(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: 0 060 949
A1

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: 81301273.9

(22) Date of filing: 25.03.81

(51) Int. Cl.³: D 21 H 5/26
D 04 H 1/72

(43) Date of publication of application:
29.09.82 Bulletin 82/39

(84) Designated Contracting States:
DE FR SE

(71) Applicant: AMERICAN CAN COMPANY
American Lane
Greenwich, Connecticut 06830(US)

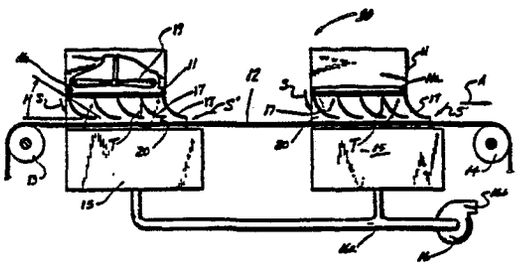
(72) Inventor: Dunkerly, Cedric A.
1219 East Marquette Street
Appleton Wisconsin 54911(US)

(74) Representative: Harvey, David G. et al,
Graham Watt & Co. Riverhead
Sevenoaks Kent TN13 2BN(GB)

(54) Apparatus for the manufacture of fibrous webs and method therefor.

(57) Fibrous web formation involves drawing fibers onto a travelling forming wire (12) from one or more overheat fiber distributors (11) with the aid of air draught created by one or more suction boxes (15) disposed beneath the wire (12) and beneath the distributor(s) (11). Production of smooth, ripple-free webs is favoured by imparting to the fibers as they leave the distributor(s) (11) a velocity component in the direction of travel of the forming wire (12) so that they impinge on the wire at an angle thereto of 21 to 30 degrees. The wire should travel at speeds in excess of 500 feet per minute (2.54 m/sec) and the air draught through the wire should be in excess of 250 feet per minute (1.27 m/sec).

FIG.1



EP 0 060 949 A1

"APPARATUS FOR THE MANUFACTURE OF FIBROUS WEBS AND METHOD THEREFOR"

This invention relates to improvements in apparatus and methods for the manufacture of fibrous webs, such as paper and the like. More particularly, but not exclusively, the invention is directed to improvements in the manufacture of tissue by the air-laying principle.

In the manufacture of fibrous webs such as paper by the air-laying principle, care must be taken to ensure uniformity of distribution of fibers on a forming wire. Air laid fibrous webs have an undesirable tendency to form ripples that extend transversely of the forming wire whereby the web is weakened in the machine direction. These ripples form when attempts are made to operate at economical, high forming wire velocities in excess of a range from about 500 feet per minute (2.54 meters per second) to about 550 feet per minute (2.79 m/sec) and at economical air velocities in a range of from about 250 to about 300 feet per minute (1.27 to 1.52 m/sec) through the forming wire. The ripples do not tend to form at lesser forming wire velocities.

U.S. Patent No. 4,004,333 discloses, in Figure 2, a formation duct 22A disposed at an angle

of incidence B to a linear foraminous forming surface 24A, angle B being in a range of from about 10 degrees to about 30 degrees, most preferably about 20 degrees. The patent further discloses that front and rear inner surfaces identified by references 32A and 34A be divergent at an angle of about 1 1/2 degrees, but preferably that they be parallel; and that the forming surface speed may be in excess of 200 feet per minute (1.01 m/sec). The velocity of air through the forming surface, the relative velocity of the fibers with respect to the forming surface in the direction of movement of the latter, and their practical importance in successful air laying are ignored.

U.S. Patent No. 4,035,870 discloses a fiber conduit 10 and a forming bell 14 coaxially aligned along an axis disposed at an acute angle to the forming surface 16 of a wire 17 so that fibers are deposited on surface 16 in a direction having a vector component coinciding with the direction of movement of surface 16.

U.S. Patent No. 3,748,693 discloses vanes 54 in a suction box 34 having upstream and downstream air outlets 38. The vanes 54 extend transversely of the direction of movement of a forming wire 30 and are selectively adjustable to differentially restrict

air flow through wire 30 so as to vary web thickness.

By this invention we have sought to provide an improved apparatus and method for the manufacture of air-laid fiber webs, wherein the webs produced are substantially devoid of ripples. Improved means for uniformly distributing fibrous material onto a forming wire of apparatus for the manufacture of fibrous webs is disclosed hereinafter.

The invention provides an apparatus for the manufacture of fiber webs, comprising a dry fibers distributor means, a forming wire, a planar section of which is disposed beneath the distributor means and is linearly movable at a predetermined first velocity and a suction box disposed beneath the planar forming wire section for drawing air through the forming wire at a predetermined second velocity normal to the said planar section, characterised by means for imparting a horizontal velocity component less than the first velocity to fibers in the direction of movement of said forming wire, to cause the fibers to impinge upon the forming wire at an angle of from 21 degrees to 30 degrees, the said second velocity being in excess of about 250 feet per minute (1.27 m/sec), and the first velocity

is in excess of about 500 feet per minute (2.54 m/sec).

For example, the invention provides an apparatus for the manufacture of fibrous webs, comprising dry fiber distributor means having a bottom, horizontally extending opening, a forming wire having a planar section disposed beneath the said opening and linearly movable at a predetermined first velocity and a suction box beneath the said planar section for drawing air through the said forming wire at a predetermined second velocity component normal to the forming wire, characterised in that the suction box is defined in part by parallel upstream and downstream walls that extend transversely of the direction of movement of the forming wire and are inclined downwardly in the said direction of movement at an angle in a range of 21 degrees to 30 degrees to the horizontal, an upper edge of the downstream wall being spaced downstream of the distributor bottom opening and thereby providing a gap extending transversely of the direction of forming wire movement, an outlet port being disposed in a lower region of the suction box adjacent a lower edge of the downstream wall

and a sealing roll being provided extending transversely of the forming wire movement and partially covering the said gap, the apparatus in use being characterised in that a horizontal velocity component less than said first velocity is imparted to air and fibers in the direction of movement of said forming wire.

The invention also provides a method for forming dry fibers into a fibrous web which is substantially devoid of transverse ripples, comprising the steps of directing fibers in a stream onto a planar section of a forming wire while moving the latter at a velocity in excess of 500 feet per minute (2.54 m/sec), maintaining the angle of impingement of the said stream on the planar section in a range from 21 degrees to 30 degrees, and maintaining a pressure drop through the said planar section by causing air to flow therethrough at a velocity normal to the planar section in excess of 250 feet per minute (1.27 m/sec).

The invention will now be described in more detail, by way of example, with reference to the drawings, in which:

Figure 1 is a diagrammatic elevational showing,

with parts fragmented and parts in section, of fibrous web forming apparatus embodying the invention and useful in carrying out the method according to the invention; and

Figures 2 to 8 are showings similar to Figure 1, and illustrating modified embodiments of the apparatus.

Figure 1 shows an apparatus 10 for forming a web of fibrous material, the apparatus comprising a set of dry fiber distributors 11 each including an impeller one of which is seen at 19. The impellers 19 are positioned above a horizontally-extending planar section of a forming wire 12 that is supported for movement on suitably mounted rollers 13 and 14 rotatable for movement of the upper flight of the forming wire in the direction of arrow A. The forming wire 12 in use travels at a predetermined velocity V_1. Suction boxes 15 are disposed beneath forming wire 12, and each is offset at its right-hand, trailing edge in the downstream direction of movement of the wire (i.e., the "machine direction") with respect to the corresponding edge of the distributor 11. A pair of parallel deckles or side plates are provided along the sides of forming wire 12 at each distributor 11, only one plate 20 of each

pair being shown. A blower 16 has its inlet 16a connected to suction boxes 15 and its discharge 16b exits to atmosphere. Blower 16 is operative to create an air flow downwardly through the horizontal, upper flight section of the forming wire 12, the air flow being normal thereto, and at a velocity V_2, which is about 250 feet per minute or preferably in excess of 250 feet per minute (1.27 m/sec).

An array of arcuate vanes 17 extends across the bottom opening 11a of each of the distributors 11 between plates 20. Vanes 17 of each array are parallel, are mutually equally spaced and extend transversely of the direction of movement A of the forming wire 12. Each vane 17 is a 90^{o} segment of a hollow right circular cylinder, and is so positioned that the tangent to the upper edge is substantially perpendicular to the plane of opening 11a, i.e. substantially parallel to the flow of air and fibers from the distributor, and the tangent to the lower edge is substantially parallel to the direction of movement of the forming wire, and spaced preferably about 1/4 inch (6.3 mm) above the latter. The vanes are spaced one from the other so that the tangent T to the upper edge of one vane intersects the lower edge region of the next upstream vane, i.e. the next

vane to the left as viewed in Fig. 1.

In accordance with the invention, the above-described trailing-edge offset portion of suction boxes 15, in combination with the shape and disposition of vanes 17, is such as to impart a horizontal velocity component V_3 to the air, and to the air-entrained fibers flowing between the bottom openings 11a of distributors 11 and the surface of forming wire 12 via the spaces between the vanes 17. Ambient air drawn in at S enhances the horizontal component V_3, while ambient air drawn in at S' aids in holding the web on the forming wire. This will be the case for the several embodiments where indicated. The horizontal velocity component V_3 is less than the velocity V_1 of the forming wire, the latter being preferably in excess of about 500 feet per minute (2.54 m/sec). The amount of offset is such as to create an air and dry-fiber flow (from openings 11a to the forming wire 12) which extends downwardly and in the direction of travel of the forming-wire at an angle H in a range of from 21 degrees to 30 degrees measured from the horizontally extending upper flight of the forming wire. Such an acute angle of fiber impingement on the wire 12 is based on the finding that successful web formation, free of

ripples extending transversely of the forming wire (i.e., across its width and across the machine direction) is achieved if the ratio of the total magnitude of the tangential velocity relative to the forming wire 12 (i.e. V_1-V_3) to that of the through air velocity normal to the forming wire (i.e. V_2) induced by the suction box does not exceed about 2.5:1, wherein 2.5 is the cotangent of acute angle H and is approximately equal to 22 degrees. The web (not shown) formed on the wire 12 is removed from the wire 12 by suitable transfer apparatus of known construction (not shown), prior to movement of the wire over pulley 14.

In the embodiment shown in Figure 2, apparatus 110 includes distributors 111, only one of which is shown, beneath which there is a planar section of a forming wire 112 movable in the direction A at a predetermined velocity V_1. Suction box 115 is disposed directly below wire 112, and again is in registry with distributor 111 at its upstream end, but is offset at its right-hand, downstream end or trailing edge. The desired advantageous angular flow of fibers from opening 111a onto wire 112 is achieved by an array of parallel, mutually equally spaced flat vanes or baffle plates 117 extending across the

opening 111a in a direction transverse to the direction of wire travel A and at an acute angle H to the horizontally extending forming wire, which angle is in the range of from 21 degrees to 30 degrees. Vanes 117 preferably are disposed so that their upper ends are vertically aligned with a flat portion of an adjacent upstream vane. This disposition and angular relationship, in combination with the velocity V_2 of air normal to the forming wire 112, imparts the desired horizontal velocity component V_3 to the fibers as described above.

The embodiment 210 shown in Figure 3 includes a distributor 211 having an outlet opening 211a disposed in registry with the suction box 215. Forming wire 212 is movable in the direction A, as in the above-described embodiments, and side plates 220 extend between the distributor and the forming wire. This embodiment is characterized by a baffle plate 215a extending horizontally from the left-hand or leading edge of suction box 215 and over a portion of the upper horizontal suction box opening 215b located beneath the forming wire. Baffle plate 215a extends transversely of the direction of movement A of the wire 212, and is so dimensioned in direction A that a line intersecting the left edge E of opening

211a of distributor 211 and the free edge E' of the baffle plate 215a is at an acute angle H in order to achieve the desired angular air flow. The desired inclined air flow is further encouraged by the disposition of air outlet port P-2 of the suction box 215 in a downstream region thereof.

Still another embodiment 310 shown in Figure 4 includes a distributor 311 and side plates 320, as described above, and a forming wire 312 movable thereunder in the direction A. A suction box 315 is disposed beneath the forming wire, in substantial registry with the distributor. A vertical partition 315a extends transversely across the suction box beneath the forming wire 312, and is located toward the upstream side of the suction box with respect to the forming-wire movement. The upper edge F of vertical baffle plate 315a is so positioned that a line touching it and the leading edge F' of distributor opening 311a is at an acute angle H of about 30 degrees to the horizontal. Outlet port P-3 is disposed in the right-hand, downstream region of suction box 315, so that flow of air through the outlet port to the inlet of the suction pump (not shown) further ensures achievement of the above described desired inclined flow of air and fiber. A cleanout port C is

provided to facilitate removal of any fibers or dust falling into the dead-zone between baffle plate 315a and the upstream wall of the suction box 315.

A still further embodiment 410 is shown in Figure 5, and comprises a forming wire 412 movable in the direction A beneath the opening 411a of a distributor 411 provided with side plates 420. A suction box 415 is disposed beneath wire 412, in registry with distributor 411. The suction box 415 includes an endless belt 415c movable in the direction of arrow B over sprocketed rollers R and R', and the belt being disposed upstream of the direction of wire movement A while extending transversely of that direction of movement. Outlet port P-4 in the region downstream of belt 415e leads to inlet 416a of a suction pump in order to achieve non-uniform flow, at a predetermined desired acute angle H to the horizontal, is achieved through the blanking action of belt 415c. A rotatable brush 418 engages the lower run of belt 415c continuously to dislodge any dust or fibers passing through forming wire 412 and landing on the belt. A line again touching or passing through the upstream edge of distributor opening 411a and tangential to the downstream end of the belt defines angle H with the horizontal.

The embodiment 510 shown in Figure 6 is similar to the Figure 5 embodiment in having side plates 520, and a forming wire 512 movable in the direction indicated by arrow A beneath opening 511a of a fiber distributor 511. A suction box 515 is disposed beneath the forming wire, in registry with distributor 511. The suction box 515 includes an outlet port P-6 adjacent the downstream side of suction box 515 and leading to inlet 516a of a suction pump in order to achieve flow through forming wire 512, at a predetermined acute angle H to the horizontal. A belt 515a is movable over sprocketed rollers R" transversely of the forming wire, and enhances deflection of fiber and air flow between the distributor 511 and the forming wire 512. A rotatable brush 515c is operative to clean the lower run of the belt 515a, advantageously disposing of the accumulation of dust and fibers thereon that normally results from sifting through the forming wire.

The embodiment 610 seen in Figure 7 includes a distributor 611 with side plates and having its bottom opening 611a disposed above a forming wire 612 movable in the direction of arrow A. A suction box 615 is disposed beneath the forming wire so that its upper opening, which is slightly larger than the

opening 611a, has its upstream or leading edge aligned with the corresponding edge of opening 611a; its downstream or trailing edge is disposed slightly downstream of opening 611a. A sealing roll 618 is positioned for rotation on an axis extending transversely of the forming wire, so that its upper left quadrant is close to the edge of opening 611a and its lowermost surface is in substantial line contact with a web in use formed on wire 612. Further to the construction of the suction box 615, there is a space between the trailing edge of its opening and roll 618. The box 615 is of generally parallelogram shape viewed from the side and its upstream and downstream walls 615d and 615e, both slope downwardly and in the downstream direction at an angle of about 30 degrees to the horizontal. Outlet port P-7 is disposed in a downstream corner of the suction box. The construction and arrangement of this embodiment is such that air and fibers will impinge onto forming wire 612 at an acute angle H of about 30 degrees.

The embodiment shown in Figure 8 comprises apparatus 710 similar to that shown in Figure 7, including the construction of distributor 711 and its opening 711a, forming wire 712 and its direction of

travel A, side walls 720, and the provision of a sealing roll 718. Suction box 715 is substantially of trapezoidal shape and has a trailing, sloping wall 715e disposed with its upper edge slightly downstream of sealing roll 718. The suction box 715 also has an upstream, sloping wall 715d with its upper edge spaced slightly downstream from the leading edge of opening 711a, this wall constituting a partition within the box 715. The suction box 715 also includes an upstream extension defined by a vertical wall 715f in combination with wall 715d and an extension parallel to 715g of the bottom wall of the suction box. A cleanout port C-7 communicates with the suction box extension, which is in fact a dead space, and is used continuously or periodically to remove dust and fibers from this space. Outlet port P-8 is disposed in a downstream corner of suction box 715, and is cooperative with the other described structure to induce impingement of fibers at an acute angle H of from 21 degrees to 30 degrees onto forming wire 712.

While no sealing means are shown on the downstream sides of the forming heads shown in FIGURES 3, 4, 5 and 6, one skilled in the art will appreciate that sealing means may be provided, such

as those shown in FIGURES 1, 2, 7 and 8. Choice of the specific design is determined in each case to best cooperate with the remainder of the system. The sealing means in the arrangements illustrated in FIGURES 1 and 2 comprise the vane 17 or 117 located at the downstream side of the distributor 11, 111.

Claims:

1. An apparatus for the manufacture of fiber webs, comprising a dry fibers distributor means (11, 11a, 111, 211, 311, 411, 511, 611, or 711), a forming wire (12, 112, 212, 312, 412, 512, 612 or 712) a planar section of which is disposed beneath the distributor means and is linearly movable at a predetermined first velocity, and a suction box (15, 115, 215, 315, 415, 515, 615 or 715) disposed beneath the planar forming wire section for drawing air through the forming wire at a predetermined second velocity normal to the said planar section, characterised by means for imparting a horizontal velocity component less than the first velocity to fibers in the direction of movement of said forming wire, to cause the fibers to impinge upon the forming wire at an angle of from 21 degrees to 30 degrees, the said second velocity being in excess of about 250 feet per minute (1.27 m/sec), and the first velocity is in excess of about 500 feet per minute (2.54 m/sec).

2. Apparatus according to claim 1, characterised in that the said means for imparting a horizontal velocity component comprises an array of parallel, mutually equally spaced vanes (17) extending transversely

of the said planar section, the vanes being disposed between the distributor means (11) and the planar section and each comprising a segment of a hollow circular cylinder so positioned that a tangent to its upper edge is substantially parallel to the flow of air and fibers from the distributor means and a tangent to its lower edge is substantially parallel to the planar section, the vanes (17) being cooperative with the suction box (15) to direct the flow of fibers from the distributor means in the direction of movement of the forming wire (12) at an acute angle to the said planar section thereof.

3. Apparatus according to claim 1, characterised in that the said means for imparting a horizontal velocity component comprises an array of parallel, mutually equally spaced baffle plates (117) extending across a bottom opening provided in the distributor means (111) in a direction transverse to the direction of movement of the forming wire (112), each vane being inclined downwardly in the direction of the said movement at an angle in the range from 21 degrees to 30 degrees to the forming wire.

4. Apparatus according to claim 1, characterised in that the said means for imparting a horizontal velocity component comprises baffle means (215a)

extending horizontally over the upstream region of an upper, horizontally extending opening (215b) provided in the suction box (215) beneath the forming wire (212), baffle means (215a) extending in a direction transverse to the forming wire movement and including a free edge portion facing in the said direction of movement, an imaginary line extending between an upstream edge of said distributor means (211) and the free edge portion of the baffle plate extending downwardly in a downstream direction at an angle in the range of from 21 degrees to 30 degrees to the forming wire (212).

5. Apparatus according to claim 4, wherein the baffle means is a plate or lip (215a) extending in the downstream direction located at the top of an upstream side of the suction box (215), and the suction box has a port (P-2), located in a downstream portion thereof for connection to a suction producing means.

6. Apparatus according to claim 4, characterised in that the baffle means comprises an endless belt (415c or 515a) having an upwardly presented surface and mounted for movement of said surface beneath the forming wire (412, 512), the apparatus further including a rotatable brush disposed to engage a lower run of said belt.

7. Apparatus according to claim 6, characterised in that the endless belt (515a) is mounted for movement of its upwardly presented surface in a direction transverse to the direction of movement of the forming wire (512).

8. Apparatus according to claim 6, characterised in that the endless belt is mounted for movement of its upwardly presented surface in the direction of movement of the forming wire (412).

9. Apparatus according to claim 1, characterised in that the suction box (315, 715) has an internal baffle plate (315a or 715d) spaced from an upstream wall thereof, an outlet port (P-3 or P-8) located in a region of the suction box downstream of the baffle plate for connection to a suction producing means an imaginary line touching an upper edge of the baffle plate (315a or 715d) and an upstream edge of a bottom discharge opening of the distributor means (311 or 711) making an angle of 21 to 30 degrees with the forming wire (312, 712), and the baffle plate in conjunction with suction communicated to the suction port (P-2 or P-8) in use causing fibers to impinge on the forming wire at an angle of 21 to 30 degrees.

10. Apparatus according to claim 9, characterised in that means defining a cleanout port (C-3 or C-8) is disposed in air flow communication with an upstream

region of the suction box located upstream of the baffle plate (315a, 715d).

11. An apparatus for the manufacture of fibrous webs, comprising dry fiber distributor means (611, 711) having a bottom, horizontally extending opening (611a, 711a), a forming wire (612, 712) having a planar section disposed beneath the said opening and linearly movable at a predetermined first velocity and a suction box beneath the said planar section for drawing air through the said forming wire at a predetermined second velocity component normal to the forming wire, characterised in that the suction box is defined in part by parallel upstream and downstream walls (615d, 615e and 715d, 715e) that extend transversely of the direction of movement of the forming wire and are inclined downwardly in the said direction of movement at an angle in a range of 21 degrees to 30 degrees to the horizontal, an upper edge of the downstream wall (615e, 715e) being spaced downstream of the distributor bottom opening (611a, 711a) and thereby providing a gap extending transversely of the direction of forming wire movement, an outlet port (P-7, P-8) being disposed in a lower region of the suction box adjacent a lower edge of the downstream wall (615e, 715e), and a sealing roll

(618, 718) being provided extending transversely of the forming wire movement and partially covering the said gap, the apparatus in use being characterised in that a horizontal velocity component less than said first velocity is imparted to air and fibers in the direction of movement of said forming wire (612, 712).

12. An apparatus according to claim 11, characterised in that an upper edge of the upstream wall (615d) is aligned with an upstream edge of the bottom opening (611a) of the distributor means (611).

13. An apparatus according to claim 11, characterised in that an upper edge of the upstream wall (715d) is located downstream of an upstream edge of the bottom opening (711a) of the distributor means (711), and in that the suction box has a further, vertical wall (715f) aligned with the said opening upstream edge, the walls (715d and 715f) in part defining a dead space portion of the suction box which is located beneath the forming wire (712), and the dead space portion being furnished with a cleanout port (C-8).

14. A method for forming dry fibers into a fibrous web which is substantially devoid of transverse

ripples, comprising the steps of directing fibers in a stream onto a planar section of a forming wire while moving the latter at a velocity in excess of 500 feet per minute (2.54 m/sec), maintaining the angle of impingement of the said stream on the planar section in a range from 21 degrees to 30 degrees, and maintaining a pressure drop through the said planar section by causing air to flow therethrough at a velocity normal to the planar section in excess of 250 feet per minute (1.27 m/sec).

FIG.1

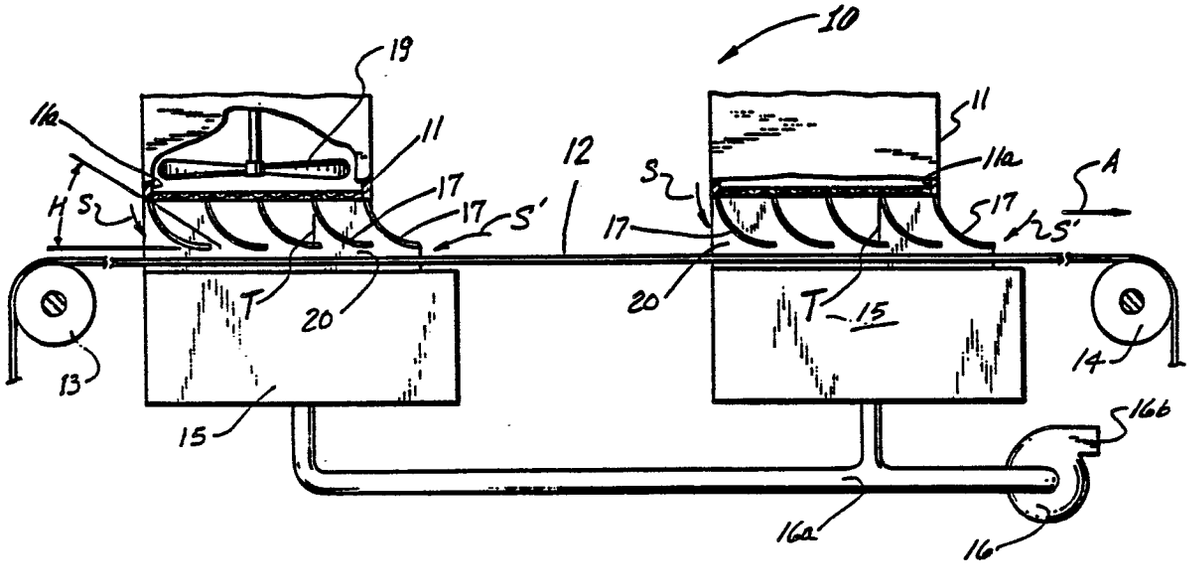


FIG.2

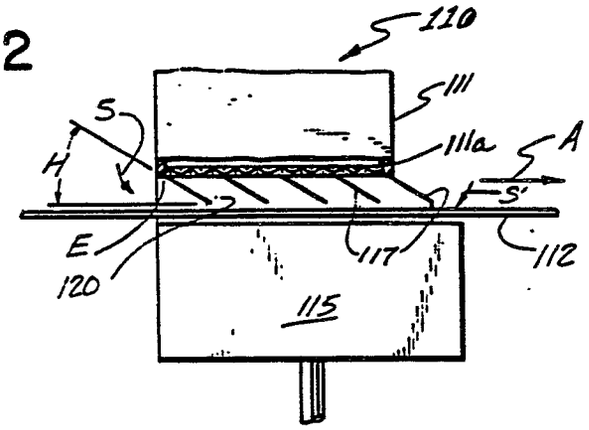


FIG.3

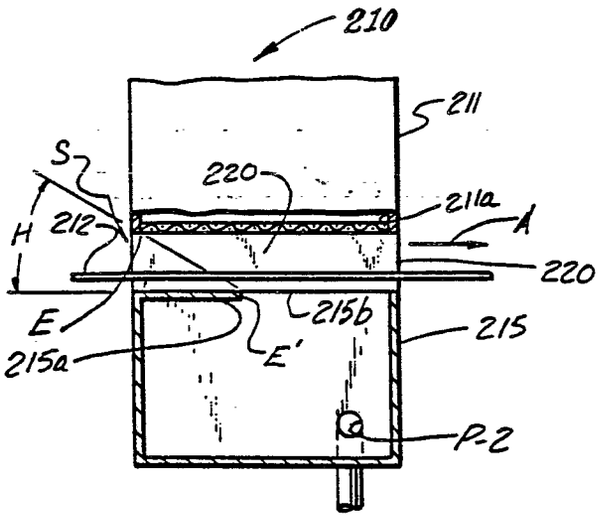


FIG.4

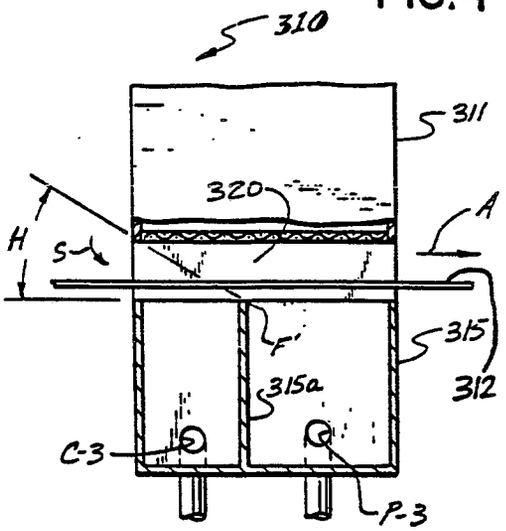


FIG.5

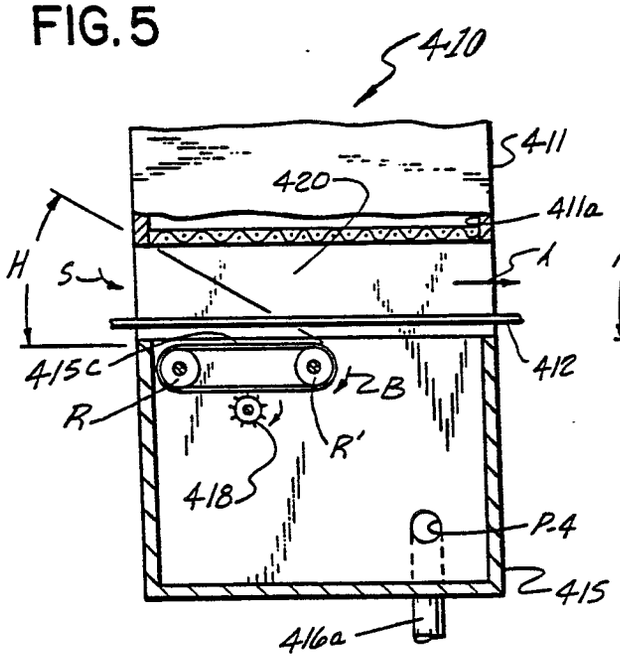


FIG.6

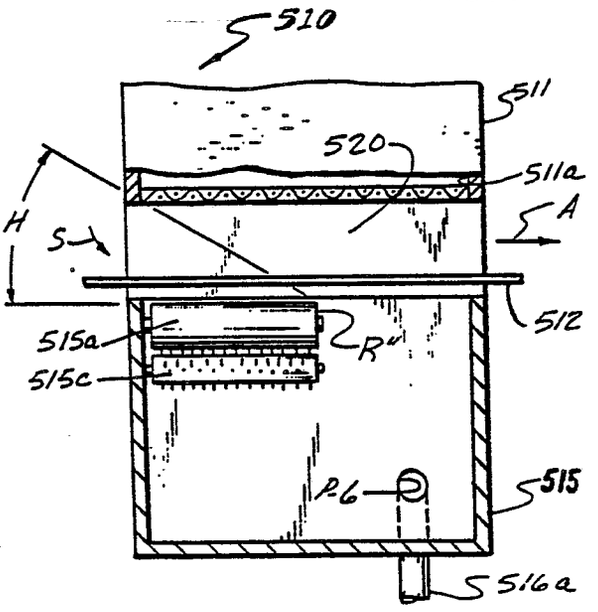
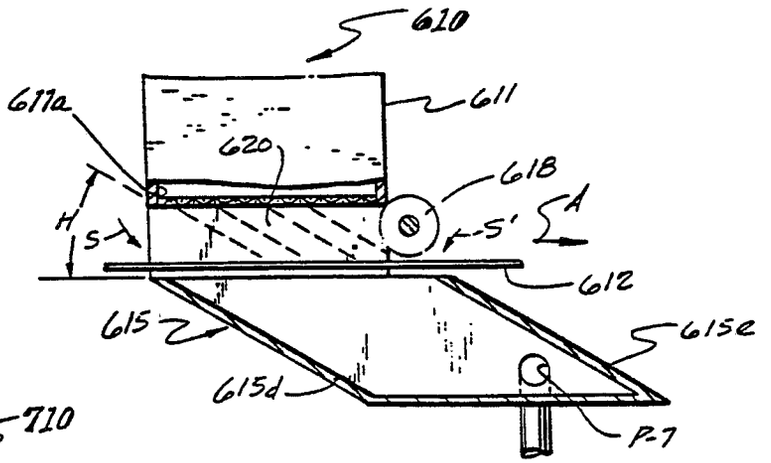


FIG.7



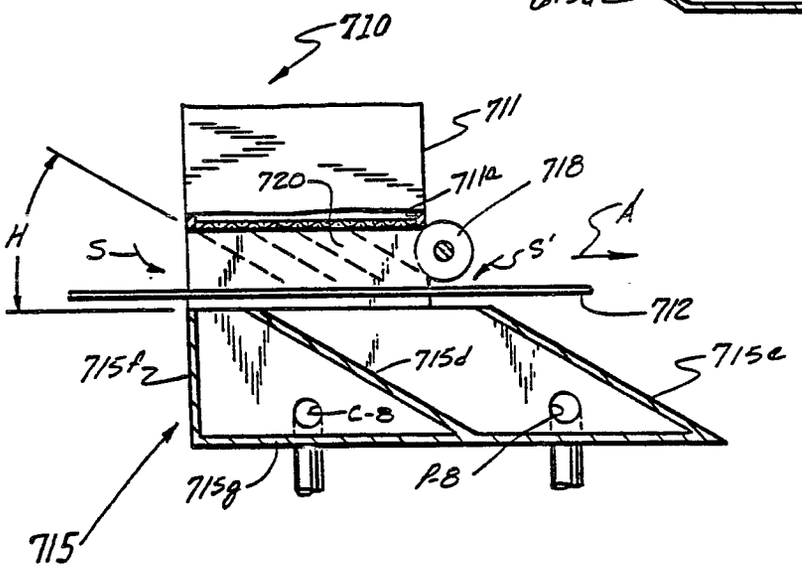


FIG.8

European Patent Office

EUROPEAN SEARCH REPORT

0060949
Application number
EP 81 30 1273

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
A	US - A - 3 755 856 (C.T. BANKS) * figure 4; column 1, lines 37-63; column 2, lines 55-62; claims 1-7 *	1,2
A	FR - A - 2 338 912 (TIITOLA) * page 3, lines 3-11 and 24-32; claim 2; figure 5 *	1,2

CLASSIFICATION OF THE APPLICATION (Int. Cl.³)

D 21 H 5/26
D 04 H 1/72

TECHNICAL FIELDS SEARCHED (Int. Cl.³)

D 21 H 5/26
D 04 H 1/72

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	29-09-1981	ELSEN-DROUOT

EPO Form 1503.1 06.78