apparatus capable of making a sheet of paper or board from a papermaking suspension, said apparatus comprising:

45 one or more supply means for introducing the papermaking suspension into a wet end of the apparatus.

ratus;
 a carrier for carrying the papermaking suspension from the wet end to an output end of the apparatus; and
 an assembly of forming elements as described above, wherein the primary blade is positioned adjacent the one or more supply means.

[0009] It will be apparent that the assembly of forming elements largely making up the forming area of the papermaking apparatus of the invention may be advantageously extended to any desired length to achieve the requisite formation characteristics simply by adding additional secondary support blades and additional drainage deckles (*ie* by increasing *n*). Moreover, in sharp contrast to conventional rigid forming boards, the forming elements of the papermaking apparatus of the invention may be assembled into the papermaking apparatus quite straightforwardly to the desired length. To exemplify its improved versatility, the papermaking apparatus may be used with a broader range of paper (or board) grades (*eg* varying in weight) than has hitherto been possible irrespective of the carrier speed.

[0010] The upper surfaces of the forming elements together present a discontinuous supporting surface (paper table) to the papermaking suspension. This discontinuous surface serves intrinsically to generate micro-turbulence in the papermaking suspension. For this purpose, the profile, thickness and/or relative positioning of the primary blade, the first secondary support blade, the first drainage deckle, the *n* additional drainage deckles and the *n* additional secondary support blades may be varied to suit the requirements of the papermaking process. Typically the discontinuous supporting surface is irregularly discontinuous. For example the discontinuous supporting surface may be stepped (*eg* irregularly stepped).

[0011] Preferably the upper surfaces of the primary blade, the first secondary support blade and the *n* consecutive additional secondary support blades are substantially coplanar at a first height and the upper surface of at least one (preferably each) of the first drainage deckle and *n* consecutive additional drainage deckles is at a height different from the first height. Particularly preferably the upper surfaces of the primary blade, the first secondary support blade and the *n* consecutive additional secondary support blades are substantially coplanar at a first height and the upper surface of each of the first drainage deckle and *n* consecutive additional drainage deckles is at a height different from the first height whereby to define a discontinuous surface which is stepped. More preferably the upper surfaces of the first drainage deckle and *n* consecutive additional drainage deckles are substantially coplanar at heights different from each other and from the first height whereby to define a discontinuous surface which is substantially irregularly stepped. Alternatively (if desired) the upper surfaces of the first drainage deckle and *n* consecutive additional

drainage deckles are substantially coplanar at a common height different from the first height whereby to define a discontinuous surface which is substantially regularly stepped

[0012] Additionally the upper surfaces of at least one of (preferably each of) the first drainage deckle and *n* consecutive additional drainage deckles is angled (*eg* angled at a height different from the first height). Typically the upper surface is angled downwardly from trailing to leading edges of the upper surface. The difference between the first and second height and any degree of angling may be judiciously chosen to generate the desired micro-turbulence into the papermaking suspension. For example, each of the first drainage deckle and *n* consecutive additional drainage deckles may be angled at a different angle to fine tune the micro-turbulence. Typically the angle is in the range 1-4° from the horizontal.

[0013] Additionally at least one (preferably more than one *eg* each) of the first drainage deckle and *n* consecutive additional drainage deckles generates micro-turbulence in the papermaking suspension by extrinsic means. In a preferred embodiment, at least one (preferably more than one *eg* each) of the first drainage deckle and *n* additional drainage deckles is adapted to transmit a means for generating micro-turbulence in the papermaking suspension. Preferably the means for generating micro-turbulence is sourced externally and may be a physical means or electromagnetic radiation. For example, the means for generating micro-turbulence may be pulses of fluid (*eg* gas or liquid such as water) or vibrations (*eg* sonic vibrations).

[0014] Preferably the upper surface of at least one (preferably more than one *eg* each) of the first drainage deckle and *n* consecutive additional drainage deckles comprises a groove adapted to transmit fluid (*eg* water) onto its upper surface. Typically the groove is a closed end groove (*ie* a groove extending downwardly from and transversely along the upper surface remote from its opposing edges). The transverse end walls of the groove may be curved (*eg* semicircular).

[0015] Preferably the groove is adapted to transmit pulses of fluid (*eg* water) onto its upper surface. Preferably to an end wall of at least one (preferably more than one *eg* each) of the first drainage deckle and *n* consecutive additional drainage deckles extends a transverse slot (*eg* a transverse substantially circular slot) outwardly from a transverse end wall of the groove. Particularly preferably to a first and second end wall of at least one (preferably more than one *eg* all) of the first drainage deckle and *n* consecutive additional drainage deckles extends respectively a first and a second transverse slot (*eg* a transverse substantially circular slot) outwardly from a first and second transverse end wall of the groove respectively. The or each transverse slot is in fluid communication with the groove and therefore with the upper surface so that pulses of fluid (*eg* water) may be transmitted therethrough onto the upper surface. The depth of the groove, the nature of the means for generating

micro-turbulence and the manner in which the means for generating micro-turbulence is applied may be judiciously chosen to refine the micro-turbulence generated intrinsically in the papermaking suspension (*eg* by dampening or amplifying the micro-turbulence imparted by the natural harmonic pitch of the forming elements) which in turn assists fibre formation and dispersal of fines throughout the sheet (*ie* improves sheet quality).

[0016] The first drainage deckle and *n* additional drainage deckles may couple the leading and trailing faces of a first and second consecutive forming element in any convenient manner. Preferably the leading and trailing faces of the drainage deckle engage the first and second consecutive forming elements through male and female portions (*eg* interlocking male and female portions) of any convenient coupling arrangement. The male and female portions may be a tongue and groove or a dovetail-type arrangement. Preferably the male and female portions are a tongue and groove. More preferably the trailing face of the drainage deckle bears a tongue adapted to engage a complementarily shaped groove on the leading face of the first forming element and the leading face of the drainage deckle bears a groove adapted to be engaged by a complementarily shaped tongue on the trailing face of the second forming element.

[0017] The thickness and/or profile of the first drainage deckle and *n* additional drainage deckles may be different but are preferably largely the same and may (in practice) be judiciously chosen to accurately control drainage of and micro-turbulence in the papermaking suspension as discussed above. Typically the trailing and leading faces of the drainage deckle are substantially perpendicular to the upper and lower surfaces. The upper edge of the leading face typically comprises a shoulder and the upper edge of the trailing face is chamfered.

[0018] The primary blade may be positioned immediately after the one or more supply means and support the carrier substantially at the point where (in use) the papermaking suspension flows onto the carrier. Typically the trailing face of the primary blade tapers downwardly and forwardly and the leading face is substantially non-tapered (*ie* substantially perpendicular to the upper and lower surfaces) and incorporates the male or (preferably) female portion (*eg* a groove) of any convenient male/female coupling arrangement (*eg* a tongue and groove). The upper edge of the leading face typically comprises a shoulder and the upper edge of the trailing face is chamfered. The primary blade is normally (but not necessarily) the same thickness as each of the first and *n* additional secondary support blades. The lower face may be adapted to enable the primary blade to be mounted on the forming box (*eg* by incorporating the male or (preferably) female portion of any convenient male/female coupling arrangement such as a dovetail type arrangement or (preferably) T-bars/T-slots).

[0019] The carrier may be a wire (or wires), belt, mesh or other arrangement driven between the wet end and the output end in a conventional manner. The carrier may

be at least partly composed of fabric, metal or plastic which may be woven or otherwise manipulated.

[0020] The one or more supply means may be head boxes or flow boxes as desired.

[0021] The first secondary support blade and *n* optional additional secondary support blades (which may be different but are preferably the same) support the carrier largely in the area where sheet formation takes place (the forming area). Typically the trailing face of the first secondary support blade and *n* optional additional secondary support blades is substantially perpendicular to the upper and lower surfaces and incorporates the female or (preferably) male portion (*eg* a tongue) of any convenient male/female coupling arrangement (*eg* a tongue and groove). The upper edge of the leading face typically comprises a shoulder and the upper edge of the trailing face is chamfered. The first secondary support blade and *n* optional additional secondary support blades are normally (but not necessarily) the same thickness as the primary blade. The lower face may be adapted to enable the first secondary support blade and *n* optional additional secondary support blades to be mounted on the forming box (*eg* by incorporating the male or (preferably) female portion of any convenient male/female coupling arrangement such as a dovetail type arrangement or (preferably) T-bars/T-slots).

[0022] By substituting the forming elements of a conventional papermaking apparatus with the assembly as hereinbefore defined, the natural harmonic pitch of the conventional papermaking apparatus is advantageously enhanced in a controlled manner.

[0023] Viewed from a yet further aspect the present invention provides a method for constructing a papermaking apparatus as hereinbefore defined comprising:

- (a) obtaining a conventional papermaking apparatus comprising one or more conventional forming elements in the forming area;
- (b) substituting at least one (preferably all) of the one or more conventional forming elements with an assembly of forming elements which include:

a primary blade positioned adjacent the one or more supply means;

a first secondary support blade coupled to a leading face of the primary blade by a first drainage deckle; and

optionally *n* consecutive additional secondary support blades and *n* consecutive additional drainage deckles, wherein a trailing face of the first additional secondary support blade is coupled to a leading face of the first secondary support blade by the first additional drainage deckle and a trailing face of the second to *n*th additional secondary support blades is coupled respectively to a leading face of the first to *n*-1th additional secondary support blades by the second to *n*th additional drainage deckle respectively,

wherein n is an integer of one or more,

whereby the upper surface of the primary blade, the first secondary support blade, the first drainage deckle, the n additional drainage deckles and the n additional secondary support blades together define a discontinuous surface for supporting the papermaking suspension.

[0024] In accordance with an embodiment of the method of the invention, the conventional forming elements include a conventional forming board and the primary blade of the assembly functionally replaces the conventional forming board. The primary blade may be (but is not necessarily) the same width as the forming board and is generally the same length.

[0025] In accordance with an embodiment of the method of the invention, the conventional forming elements include one or more forming foils and the first and n optional additional secondary support blades functionally replace the one or more forming foils. In this embodiment, n will be determined by the user in accordance with the demands of the application.

[0026] In a preferred embodiment of the method of the invention, the forming elements are mounted individually on existing T-bars of the forming box of the conventional papermaking apparatus thereby retaining the harmonic pitch of the conventional papermaking apparatus but refining it accordingly. In contrast, the rather more cumbersome rigid TURBOFORM™ board is mounted in the conventional papermaking apparatus on at least two T-bars simultaneously.

[0027] Viewed from an even yet further aspect the present invention provides a kit of parts comprising one or more of the forming elements selected from the group consisting of a primary blade as hereinbefore defined, a first secondary support blade as hereinbefore defined, n additional secondary support blades as hereinbefore defined and n consecutive additional drainage deckles as hereinbefore defined, said one or more of the forming elements capable of being assembled into an assembly as hereinbefore defined.

[0028] The present invention will now be described in a non-limitative sense with reference to the accompanying Figures in which:

Figure 2 illustrates schematically an isolated side view of a first embodiment of the assembly of forming elements of the invention;

Figure 3 illustrates schematically an isolated side view of a second embodiment of the assembly of forming elements of the invention;

Figure 4 illustrates a primary blade;

Figure 5 illustrates a secondary blade;

Figure 6 illustrates a drainage deckle of the first embodiment;

Figure 7 illustrates a drainage deckle of the second embodiment;

Figure 8 illustrates a conventional papermaking apparatus in use; and

Figure 9 illustrates a papermaking apparatus of the invention in use.

[0029] Figure 2 illustrates schematically an isolated side view of the assembly of forming elements 1 of a first embodiment of a papermaking apparatus of the invention. The assembly of forming elements 1 includes a primary blade 2 positioned immediately after the one or more supply means (not shown), a first secondary support blade 3, first and second consecutive additional secondary support blades 4a and 4b, a first drainage deckle 5 and first and second additional drainage deckles 6a, 6b. The assembly of forming elements 1 defines a discontinuous upper surface for supporting the papermaking suspension carried by a papermaking wire 7.

[0030] The primary blade 2 is illustrated alone in Figure 4. A trailing face 42a of the primary blade 2 tapers downwardly and forwardly. A leading face 41a of the primary blade 2 is perpendicular to the upper and lower surfaces and is provided with a shoulder 42 at its upper edge. The lower surface incorporates T-shaped slots 49a, 49b which engage T-shaped bars on the forming box.

[0031] The first secondary support blade 3 and first and second additional secondary support blades 4a, 4b are the same and are illustrated alone in Figure 5. A trailing face 21a of the first secondary support blade 3 and first and second additional secondary support blades 4a, 4b is perpendicular to the upper and lower surfaces and is provided with a chamfer 500 at its upper edge. A leading face 21b of the first secondary support blade 3 and first and second additional secondary support blades 4a, 4b is perpendicular to the upper and lower surfaces and is provided with a shoulder 501 at its upper edge. The first secondary support blade 3 and first and second additional secondary support blades 4a, 4b are the same thickness as the primary blade 2. The lower surface incorporates a T-shaped slot 59a which engages a T-shaped bar on the forming box.

[0032] The upper surfaces of the primary blade 2, the first secondary support blade 3 and the first and second consecutive additional secondary support blades 4a and 4b are substantially coplanar at a first height.

[0033] The first drainage deckle 5, first additional drainage deckle 6a and second additional drainage deckle 6b are essentially (but not precisely) the same and are illustrated alone in perspective view in Figure 6. The upper surfaces 65 of each of the first drainage deckle 5, first additional drainage deckle 6a and second additional drainage deckle 6b are at heights different from the common height of the primary blade 2, the first secondary support blade 3 and the first and second additional secondary support blade 4a, 4b whereby to define a discontinuous surface which is substantially irregularly stepped. Moreover the upper surface 65 of each of the first drainage deckle 5, first additional drainage deckle 6a and second additional drainage deckle 6b is angled at a different an-

gle in the range 1-4°. The difference between the heights creates voids 11a, 11b and 11c. The voids 11a, 11b and 11c and the variable angling of the upper surfaces 65 of the first drainage deckle 5, first additional drainage deckle 6a and second additional drainage deckle 6b contribute to the generation of micro-turbulence in the papermaking suspension.

[0034] The trailing face 21a of the first additional secondary support blade 4a is coupled to the leading face 21b of the first secondary support blade 3 by the first additional drainage deckle 6a and the trailing face 21a of the second additional secondary support blade 4b is coupled to the leading face 21b of the first additional secondary support blade 4a by the second additional drainage deckle 6b. The trailing face 1a of the first secondary support blade 3 is coupled to the leading face 41a of the primary blade 2 by the first drainage deckle 5.

[0035] The first drainage deckle 5 and first and second additional drainage deckles 6a, 6b couple the leading and trailing faces of the forming elements by a tongue and groove arrangement. For example, a trailing face 71a of the drainage deckle 5 bears a tongue 72 adapted to engage a complementarily shaped groove 73 on the leading face 41a of the primary blade 2 and the leading face 74a of the drainage deckle 5 bears a groove 75 adapted to be engaged by a complementarily shaped tongue 76 on the trailing edge of the first secondary support blade 3.

[0036] Figure 3 illustrates schematically an isolated side view of the assembly of forming elements 31 of a second embodiment of a papermaking apparatus of the invention which is particularly useful in slow speed papermaking apparatus. The assembly 31 is largely the same as the assembly 1 described for the first embodiment hereinbefore but has a different first drainage deckle 35 and first and second additional drainage deckles 36a, 36b (see Figure 7). Each of the first drainage deckle 35 and first and second additional drainage deckles 36a, 36b is adapted to introduce micro-turbulence into the papermaking suspension by extrinsic means. Each of the first drainage deckle 35 and first and second additional drainage deckles 36a, 36b comprises a closed end groove 301 extending downwardly from and transversely along the upper surface 300. To an end wall 302 of each of the first drainage deckle 35 and first and second additional drainage deckles 36a, 36b extends a first transverse circular slot 303 outwardly from the groove 301. To an opposing end wall 304 of each of the first drainage deckle 35 and first and second additional drainage deckles 36a, 36b extends a second transverse circular slot 305 outwardly from the groove 301. Through the slots 303, 305 may be transmitted pulses of water which reach the upper surface 300 through the groove 301 and generate micro-turbulence in the papermaking suspension.

[0037] To illustrate the general improvements in the generation of micro-turbulence, Figures 8 and 9 illustrate respectively a papermaking suspension during dewatering in a conventional papermaking apparatus and a pa-

permaking apparatus of the invention.

Claims

1. An assembly of forming elements (1) including:

a primary blade (2) capable of being positioned adjacent one or more supply means at the wet end of a papermaking apparatus;
a first secondary support blade (3) coupled to a leading face (41a) of the primary blade by a first drainage deckle (5); and
n consecutive additional secondary support blades (4a, 4b) and n consecutive additional drainage deckles (6a, 6b), wherein a trailing face (21a) of the first additional secondary support blade (4a) is coupled to a leading face (21b) of the first secondary support blade (3) by the first additional drainage deckle (6a) and a trailing face (21a) of the second to nth additional secondary support blades (4b) is coupled respectively to a leading face (21b) of the first to n-1th additional secondary support blades (4a) by the second to nth additional drainage deckle (6b) respectively, wherein n is an integer of one or more, wherein the upper surfaces (65) of at least one of the first drainage deckle and n consecutive additional drainage deckles is angled downwardly from trailing to leading edges of the upper surface,

whereby the upper surface of the primary blade, the first secondary support blade, the first drainage deckle, the n additional drainage deckles and the n additional secondary support blades together define a discontinuous surface for supporting a papermaking suspension being carried by a carrier from the wet end to an output end of the papermaking apparatus.

2. A papermaking apparatus capable of making a sheet of paper or board from a papermaking suspension, said apparatus comprising:

one or more supply means for introducing the papermaking suspension into a wet end of the apparatus;
a carrier for carrying the papermaking suspension from the wet end to an output end of the apparatus; and
an assembly of forming elements (1) as claimed in claim 1 wherein the primary blade (2) is positioned adjacent the one or more supply means.

3. A papermaking apparatus as claimed in claim 2 wherein the discontinuous supporting surface is irregularly discontinuous.

4. A papermaking apparatus as claimed in claim 2 or 3 wherein the discontinuous supporting surface is stepped
 5. A papermaking apparatus as claimed in any preceding claim 2 to 4 wherein the upper surfaces of the primary blade (2), the first secondary support blade (3) and the n consecutive additional secondary support blades (4a, 4b) are substantially coplanar at a first height and the upper surface (65) of at least one of the first drainage deckle (5) and n consecutive additional drainage deckles (6a, 6b) is at a height different from the first height.
 6. A papermaking apparatus as claimed in claim 5 wherein the upper surfaces of the primary blade (2), the first secondary support blade (3) and the n consecutive additional secondary support blades (4a, 4b) are substantially coplanar at a first height and the upper surface (65) of each of the first drainage deckle (5) and n consecutive additional drainage deckles (6a, 6b) is at a height different from the first height whereby to define a discontinuous surface which is stepped.
 7. A papermaking apparatus as claimed in claim 6 wherein the upper surfaces (65) of the first drainage deckle (5) and n consecutive additional drainage deckles (6a, 6b) are substantially coplanar at heights different from each other and from the first height whereby to define a discontinuous surface which is substantially irregularly stepped.
 8. A papermaking apparatus as claimed in claim 6 wherein the upper surfaces (65) of the first drainage deckle (5) and n consecutive additional drainage deckles (6a, 6b) are substantially coplanar at a common height different from the first height whereby to define a discontinuous surface which is substantially regularly stepped.
 9. A papermaking apparatus as claimed in any preceding claim 2 to 8 wherein at least one of the first drainage deckle (5) and n consecutive additional drainage deckles (6a, 6b) generates micro-turbulence in the papermaking suspension by extrinsic means.
 10. A papermaking apparatus as claimed in any preceding claim 2 to 9 wherein at least one of the first drainage deckle (5) and n additional drainage deckles (6a, 6b) is adapted to transmit a means for generating micro-turbulence in the papermaking suspension.
 11. A papermaking apparatus as claimed in any preceding claim 2 to 10 wherein the upper surface of at least one of the first drainage deckle (35) and n consecutive additional drainage deckles (36a, 36b) comprises a groove (301) adapted to transmit fluid onto its upper surface.
 12. A papermaking apparatus as claimed in claim 11 wherein the groove (301) is adapted to transmit pulses of fluid onto its upper surface.
 13. A papermaking apparatus as claimed in claim 11 or 12 wherein to an end wall (302) of at least one of the first drainage deckle (35) and n consecutive additional drainage deckles (36a, 36b) extends a transverse slot (303) outwardly from a transverse end wall of the groove (301).
 14. A papermaking apparatus as claimed in any of claims 11 to 13 wherein to a first and second end wall (302, 304) of at least one of the first drainage deckle (35) and n consecutive additional drainage deckles (36a, 36b) extends respectively a first and a second transverse slot (303, 305) outwardly from a first and second transverse end wall of the groove respectively.
 15. A method for constructing a papermaking apparatus as defined in any of claims 2 to 14 comprising:
 - (a) obtaining a conventional papermaking apparatus comprising one or more conventional forming elements in the forming area;
 - (b) substituting at least one of the one or more conventional forming elements with an assembly of forming elements (1) which include:
 - a primary blade (2) positioned adjacent the one or more supply means;
 - a first secondary support blade (3) coupled to a leading face (41a) of the primary blade by a first drainage deckle (5); and
 - n consecutive additional secondary support blades (4a, 4b) and n consecutive additional drainage deckles (6a, 6b), wherein a trailing face (21a) of the first additional secondary support blade (4a) is coupled to a leading face (21b) of the first secondary support blade (3) by the first additional drainage deckle (6a) and a trailing face (21a) of the second to nth additional secondary support blades (4b) is coupled respectively to a leading face (21 b) of the first to n-1th additional secondary support blades (4a) by the second to nth additional drainage deckle (6b) respectively, wherein n is an integer of one or more, wherein the upper surfaces (65) of at least one of the first drainage deckle and n consecutive additional drainage deckles is angled downwardly from trailing to leading edges of the upper surface
- whereby the upper surface of the primary blade, the

first secondary support blade, the first drainage deckle, the n additional drainage deckles and the n additional secondary support blades together define a discontinuous surface for supporting the paper-making suspension.

16. A kit of parts for forming an assembly of forming elements (1) as claimed in claim 1 or for forming an assembly of forming elements (1) for use with a papermaking apparatus according to any of the preceding claims 2-14.

Patentansprüche

1. Anordnung von Formierelementen (1) mit:

einer primären Streichleiste (2), die angrenzend an eine oder mehrere Zuführeinrichtungen in der Nasspartie einer Papiermaschine positioniert werden kann;
einer ersten sekundären Stütz-Streichleiste (3), die mit einer vorderen Seite (41 a) der primären Streichleiste durch eine erste Entwässerungsbegrenzung (5) verbunden ist; und
n aufeinanderfolgenden zusätzlichen sekundären Stütz-Streichleiste (4a, 4b) und n aufeinanderfolgenden zusätzlichen Entwässerungsbegrenzungen (6a, 6b), wobei eine hintere Seite (21a) der ersten zusätzlichen sekundären Stütz-Streichleiste (4a) mit einer vorderen Seite (21 b) der ersten sekundären Stütz-Streichleiste (3) durch die erste zusätzliche Entwässerungsbegrenzung (6a) verbunden ist und eine hintere Seite (21 a) der zweiten bis n-ten zusätzlichen sekundären Stütz-Streichleisten (4b) jeweils mit einer vorderen Seite (21 b) der ersten bis n-ten zusätzlichen sekundären Stütz-Streichleisten (4a) jeweils durch die zweiten bis n-ten zusätzlichen Entwässerungsbegrenzungen (6b) verbunden ist, wobei n eine ganze Zahl von Eins oder mehr ist, wobei die Oberseiten (65) von wenigstens einer der ersten Entwässerungsbegrenzung und der n aufeinanderfolgenden zusätzlichen Entwässerungsbegrenzungen ausgehend von hinteren zu vorderen Kanten der Oberseite nach unten abgewinkelt sind, wodurch die Oberseite der primären Streichleiste, der ersten sekundären Stütz-Streichleiste, der ersten Entwässerungsbegrenzung, der n zusätzlichen Entwässerungsbegrenzungen und der n zusätzlichen sekundären Stütz-Streichleisten zusammen eine diskontinuierliche Oberfläche zum Abstützen einer Papiersuspension definieren, die von einem Träger von der Nasspartie zu einem Ausgabeende der Papiermaschine getragen wird.

2. Papiermaschine, geeignet zur Herstellung einer Papier- oder Kartonbahn aus einer Papiersuspension, mit:

einer oder mehrerer Zuführeinrichtungen für das Einführen der Papiersuspension in eine Nasspartie der Maschine;
einen Träger zum Tragen der Papiersuspension von der Nasspartie zu einem Ausgabeende der Vorrichtung; und
eine Anordnung von Formierelementen (1) gemäß Anspruch 1, wobei die primäre Streichleiste (2) benachbart der einen oder mehreren Zuführeinrichtung(en) positioniert ist.

3. Papiermaschine nach Anspruch 2, wobei die diskontinuierliche Stützfläche unregelmäßig diskontinuierlich ist.

4. Papiermaschine nach Anspruch 2 oder 3, wobei die diskontinuierliche Stützfläche gestuft ist.

5. Papiermaschine nach einem der vorhergehenden Ansprüche 2 bis 4, wobei die Oberseiten der primären Streichleiste (2), der ersten sekundären Stütz-Streichleiste (3) und der n aufeinanderfolgenden zusätzlichen sekundären Stütz-Streichleisten (4a, 4b) im Wesentlichen koplanar bei einer ersten Höhe sind und sich die Oberseite (65) von wenigstens einer der ersten Entwässerungsbegrenzung (5) und der n aufeinanderfolgenden zusätzlichen Entwässerungsbegrenzungen (6a, 6b) auf einer Höhe befindet, die sich von der ersten Höhe unterscheidet.

6. Papiermaschine nach Anspruch 5, wobei die Oberseiten der primären Streichleiste (2), der ersten sekundären Stütz-Streichleiste (3) und der n aufeinanderfolgenden zusätzlichen sekundären Stütz-Streichleisten (4a, 4b) im Wesentlichen koplanar bei einer ersten Höhe sind und sich die Oberseiten (65) von der ersten Entwässerungsbegrenzung (5) und aller n aufeinanderfolgenden zusätzlichen Entwässerungsbegrenzungen (6a, 6b) auf einer Höhe befinden, die sich von der ersten Höhe unterscheidet, wodurch eine diskontinuierliche Oberfläche definiert wird, die gestuft ist.

7. Papiermaschine nach Anspruch 6, wobei die Oberseiten (65) der ersten Entwässerungsbegrenzung (5) und der n aufeinanderfolgenden zusätzlichen Entwässerungsbegrenzungen (6a, 6b) im Wesentlichen koplanar bei Höhen sind, die sich voneinander und von der ersten Höhe unterscheiden, wodurch eine diskontinuierliche Oberfläche definiert wird, die im Wesentlichen unregelmäßig gestuft ist.

8. Papiermaschine nach Anspruch 6, wobei die Oberseiten (65) der ersten Entwässerungsbegrenzung

- (5) und der n aufeinanderfolgenden zusätzlichen Entwässerungsbegrenzungen (6a, 6b) im Wesentlichen koplanar bei einer gemeinsamen Höhe sind, die sich von der ersten Höhe unterscheidet, wodurch eine diskontinuierliche Oberfläche definiert wird, die im Wesentlichen regelmäßig gestuft ist. 5
9. Papiermaschine nach einem der vorhergehenden Ansprüche 2 bis 8, wobei wenigstens eine von der ersten Entwässerungsbegrenzung (5) und der n aufeinanderfolgenden zusätzlichen Entwässerungsbegrenzungen (6a, 6b) eine Mikroturbulenz in der Papiersuspension durch extrinsische Mittel erzeugt. 10
10. Papiermaschine nach einem der vorhergehenden Ansprüche 2 bis 9, wobei wenigstens eine der ersten Entwässerungsbegrenzung (5) und der n aufeinanderfolgenden zusätzlichen Entwässerungsbegrenzungen (6a, 6b) ausgelegt ist, um ein Mittel zum Erzeugen von Mikroturbulenz in der Papiersuspension zu übertragen. 15 20
11. Papiermaschine nach einem der vorhergehenden Ansprüche 2 bis 10, wobei die Oberseite von wenigstens einer der ersten Entwässerungsbegrenzung (35) und der n aufeinanderfolgenden zusätzlichen Entwässerungsbegrenzungen (36a, 36b) eine Nut (301) umfasst, die ausgelegt ist, um ein Fluid auf ihre Oberseite zu übertragen. 25 30
12. Papiermaschine nach Anspruch 11, wobei die Nut (301) ausgelegt ist, um Fluid-Pulse auf ihre Oberseite zu übertragen.
13. Papiermaschine nach Anspruch 11 oder 12, wobei sich zu einer Endwand (302) von wenigstens einer der ersten Entwässerungsbegrenzung (35) und der n aufeinanderfolgenden zusätzlichen Entwässerungsbegrenzungen (36a, 36b) ein quer verlaufender Schlitz (303) nach außen gerichtet ausgehend von einer quer verlaufenden Endwand der Nut (301) erstreckt. 35 40
14. Papiermaschine nach einem der Ansprüche 11 bis 13, wobei sich zu einer ersten und einer zweiten Endwand (302, 304) von wenigstens einer der ersten Entwässerungsbegrenzung (35) und der n aufeinanderfolgenden zusätzlichen Entwässerungsbegrenzungen (36a, 36b) jeweils ein erster und ein zweiter quer verlaufender Schlitz (303, 305) nach außen gerichtet ausgehend von einer ersten bzw. einer zweiten quer verlaufenden Endwand der Nut erstrecken. 45 50
15. Verfahren zum Bauen einer Papiermaschine gemäß einem der Ansprüche 2 bis 14, umfassend: 55

(a) Beziehen einer herkömmlichen Papierma-

schine, die ein oder mehrere herkömmliche Formierelemente in dem Formierungsbereich aufweist;

(b) das Ersetzen wenigstens eines der einen oder mehreren herkömmlichen Formierelemente durch eine Anordnung von Formierelementen (1), die enthalten:

eine primäre Streichleiste (2), die benachbarten der einen oder mehreren Zuführeinrichtung(en) positioniert ist;

eine erste sekundäre Stütz-Streichleiste (3), die mit einer vorderen Seite (41 a) der primären Streichleiste durch eine erste Entwässerungsbegrenzung (5) verbunden ist; und

n aufeinanderfolgende zusätzliche sekundäre Stütz-Streichleisten (4a, 4b) und n aufeinanderfolgende zusätzliche Entwässerungsbegrenzungen (6a, 6b), wobei eine hintere Seite (21 a) der ersten zusätzlichen sekundären Stütz-Streichleiste (4a) mit einer vorderen Seite (21 b) der ersten sekundären Stütz-Streichleiste (3) durch die erste zusätzliche Entwässerungsbegrenzung (6a) verbunden ist und eine hintere Seite (21 a) der zweiten bis n-ten zusätzlichen sekundären Stütz-Streichleisten (4b) jeweils mit einer vorderen Seite (21 b) der ersten bis n-ten zusätzlichen sekundären Stütz-Streichleisten (4a) jeweils durch die zweiten bis n-ten zusätzlichen Entwässerungsbegrenzungen (6b) verbunden ist, wobei n eine ganze Zahl von Eins oder mehr ist, wobei die Oberseiten (65) von wenigstens einer der ersten Entwässerungsbegrenzung und der n aufeinanderfolgenden zusätzlichen Entwässerungsbegrenzungen ausgehend von hinteren zu vorderen Kanten der Oberseite nach unten abgewinkelt sind, wodurch die Oberseite der primären Streichleiste, der ersten sekundären Stütz-Streichleiste, der ersten Entwässerungsbegrenzung, der n zusätzlichen Entwässerungsbegrenzungen und der n zusätzlichen sekundären Stütz-Streichleiste zusammen eine diskontinuierliche Oberfläche zum Abstützen der Papiersuspension definieren.

16. Bausatz für das Bilden einer Anordnung von Formierelementen (1), gemäß Anspruch 1, oder für das Bilden einer Anordnung von Formierelementen (1) für die Verwendung mit einer Papiermaschine nach einem der Ansprüche 2 bis 14.

Revendications

1. Ensemble d'éléments de formage (1) comprenant :

une lame principale (2) pouvant être positionnée de manière adjacente à un ou plusieurs moyens d'alimentation au niveau de l'extrémité mouillée d'un appareil de fabrication de papier ;
une première lame de support secondaire (3) couplée à une face d'attaque (41 a) de la lame principale par un premier tiroir de drainage (5) ;
et
n lames de support secondaires supplémentaires consécutives (4a, 4b) et n tiroirs de drainage supplémentaires consécutifs (6a, 6b), dans lequel une face de fuite (21a) de la première lame de support secondaire supplémentaire (4a) est couplée à une face d'attaque (21 b) de la première lame de support secondaire (3) par le premier tiroir de drainage supplémentaire (6a) et une face de fuite (21 a) de la deuxième des n^{ième} lames de support secondaires supplémentaires (4b) est couplée respectivement à une face d'attaque (21 b) de la première des n-1^{ième} lames de support secondaires supplémentaires (4a) par le deuxième des n^{ième} tiroirs de drainage supplémentaires (6b) respectivement, dans lequel n est un nombre entier d'un ou plus, dans lequel les surfaces supérieures (65) d'au moins l'un parmi le premier tiroir de drainage et n tiroirs de drainage supplémentaires consécutifs sont coudées vers le bas des bords de fuite aux bords d'attaque de la surface supérieure, moyennant quoi la surface supérieure de la lame principale, la première lame de support secondaire, le premier tiroir de drainage, les n tiroirs de drainage supplémentaires et les n lames de support secondaires supplémentaires définissent ensemble une surface discontinue pour supporter une suspension de fabrication de papier qui est transportée par un transporteur de l'extrémité mouillée à une extrémité de sortie de l'appareil de fabrication de papier.

2. Appareil de fabrication de papier pouvant fabriquer une feuille de papier ou de carton à partir d'une suspension de fabrication de papier, ledit appareil comprenant :

un ou plusieurs moyens d'alimentation pour introduire la suspension de fabrication de papier dans une extrémité mouillée de l'appareil ;
un transporteur pour transporter la suspension de fabrication de papier de l'extrémité mouillée à une extrémité de sortie de l'appareil ; et
un ensemble d'éléments de formage (1) selon la revendication 1, dans lequel la lame principale (2) est positionnée de manière adjacente aux

un ou plusieurs moyens d'alimentation.

3. Appareil de fabrication de papier selon la revendication 2, dans lequel la surface de support discontinue est irrégulièrement discontinue.

4. Appareil de fabrication de papier selon la revendication 2 ou 3, dans lequel la surface de support discontinue est étagée.

5. Appareil de fabrication de papier selon l'une quelconque des revendications 2 à 4 précédentes, dans lequel les surfaces supérieures de la lame principale (2), de la première lame de support secondaire (3) et des n lames de support secondaires supplémentaires consécutives (4a, 4b) sont sensiblement coplanaires à une première hauteur et la surface supérieure (65) d'au moins l'un parmi le premier tiroir de drainage (5) et les n tiroirs de drainage supplémentaires consécutifs (6a, 6b) est à une hauteur différente de la première hauteur.

6. Appareil de fabrication de papier selon la revendication 5, dans lequel les surfaces supérieures de la lame principale (2), de la première lame de support secondaire (3) et des n lames de support secondaires supplémentaires consécutives (4a, 4b) sont sensiblement coplanaires à une première hauteur et la surface supérieure (65) de chacun parmi le premier tiroir de drainage (5) et les n tiroirs de drainage supplémentaires consécutifs (6a, 6b) est à une hauteur différente de la première hauteur afin de définir une surface discontinue qui est étagée.

7. Appareil de fabrication de papier selon la revendication 6, dans lequel les surfaces supérieures (65) du premier tiroir de drainage (5) et des n tiroirs de drainage supplémentaires consécutifs (6a, 6b) sont sensiblement coplanaires à des hauteurs différentes les unes des autres et de la première hauteur afin de définir une surface discontinue qui est étagée de manière sensiblement irrégulière.

8. Appareil de fabrication de papier selon la revendication 6, dans lequel les surfaces supérieures (65) du premier tiroir de drainage (5) et des n tiroirs de drainage supplémentaires consécutifs (6a, 6b) sont sensiblement coplanaires à une hauteur commune différente de la première hauteur afin de définir une surface discontinue qui est étagée de manière sensiblement régulière.

9. Appareil de fabrication de papier selon l'une quelconque des revendications 2 à 8 précédentes, dans lequel au moins l'un parmi le premier tiroir de drainage (5) et les n tiroirs de drainage supplémentaires consécutifs (6a, 6b) génère une micro-turbulence dans une suspension de fabrication de papier par

des moyens extrinsèques.

10. Appareil de fabrication de papier selon l'une quelconque des revendications 2 à 9 précédentes, dans lequel au moins l'un parmi le premier tiroir de drainage (5) et les n tiroirs de drainage supplémentaires (6a, 6b) est adapté pour transmettre des moyens pour générer une micro-turbulence dans la suspension de fabrication de papier. 5
11. Appareil de fabrication de papier selon l'une quelconque des revendications 2 à 10 précédentes, dans lequel la surface supérieure d'au moins l'un parmi le premier tiroir de drainage (35) et les n tiroirs de drainage supplémentaires consécutifs (36a, 36b) comprend une rainure (301) adaptée pour transmettre du fluide sur sa surface supérieure. 10 15
12. Appareil de fabrication de papier selon la revendication 11, dans lequel la rainure (301) est adaptée pour transmettre des impulsions de fluide sur sa surface supérieure. 20
13. Appareil de fabrication de papier selon la revendication 11 ou 12, dans lequel, une fente transversale (303) s'étend vers l'extérieur à partir d'une paroi d'extrémité transversale de la rainure (301) jusqu'à une paroi d'extrémité (302) d'au moins l'un parmi le premier tiroir de drainage (35) et les n tiroirs de drainage supplémentaires consécutifs (36a, 36b). 25 30
14. Appareil de fabrication de papier selon l'une quelconque des revendications 11 à 13, dans lequel une première et une deuxième fente transversale (303, 305) s'étendent respectivement vers l'extérieur à partir d'une première et d'une deuxième paroi d'extrémité transversale de la rainure, respectivement jusqu'à une première et une deuxième paroi d'extrémité (302, 304) d'au moins l'un parmi le premier tiroir de drainage (35) et les n tiroirs de drainage supplémentaires consécutifs (36a, 36b). 35 40
15. Procédé pour construire un appareil de fabrication de papier selon l'une quelconque des revendications 2 à 14, comprenant les étapes consistant à: 45
 - (a) obtenir un appareil de fabrication de papier classique comprenant un ou plusieurs éléments de formage classiques dans la zone de formage ; 50
 - (b) remplacer au moins l'un parmi les un ou plusieurs éléments de formage classique par un assemblage d'éléments de formage (1) qui comprend : 55

une lame principale (2) positionnée de manière adjacente à un ou plusieurs moyens d'alimentation ;

une première lame de support secondaire (3) couplée à une face d'attaque (41 a) de la lame principale par un premier tiroir de drainage (5) ; et

n lames de support secondaires supplémentaires consécutives (4a, 4b) et n tiroirs de drainage supplémentaires consécutifs (6a, 6b), dans lequel une face de fuite (21 a) de la première lame de support secondaire supplémentaire (4a) est couplée à une face d'attaque (21 b) de la première lame de support secondaire (3) par le premier tiroir de drainage supplémentaire (6a) et une face de fuite (21a) de la deuxième des n^{ième} lames de support secondaires supplémentaires (4b) est couplée respectivement à une face d'attaque (21 b) de la première des n-1^o lames de support secondaires supplémentaires (4a) par le deuxième des n^{ième} tiroirs de drainage supplémentaires (6b) respectivement, dans lequel n est un nombre entier d'un ou plus, dans lequel les surfaces supérieures (65) d'au moins l'un parmi le premier tiroir de drainage et les n tiroirs de drainage supplémentaires consécutifs sont coudées vers le bas des bords de fuite aux bords d'attaque de la surface supérieure,

moyennant quoi la surface supérieure de la lame principale, la première lame de support secondaire, le premier tiroir de drainage, les n tiroirs de drainage supplémentaires et les n lames de support secondaires supplémentaires définissent ensemble une surface discontinue pour supporter une suspension de fabrication de papier.

16. Ensemble de pièces pour former un ensemble d'éléments de formage (1) selon la revendication 1 ou pour former un ensemble d'éléments de formage (1) destiné à être utilisé avec un appareil de fabrication de papier selon l'une quelconque des revendications 2 à 14 précédentes.

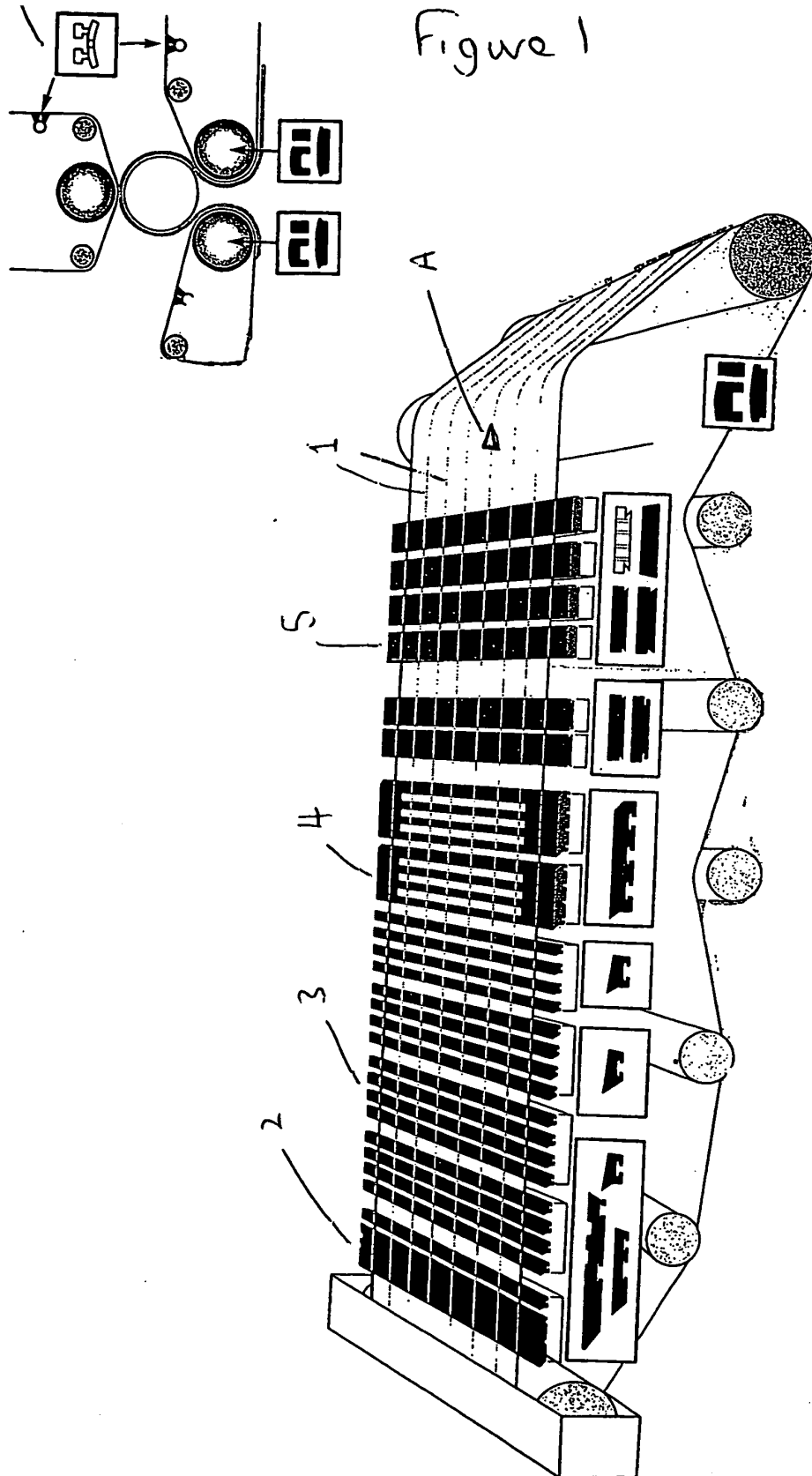


Figure 2

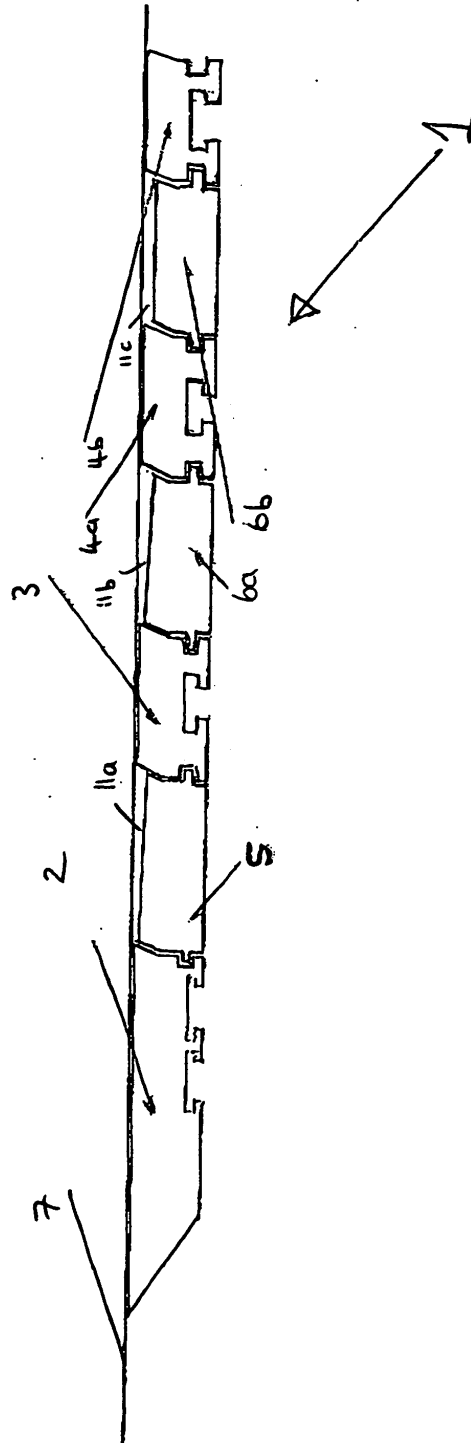


Figure 3

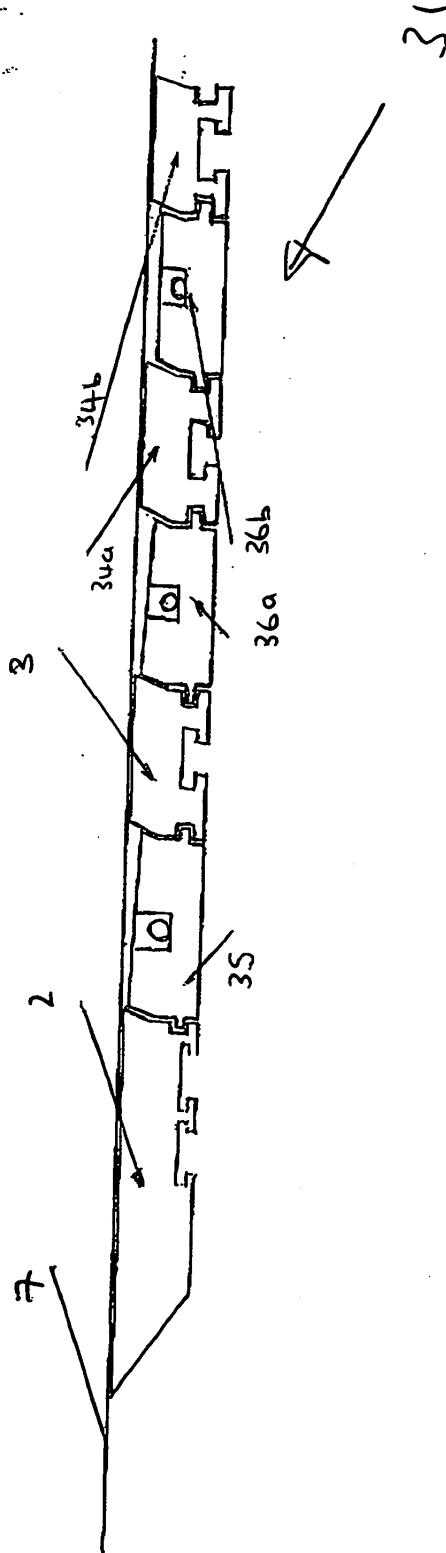
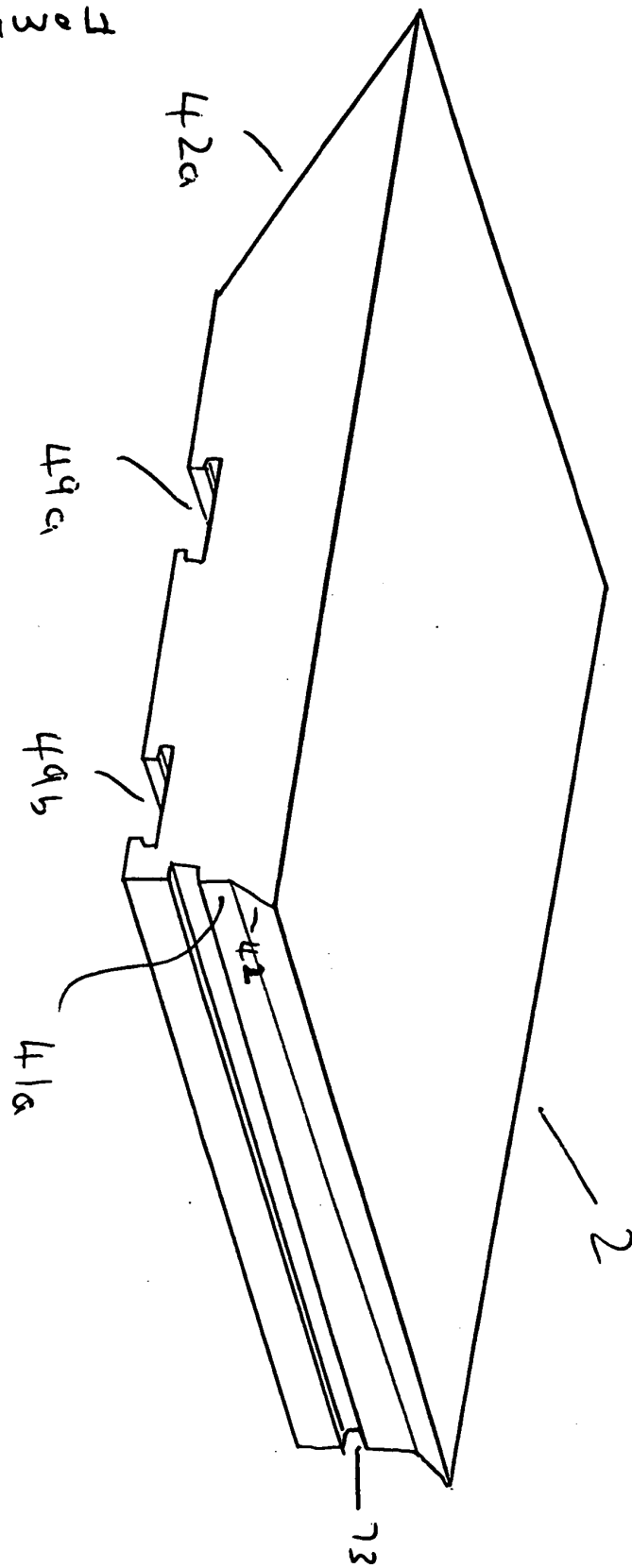
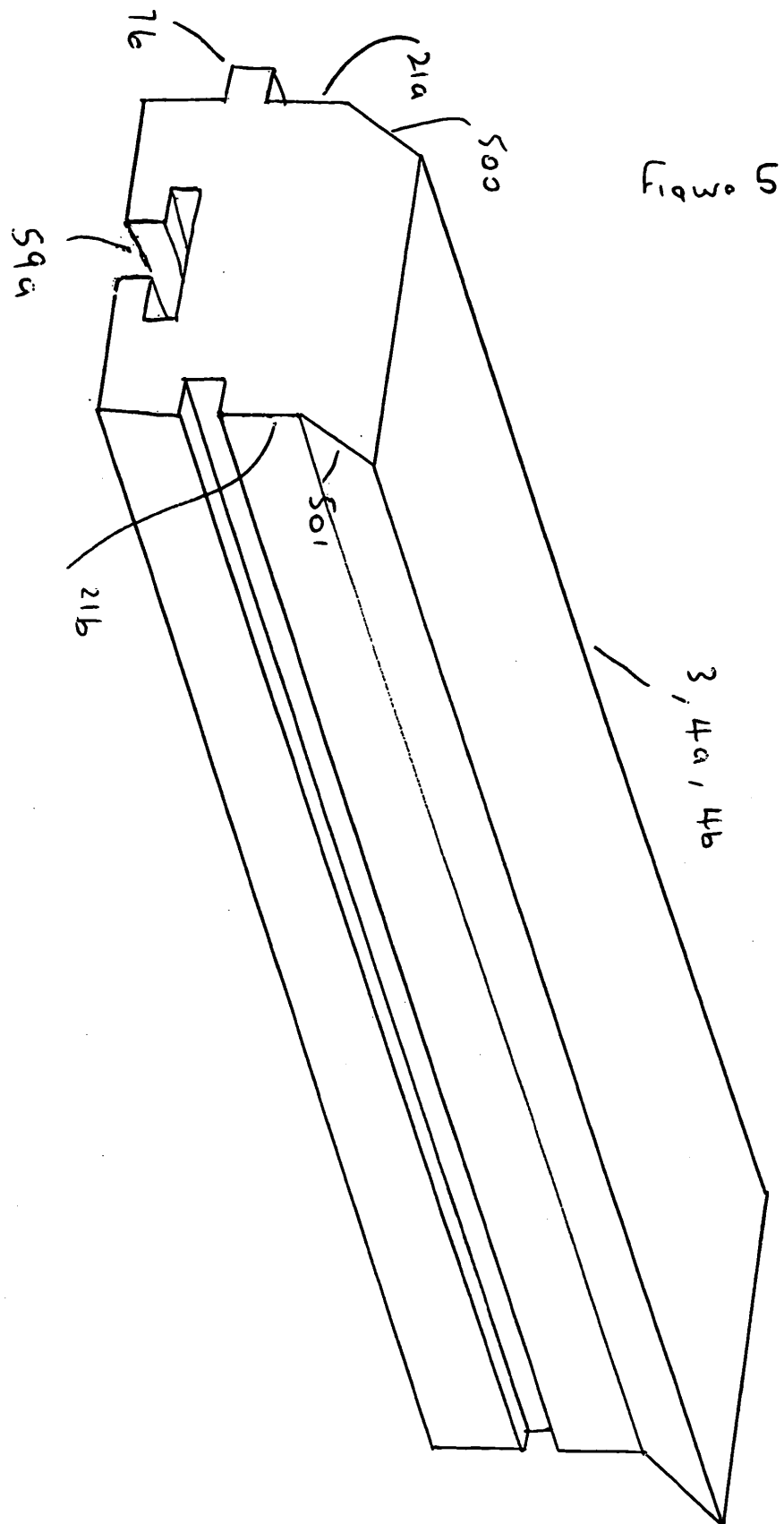


Figure 4





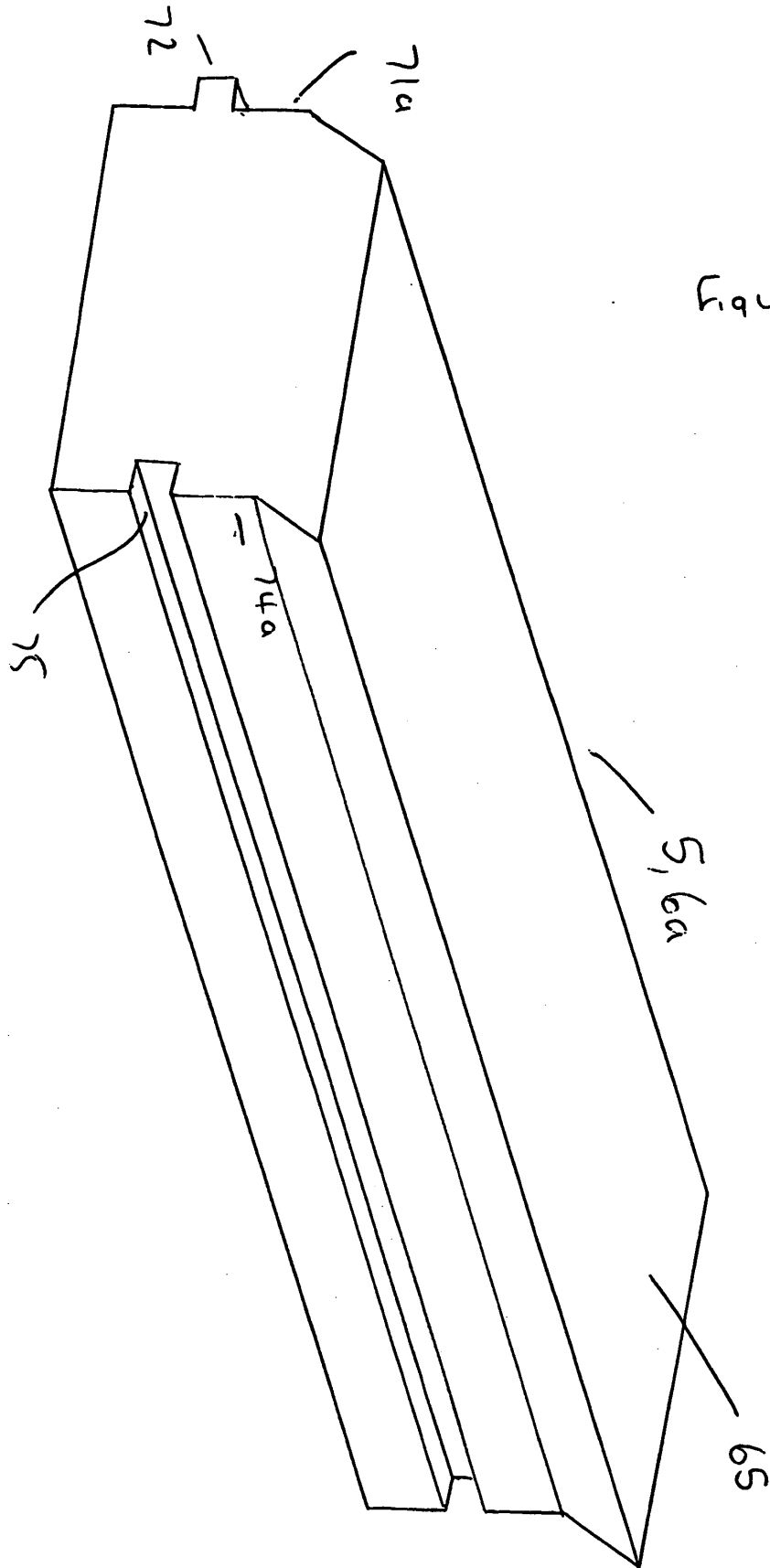
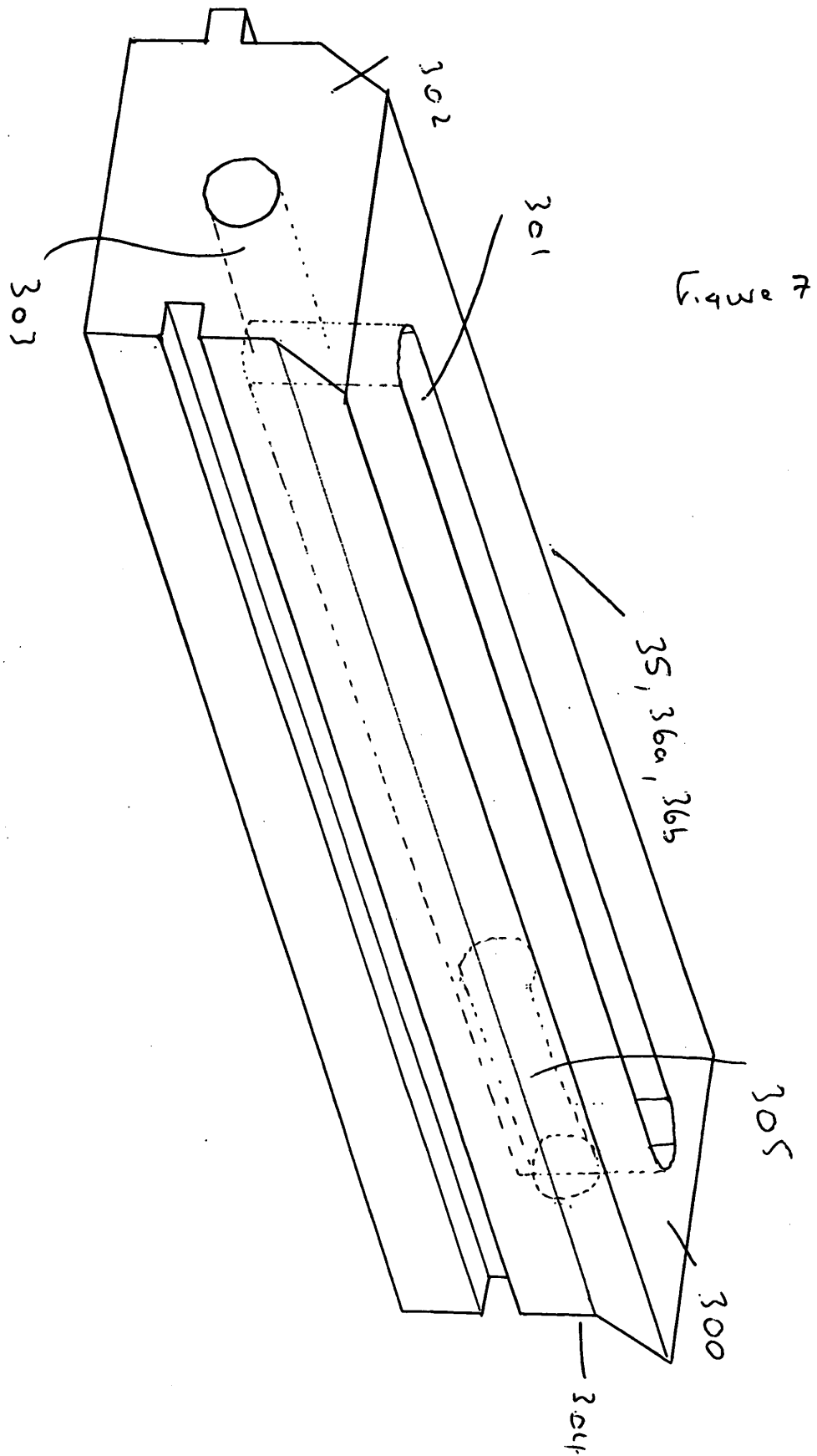


Figure 6



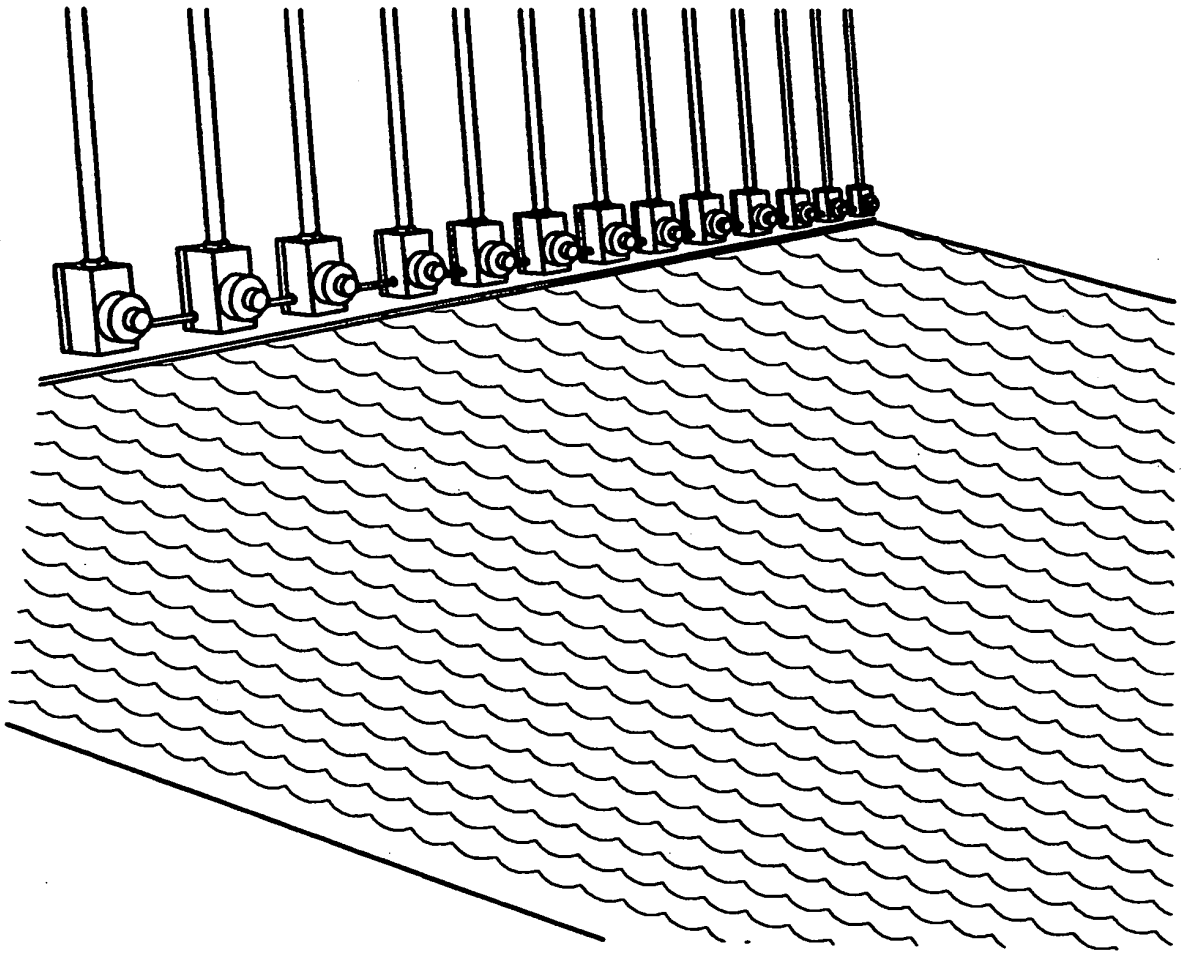


FIG. 8

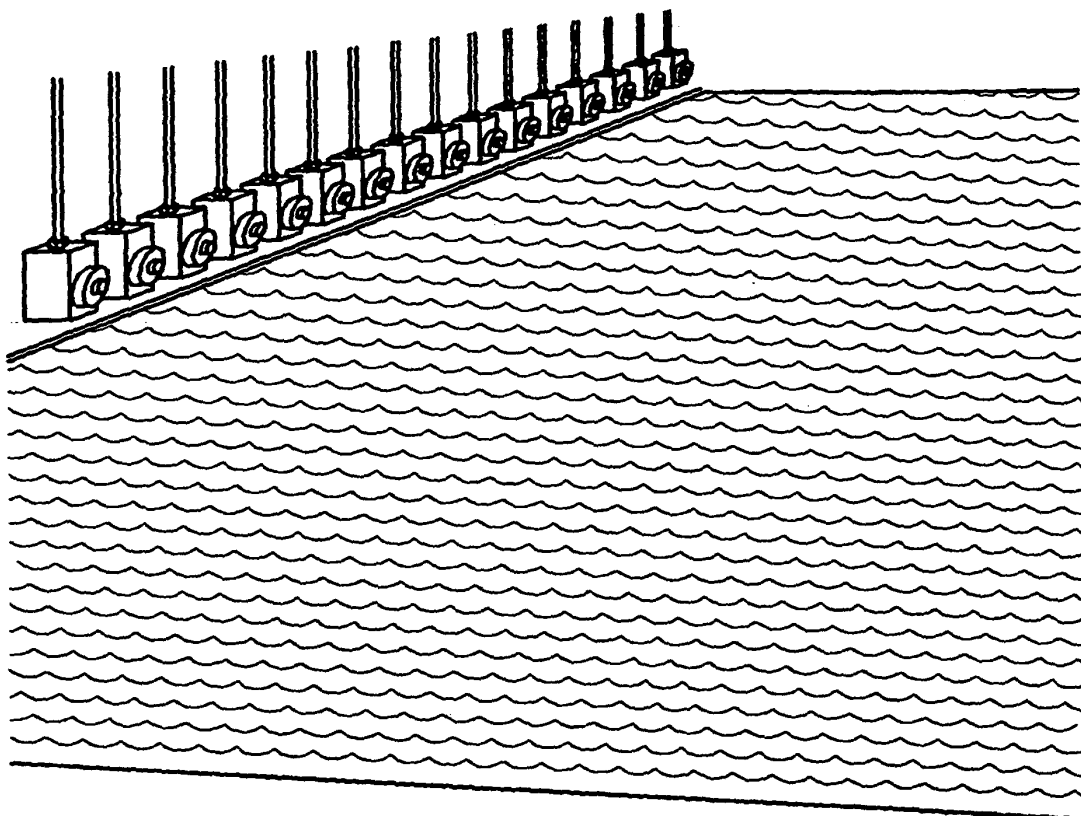


FIG. 9

REFERENCES CITED IN THE DESCRIPTION

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