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 **A method of and an installation for processing a web of material, while applying the flow-through principle.**

 A method of processing a web (2) by bringing said web into contact with at least one porous cylinder (1, 4, 6) having a mesh value of at least 100, a process fluid under pressure being passed through said porous cylinder with such a speed that the pressure drop of said fluid in the porous cylinder is five times greater than the pressure drop across the web.

An installation for processing a web thereby applying this method, comprises means for the relative movement of a web (2) along the outer surface of at least one porous cylinder (1, 4, 6) and means for feeding a pressurized process fluid through said cylinder and said web in the contacting zone between these two.

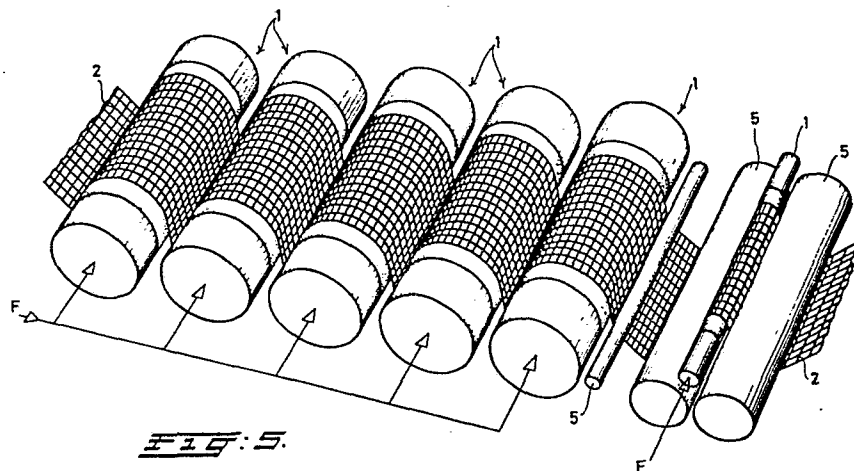


FIG. 5.

EP 0 050 901 A1

A method of and an installation for processing a web of material, while applying the flow-through principle.

The invention relates to a method of processing a web of material while applying the flow-through principle, the web being conveyed along a contacting member by means of which a process fluid under pressure is passed trans-
5 versely through said web at a great speed.

A method of this kind has been occasionally used in certain embodiments, steam then being used as a process fluid, for removing moisture particles from the web. Starting from this state of the art, it is an object of
10 the present invention to provide a method of performing, in the widest sense, an improved finishing process of the web of material which is characterized by a short contacting time, a compact type of construction of the installation required, and a low consumption of energy and auxili-
15 ary substances (additives).

These objects are attained with the method according to the invention in that a porous material having a mesh value of at least 100 is used in the contacting member such, that the pressure drop in the process fluid in the porous
20 material, amounts to at least 5 times the pressure drop through the web, the superficial fluid speed being kept greater than 0,1 m/sec. In this respect it should be noted that the term "mesh value" for the porous material as used

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hereinbefore is analogous to the generally accepted indications, as used for the permeability of perforated plates. A gas aerosol or similar fluid is used as the process fluid. The term "superficial fluid" speed is understood to
5 be the speed through the void cross-section. The difference in pressure drop provides a restriction of leakage losses on either side of the web of material.

The use of a porous contacting member entails a very intensive treatment per unit area of the web of material, as
10 a result of which the time required for the relative processing can be significantly reduced as compared with the state of art. This results in an increased output of a processing installation having a compact construction which thus far, however, required much space.

15 In connection with the invention it is observed that FR - A - 2 354 824 discloses a method in which pulsations of the process fluid flow are applied for obtaining a specific finishing effect. However, no porous material is used. It is further observed that in the GB - A - 760 394
20 a porous roller is described through which a viscous substance is pressed for impregnating purposes.

More particularly, the present invention relates to a method of dehydrating a textile web down to the swelling-water contents of the fibres while using the expelling principle,
25 the fluid used herein being gaseous and having a temperature of more than 100°C. Such a method is known from NL - A - 74,12216.

The contacting member as used therein is carried out as a venturi slot passage through which overheated steam is made to
30 flow which, when coming into contact with the textile web, has reached approximately the speed of sound. According to the

present invention, the superficial fluid speed in the porous contacting member exceeds 1,0 m/sec, said porous material having a mesh value which is greater than 200. When using the latter method the water adhering to said

5 fibres will flow towards the outer side of the fabric due to the difference in pressure across the textile web. Due to the difference in flow resistance, the flow between the threads proceeds much faster than in the interior of the threads.

10 The method according to the present invention may still be amplified in that, after completing the processing, the web of material is subjected to an additional treatment according to the vaporization principle, in which case the web of material is passed over a roller with a porous surface

15 having a mesh value greater than 200, a hot gas having a temperature of at most 200°C being pressed through this roller at a pressure-drop ratio exceeding 2, while maintaining a total contacting time of more than 1 second. As compared to the state of the art, the method according to

20 the invention allows a considerable shortening of the processing time, which results in an increased processing capacity and a more compact construction of the installation.

The basic conception underlying the present invention is the use of a contacting member in the form of a porous material,

25 Related thereto is a further aspect of the invention concerning a method of applying a viscous substance on to a web of material while using a rotatable cylinder provided with a permeable surface to which the substance is fed internally, the web then travelling along said surface. According to the invention, a cylinder is used which is provided

30 with a jacket of a porous material having a mesh value greater than 200, the concerning substance being fed at an increased pressure to said cylinder via at least one of its

closed ends, said substance being pressed through the porous surface at a speed which is less than 0,01 m/sec.

The aforesaid method can be used in at least two manners, one of which, for example, is the printing of a web of material. In that case the web is passed along the greater part of the surface of the porous cylinder, said surface being provided with an impermeable covering in the negative pattern of the design intended. However, it is also possible to perform the method such, that the web travels tangentially along the surface of the porous cylinder, the substance being a gas-liquid mixture.

The invention is furthermore embodied in an installation for performing one or several of the methods described hereinbefore, said installation comprising at least one contacting member and means for conveying at least one web of material along said member under some tension. Such an installation, a very special embodiment of which is also known from the aforementioned NL - A - 74,12216, is characterized according to the invention, in that the contacting member is provided with, or consists of a porous material having a radially outwardly directed curved surface along which the web of material can be conveyed at a relative speed, the opposite face of the porous material being connected to an inlet for process fluid. As compared with installations hitherto destined for this purpose, it is possible to realize an installation with a considerable capacity confined within a limited space.

The installation according to the invention can be used more particularly, for performing a drying process, the time required to this end for contacting the web of material with the porous material, only being a few seconds. An

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installation consuming little energy can be so designed that the contacting member consists of a double-walled cylinder which - during operation - is kept stationary and of which only the outer surface is porous, said cylinder being provided with a slot passage means - directed according to a generating line - comprising guide means guiding the web processed along the cylinder surface inwardly through said slot passage means.

The invention will be further explained with reference to the accompanying drawings, which first illustrate some aspects of the method according to the invention and then subsequently, diagrammatically the constructional features of the installation, while finally the various stages of the dehydrating process and subsequent drying of a textile web, are illustrated on a strongly enlarged scale.

Fig. 1 is a first embodiment of an installation according to the invention, wherein the contacting member consists of a porous pipe having a limited diameter, for the use of the flow-through principle, and more particularly, for dehydrating a textile web.

Fig. 2 is a similar installation wherein the contacting member is a hollow porous pipe having a larger diameter, the web being conveyed along almost the entire circumference of the said pipe so as to obtain a drying of the web by using the vaporization principle.

Figs. 3a, 3b, 3c are a third embodiment of an installation according to the invention, in which the contacting member consists of a porous bar having a curved surface along which the web can travel.

Fig. 4 illustrates a multiple embodiment of the modified embodiment in figs. 3a, b.

Fig. 5 is a view of a combined installation according to the invention in which the web is successively dehydrated and dried.

5 Figs. 6a, 6b and 6c show a perspective view, a cross-sectional view and a detail of a so-called annular winding-drying installation, respectively.

Figs. 7a, 7b and 7c show the use of a permeable back-up follower for supporting the web of material during its travel along the contacting member.

10 Fig. 8 is a view of a possible use of the invention in order to print a textile web.

Fig. 9 shows the manner in which a porous contacting member can be used for applying a layer of foam substance on to a web of material.

15 Fig. 10 is a diagrammatical exploded view of the course of the process for dehydrating and drying a textile web.

Fig. 1 shows the improved finishing installation according to the invention in its most elementary but also most essential form. Said installation consists of a contacting member 1 in the form of a narrow, hollow pipe, having a diameter of a few centimeters. As can be seen in said figure, both ends of the pipe may be impermeable. A web 2 of material is conveyed along the porous portion of the pipe 1 by means of two guide rollers 3. With the aid of said rollers, the web 2 is made to travel under some tension along the greater portion of the circumference of the porous pipe 1. The pipe 1 is closed at one end, whilst the other end comprises an inlet F for the process fluid. When this installation is used for dehydrating a textile web, steam under a pressure of 5 bars (i.e. 500 kPa) and having a temperature of 151°C is fed to the contacting member 1 via inlet F. Said process fluid will then forcefully flow radially outwards, via the pores of the porous material,

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whereby a pressure drop across the porous material will occur of e.g. more than 400 kPa. The fluid emanating from the pipe 1 has to overcome the capillary forces of the liquid between the fibres of the web 2, in order to so
5 achieve the dehydration intended. The fluid speed then occurring is approximately 10 m/sec. The permeability of the pipe 1 may amount to a mesh value of 1000 (pores per linear inch), which about corresponds to the size of a fibre of the web 2. The pressure drop of the fluid across
10 said web 2 will amount to approximately 50 kPa. By way of example the following details of the porous material of the contacting member 1 may be given:

- as materials qualify a synthetic material, bronze,
15 stainless steel, ceramic material, glass or fibrous material;
- the thickness of the porous jacket of the pipe 1 amounts to 1-5 mm;
- the specific permeability amounts to 10^{-12} m^2 ;
- the porosity amounts to approximately 25%.

20 The installation of fig. 2 differs from the embodiment of fig. 1 in that the contacting member 1 is a porous tube 4 having a diameter larger than that of fig. 1, e.g. of 10-50 cm. Instead of the guide rollers 3 of fig. 1, there are provided supporting rollers 5 by means of which the
25 web 2 of material is made to travel along almost the entire circumference of the pipe 1. The jacket of the tube 4 is made of the same sort of porous material as described hereinbefore with respect to pipe 1 of fig. 1. Hot compressed air of approximately 120° - 150° C under an overpressure
30 of 100-200 kPa can be fed to said tube via inlet F. After a preceding dehydrating process, the web 2 of material may thus be subjected to a supplementary treatment according

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to the vaporization principle. In the embodiment of fig. 2, the following values may be given for the speed, dimensions and tensile force of the web 2:

- web travelling speed is, for instance, 1-2 m/sec.
 - 5 - The web width may be chosen arbitrarily but is preferably such that the web 2 or several adjacent webs cover the greater portion of the porous tube 4.
 - The tensile force in the web 2 may have a value comprised between 100-1000 N/m of cloth width.
- 10 It should be noted that the porous pipe 1 of the modified embodiment of fig. 1 may be kept stationary, web 2 then travelling along the porous surface. The pipe 1 may also, however, travel along with the web 2, either slowly or at the same speed. The porous tube 4 of the variant according to fig. 2 preferably rotates at a speed corresponding to the
- 15 travelling speed of the web 2.

In the embodiment of the invention according to figs. 3a, 3b and 3c the contacting member 1 is formed as a porous bar 6 embedded in a rib of a hollow, substantially prismatic

20 holder 7. There are provided guide rollers 5 so that the web 2 is conveyed along almost the entire outwardly directed surface of the bar 6. The holder 7 comprises an inlet F for the process fluid.

Fig. 3c shows that the bar 6 need not have a circular

25 section, but may have a partially prismatic form.

Fig. 4 is a multiple construction of a modified form according to fig. 3a, the hollow holder 8 having a polygonal shape with a number of corner ribs on each of which there is disposed a porous bar 6. The holder is closed at one

30 end, whereas the other end is provided with an inlet F for

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the process fluid. The holder 8 is rotatably disposed and provided with a drive means (not shown) which produces a rotation of the holder in the same direction as the travelling movement of the web 2, but at a lower speed. Said web 2 is conveyed along almost the entire circumference of the holder 8 by means of two supporting rollers 5.

Fig. 5 shows a combined installation which is built up from the elements as shown in figs. 1 and 2. The pipe 1 along which the web of material 2 travels first, is fed with steam as a process fluid in a manner as described with respect to fig. 1. Dry air is fed to the five porous tubes 4 as a process fluid. This sequential arrangement of several porous tubes 4 is required to obtain the necessary contacting time of the web 2 with the process fluid, which time amounts to a few seconds.

An alternative solution of said sequential arrangement of the tubes 4 of fig. 5 is shown in figs. 6a, 6b and 6c. These figures relate to a so-called annular winding drying installation, in which the web of material 2 has been wound several times around the porous contacting member 1. The web travels to the contacting member 1 via a tension roller 9. Said roller consists of a double-walled cylinder 10, 11 only the outer surface 10 of which being porous. The double-walled cylinder is provided with a slot passage means 12 directed according to a generating line of the cylinder. Fig. 6c shows the guide means (rollers 13) for discharging the web 2 processed along the surface 10, inwardly through the slot passage 12. The process fluid (hot air) is transported under pressure into the annular space 14 between the cylinder jackets 10, 11 and flows, through

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the superimposed windings of the web 2 about the cylinder, which is stationary during operation. The hot dry air supplied to the space 14 may have an overpressure of 400 kPa and a temperature of 140°C. During operation, the various windings of the web 2 present about the cylinder 10, 11 become detached from one another, which condition is maintained because the pressure drop in the hot air proceeding radially outwards, compensates for the tension in the web.

10 In order to perform the method according to the invention, an appropriate contact between the porous contacting member on the one hand and the web of material (the fabric) on the other hand, is of great importance. So as to make up for the difference in pressure across the thickness of the fabric, 15 resulting from the fluid flow in and about the fabric threads, a sufficient tensile stress should be exerted upon the web of material 2. When processing vulnerable fabrics it is desirable to use a permeable supporting belt 15, (a so-called back-up follower). This is shown in figs. 7a, 20 7b and 7c. The back-up follower 15 is therein passed along supporting means 16 which in the embodiment of fig. 7b, consist of cylinders and in the embodiment of fig. 7c of several rollers. The path along which the back-up follower 15 travels coincides with the effective surface of the porous 25 contacting member 1, thus ensuring the necessary contacting pressure.

The modified embodiment according to fig. 8 shows the contacting member 1 in the form of a porous cylinder 17 by means of which the web of material 2 can be died or printed. 30 The color paste is supplied within the cylinder 17 under some overpressure. The web 2 is conveyed along the greater

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portion of the surface of the cylinder 17 by means of several supporting rollers. For the purpose of printing a certain design, the surface of the cylinder 17 is provided with an impermeable covering in the negative pattern of the intended design.

In the embodiment of fig. 9 there is supplied a substance under pressure consisting of a gas-liquid mixture, instead of a color paste, while using an identical cylinder 17. During rotation of the cylinder the said mixture will gradually pass outwards through the porous material and form a foam layer on the cylinder jacket. As the web 2 of material travels tangentially along the cylinder surface the foam layer is deposited upon said web. The web 2 is then supported by a roller 18.

Fig. 10 is a view of dehydrating and drying a fabric web while using, for instance, the installation of fig. 5. The porous contacting members are shown as flat faces over which the fabric 2 travels. During the dehydrating process five processing stages, A-E may be discerned:

A. The transport of liquids proceeds in this case by displacement, i.e. the so-called convective substance transport. The difference in pressure across the fabric web causes adhering water to flow towards the outer side of the fabric. The flow between the threads then proceeds at a much faster rate than within the threads, due to the difference in flow resistance (specific permeability).

B. In this stage adhering water is removed so that also in this case a convective substance transport may be said to occur. The flow of process fluid penetrates the liquid film formed, and entrains the adhering water in the form of

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5 drops. Dehydrating the fine capillaries between the fibres requires in that event a considerably higher fluid pressure so as to compensate for the surface tensions, which are greater than the forces of resistance in the rough pores between the threads.

10 C. In this stage there occurs a heating of the fabric so that a so-called convective-conductive heat transport takes place. The expansion of steam in the porous contacting member 1 and in the fabric 2 entails a heating of the fabric to above the temperature of equilibrium under atmospheric conditions.

15 D. In this stage there occurs a flash vaporization, i.e. a substance diffusion and phase transition. When after leaving the porous contacting member the fabric comes into contact with the ambient air, the decrease of the water-vapour pressure at the fabric surface will cause a rapid vaporization from the fabric, such that the fabric temperature will decrease.

20 E. In this stage the swelling water is vaporized and there may be said to be a convection-conduction heat and substance transport. An intensive flow of hot dry air through the fabric is obtained by passing the dehydrated fabric along the contacting member according to fig. 2 (see also fig. 5), to wit a porous tube having a high mesh value. This will
25 bring about an even distribution of the air stream. Due to the decrease of the gauze permeability of the fabric web 2 at a decreasing moisture contents and the simultaneous contraction of the air flow cooling down at the location of the highest moisture contents, the flow through the
30 thread will intensify, thus resulting in a rapid removal of the fibre-bound swelling water.

The duration of the dehydrating process in the stages A, B

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and C determines the ratio between the diameter of the porous pipe 1 and the speed of the web of material. The brief residence time in the case of processing thin permeable fabrics and the low speed of travel requires a small pipe diameter. The flash vaporization process in the ambient air during stage D proceeds very rapidly when an appropriate ventilation is used. In the event of an insufficient ventilation it is possible to utilize the discharge air from stage E in counterflow with the fabric web. In stage E the same factors as mentioned in stage A play a part, viz., the mesh value, pressure ratio, web tension and diameter of the porous tube. The combined heat and substance transport entails other numeral values for these factors, also as a result of the different viscosity of the process fluid and the changing permeability of the web of material as processed (fabric and threads).

The method according to the invention provides the possibility of attaining an intensity of the processing operation, coupled with a proper handling ability of the process and product streams, such that the following practical applications can be achieved:

- a) separation processes with or without a phase transition:
 - dehydrating, heating and drying (described hereinbefore);
 - final pressing, air removal, pad dyeing, and PVA desizing;
- b) chemical reactions:
 - dyeing;
 - bleaching in the gas phase and NH_3 mercerization.
- c) coating operations:
 - printing;
 - applying

Claims:

1. A method of processing a web of material while applying the flow-through principle, the web being conveyed along a contacting member by means of which a process fluid under pressure is passed transversely through said web at a great speed,
5 characterized in that a porous material having a mesh value of at least 100 is used in the contacting member, such that the pressure drop in the process fluid in the porous material amounts to at least five times the pressure drop through
10 the web, the superficial fluid speed being kept greater than 0,1 m/sec.
2. A method according to claim 1, more particularly, for dehydrating a textile web down to the swelling-water contents of the fibres by using the expelling principle, the fluid used herein being gaseous and having a
15 temperature of more than 100°C, characterized in that the superficial fluid speed exceeds 1,0 m/sec, and in that the porous material has a mesh value which is
20 greater than 200.
3. A method according to claim 1 or 2, characterized in that after having completed the processing, the web of
25 material is subjected to an additional treatment according to the vaporization principle, in which case the web of material is passed over a roller with a porous surface having a mesh value greater than 200, a hot gas having a temperature of at most 200°C being pressed through this
30 roller at a pressure-drop ratio exceeding 2, while maintaining a total contacting time of more than 1 second.

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4. A method according to claim 3 in conjunction with claim 2, characterized in that after dehydration a drying of the web is performed by using at least one cylinder consisting of porous material, a drying gas having a temperature of approximately 100°C being passed through said cylinder(s).
5. A method of applying a viscous substance on to a web of material while using a rotatable cylinder provided with a permeable surface to which the substance is fed internally, the web then being conveyed along the cylinder surface, characterized in that a cylinder is used which is provided with a jacket of a porous material having a mesh value greater than 200, while the substance is supplied to said cylinder under increased pressure via at least one of its closed ends, said substance being pressed through the porous surface at a speed which is less than 0,01 m/sec.
6. A method according to claim 5, more particularly, for printing a web of material, characterized in that the web (2) is made to travel along the greater part of the surface of the porous cylinder, said surface being provided with an impermeable covering forming the negative pattern of the design intended.
7. A method according to claim 5, characterized in that the web travels tangentially along the surface of the porous cylinder and in that the substance consists of a gas-liquid mixture.

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8. An installation for performing the method according to any one of the preceding claims, comprising at least one contacting member and means for conveying at least one web of material along said member under some tension,
5 characterized in that the contacting member (1) is provided with, or consists of a porous material having a radially outwardly directed curved surface along which the web of material
10 (2) can be conveyed at a relative speed, the opposite face of the porous material being connected to a feed of the process fluid.
9. An installation according to claim 8, characterized in
15 that the porous material has the form of a hollow pipe (1) bearing on hollow (supported) shaft ends, guide rollers (3) and/or supporting rollers (4) being provided so that the web (2) can travel along a large area of the porous surface, at least one of the shaft ends being provided with an inlet
20 (F) for the process fluid (figs. 1, 2 and 5).
10. An installation according to claim 8, characterized in
that the porous material has the form of a bar (6) which is embedded in a rib of a hollow, substantially prismatic
25 holder (7), guide rollers (5) being provided so that the web (2) is conveyed along almost the entire outwardly directed surface of the bar, said holder (7) being connected to the inlet (F) for the process fluid (figs. 3, 3a, 3b).
11. An installation according to claim 10, characterized in
30 that the hollow holder (8) has a polygonal form and comprises a number of corner ribs on each of which there is disposed a porous bar (6), said holder being rotatably disposed and provided with a drive means (fig. 4).

12. An installation according to claim 8 or 9, more particularly destined to perform the method according to claim 3 or 4,

characterized in

5 that there is provided at least one drying member consisting of a hollow tube in the form of a cylinder (4) having a jacket of porous material, the tube being connected to a source of hot dry air, means (5) being provided for additionally guiding the dehydrated textile web (2) along
10 said cylinder(s) (figs. 2 and 5).

13. An installation according to claim 8 or 9, characterized in

15 that the contacting member consists of a double-walled cylinder (10, 11) the outer wall (10) of which is porous only, which cylinder - during operation - is stationary and is provided with a slot passage means (12) - directed according to a generating line - the latter comprising
20 guide means (13) for guiding the web (2) processed along the cylinder surface inwardly through said slot passages (figs. 6a, 6b, 6c).

14. An installation according to any one of claims 8-12, characterized in

25 that there are provided supporting means (16) for conveying a permeable supporting belt (15) under some tension along a path, part of which at least coincides with the effective surface of the porous contacting member (1) (figs. 7a, 7b, 7c).

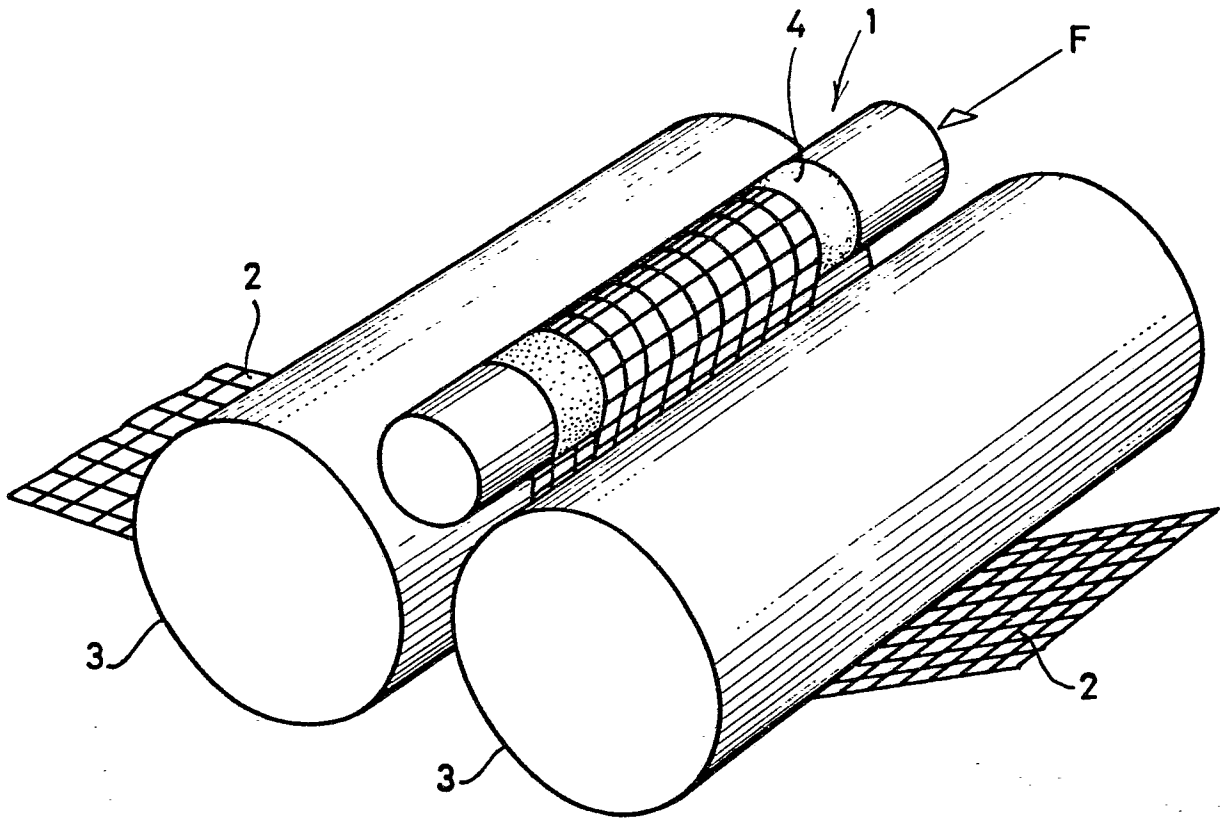


FIG. 1.

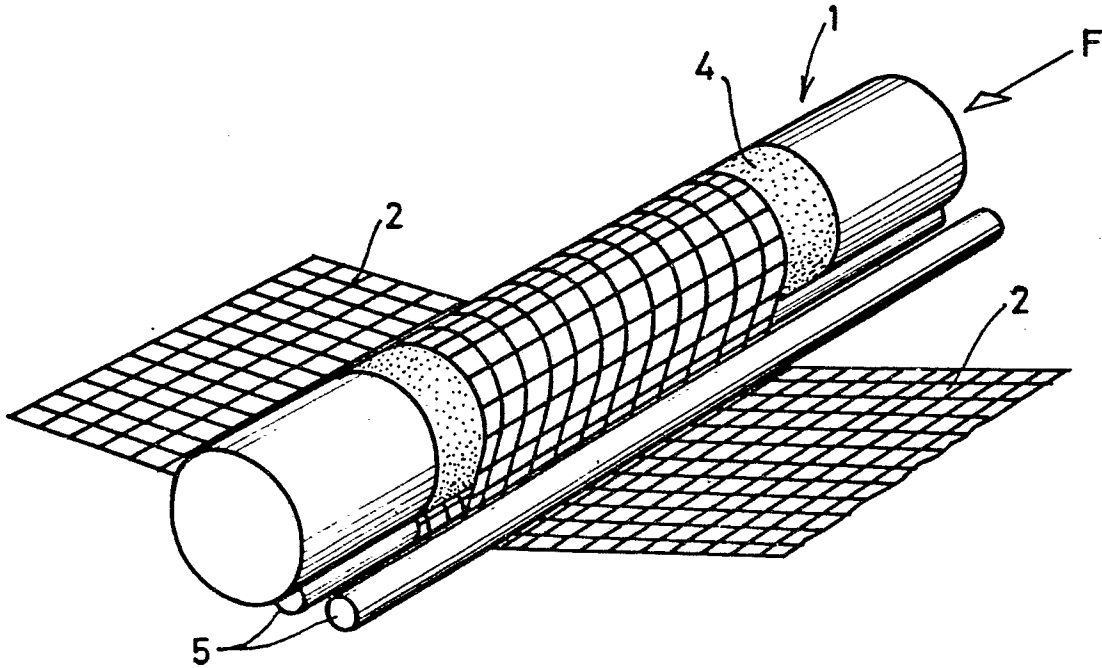


FIG. 2.

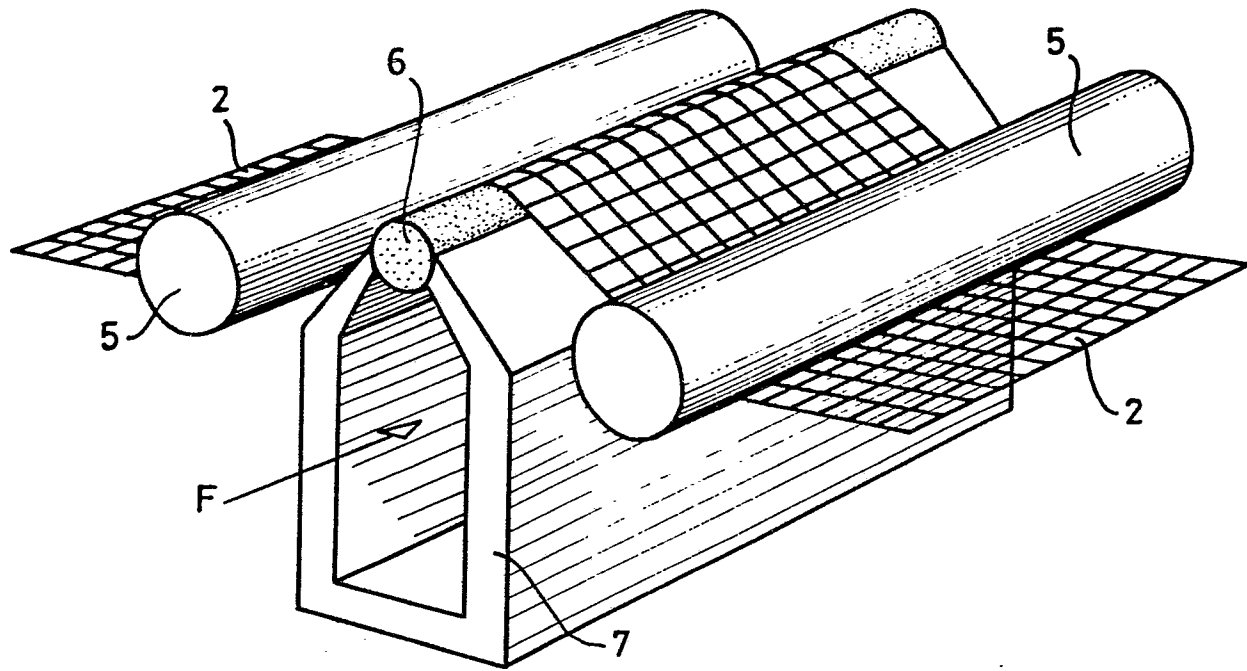


FIG. 3A.

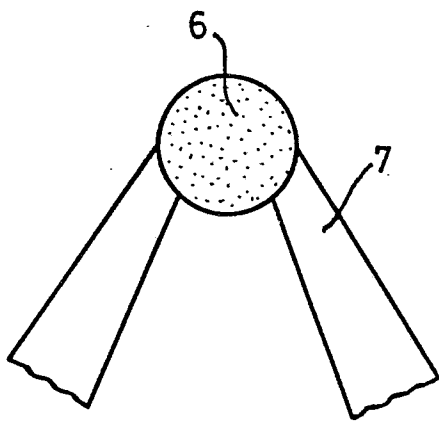


FIG. 3B.

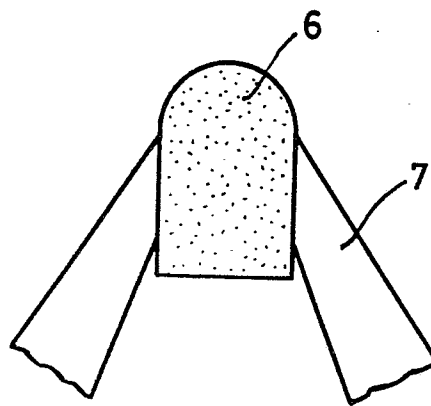


FIG. 3C.

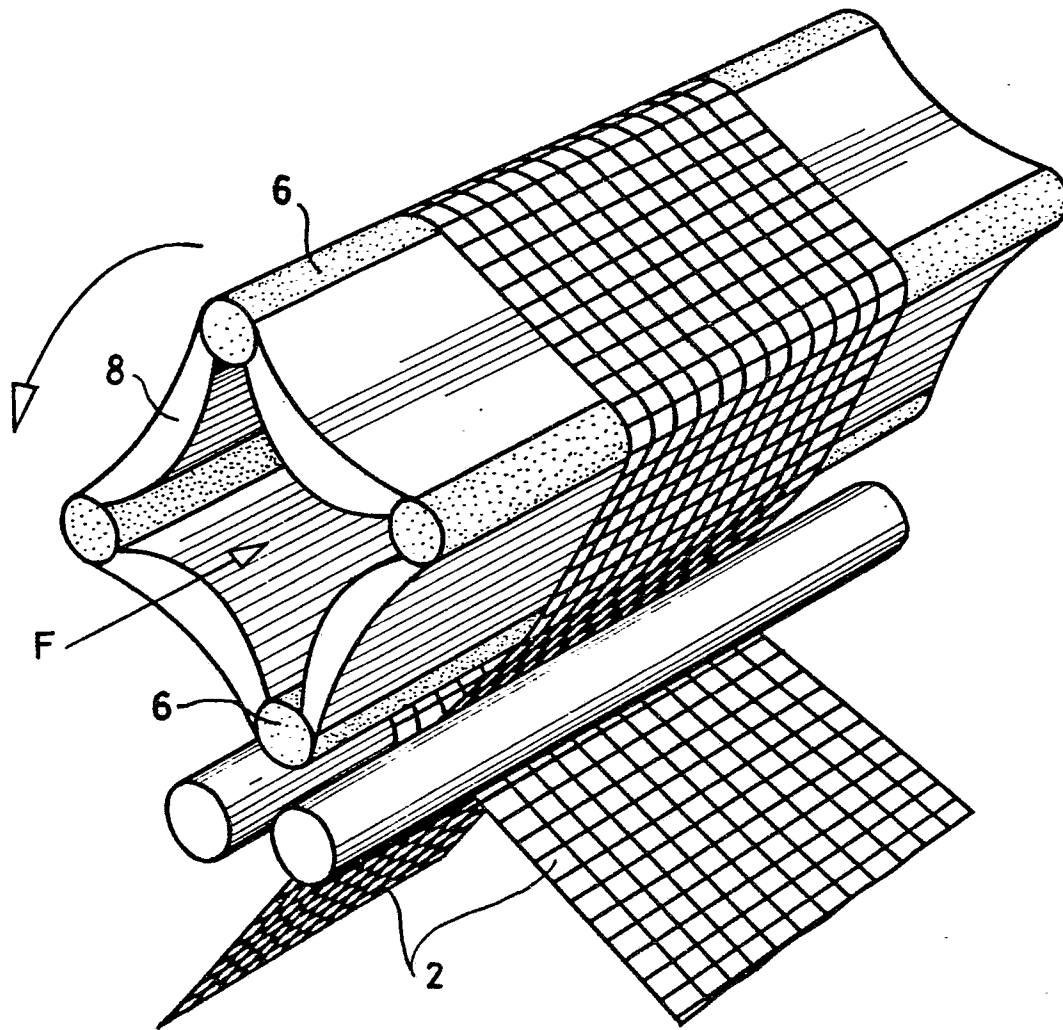


FIG: 4.

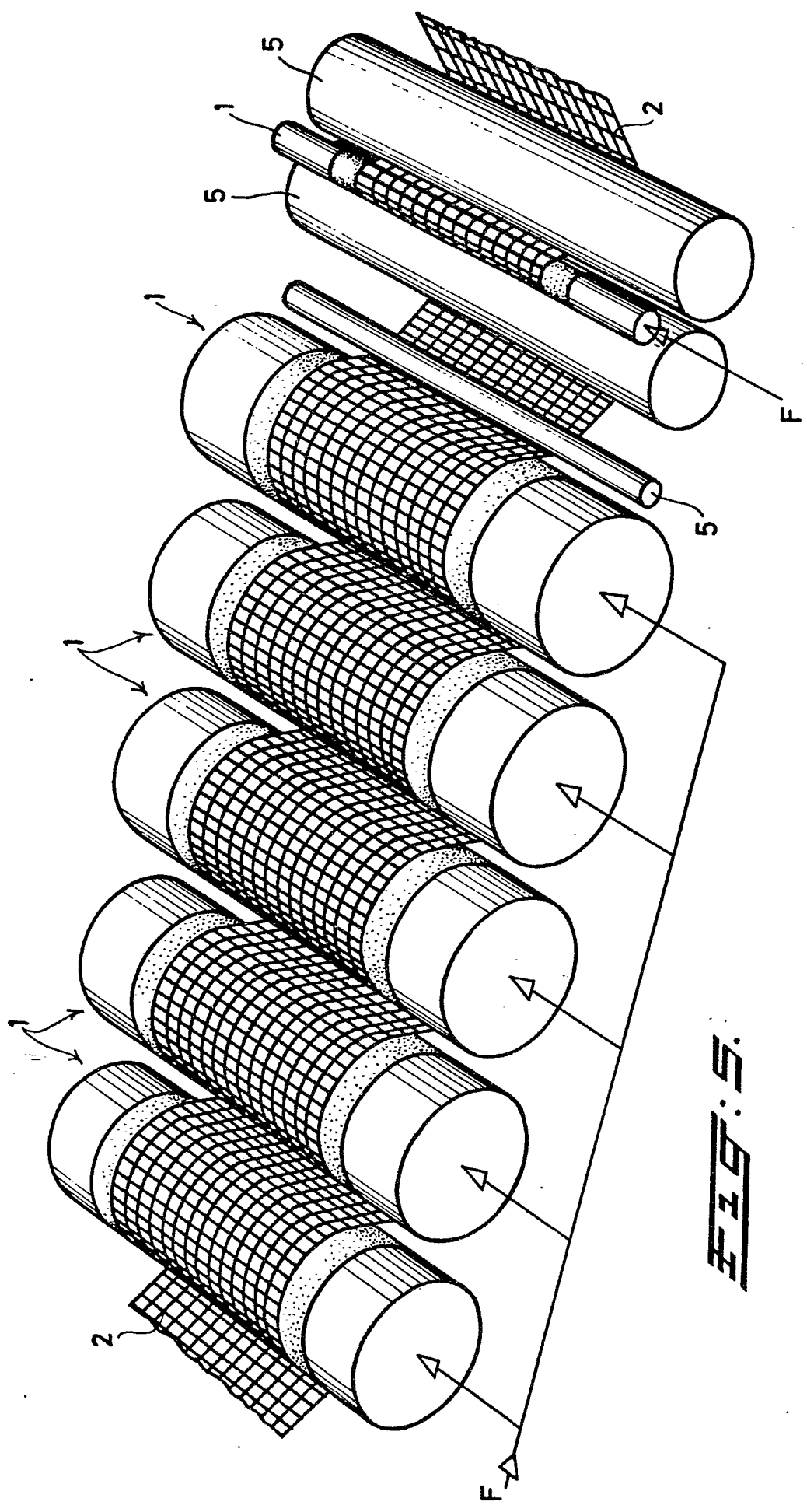


FIG. 5.

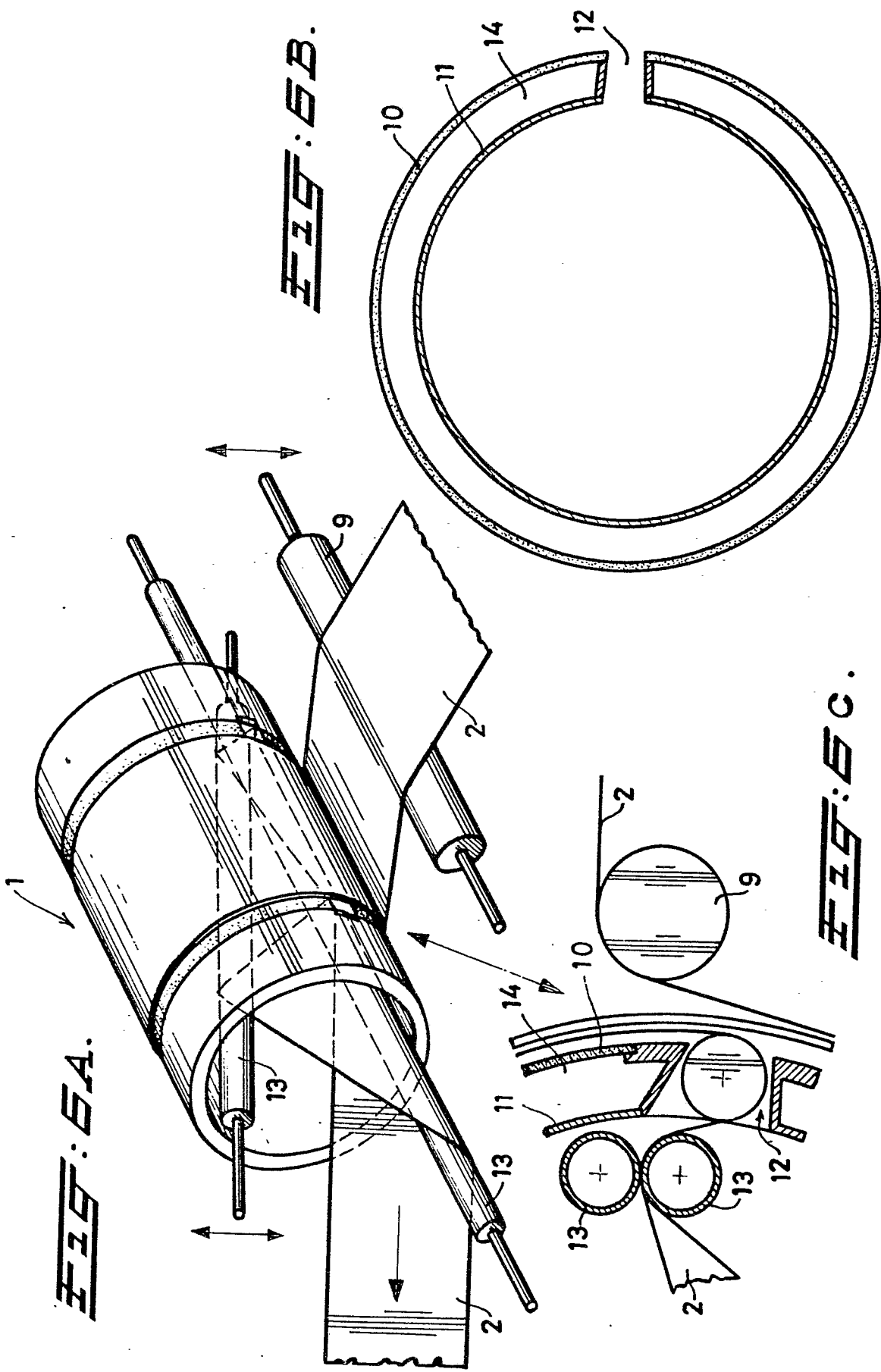
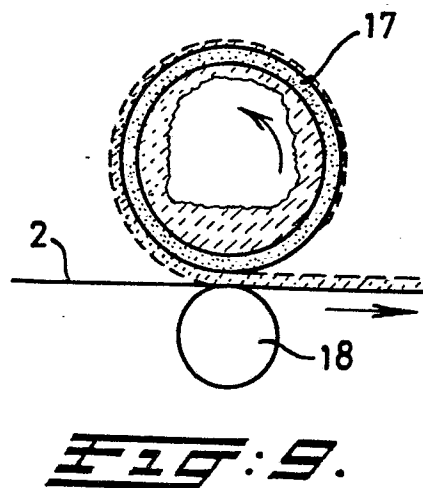
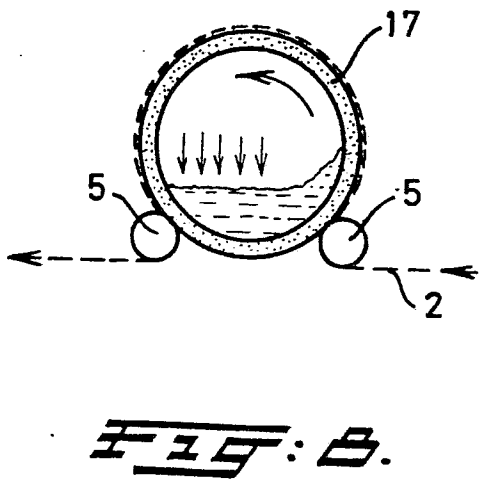
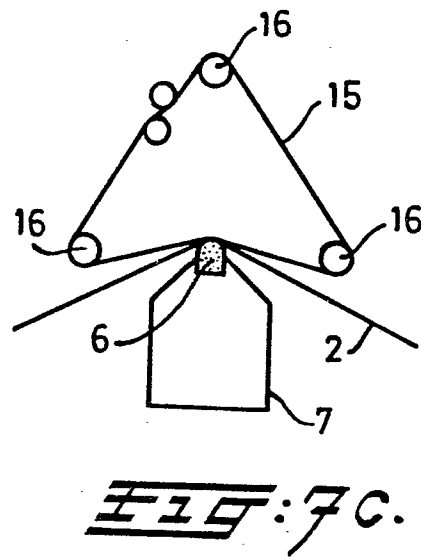
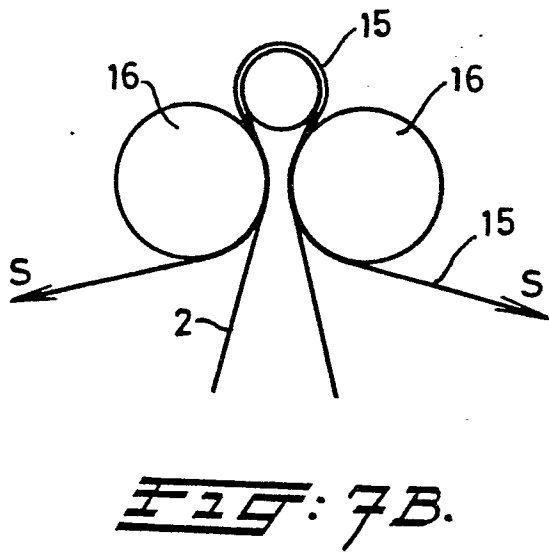
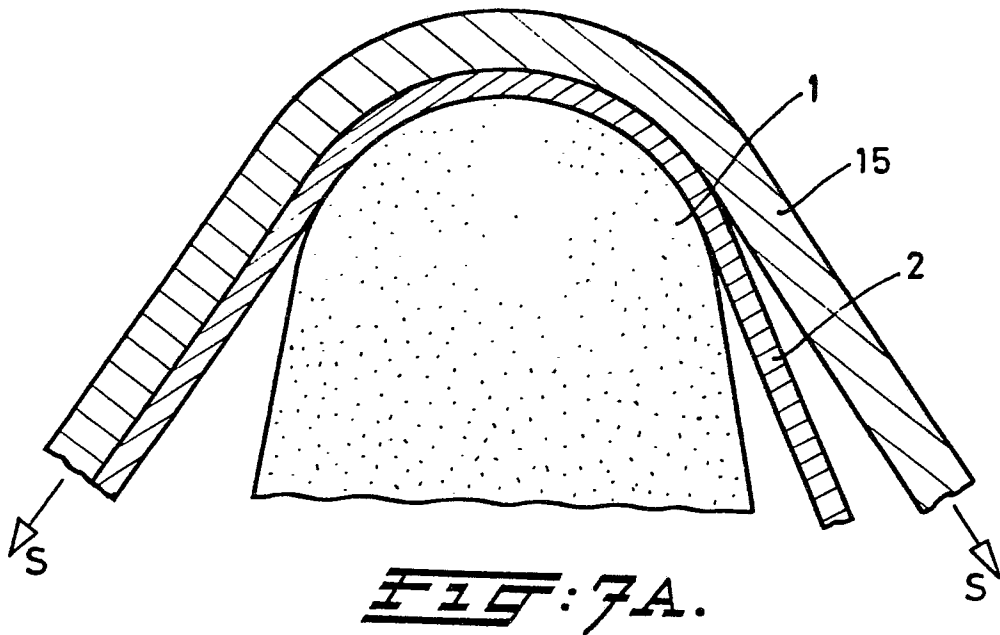
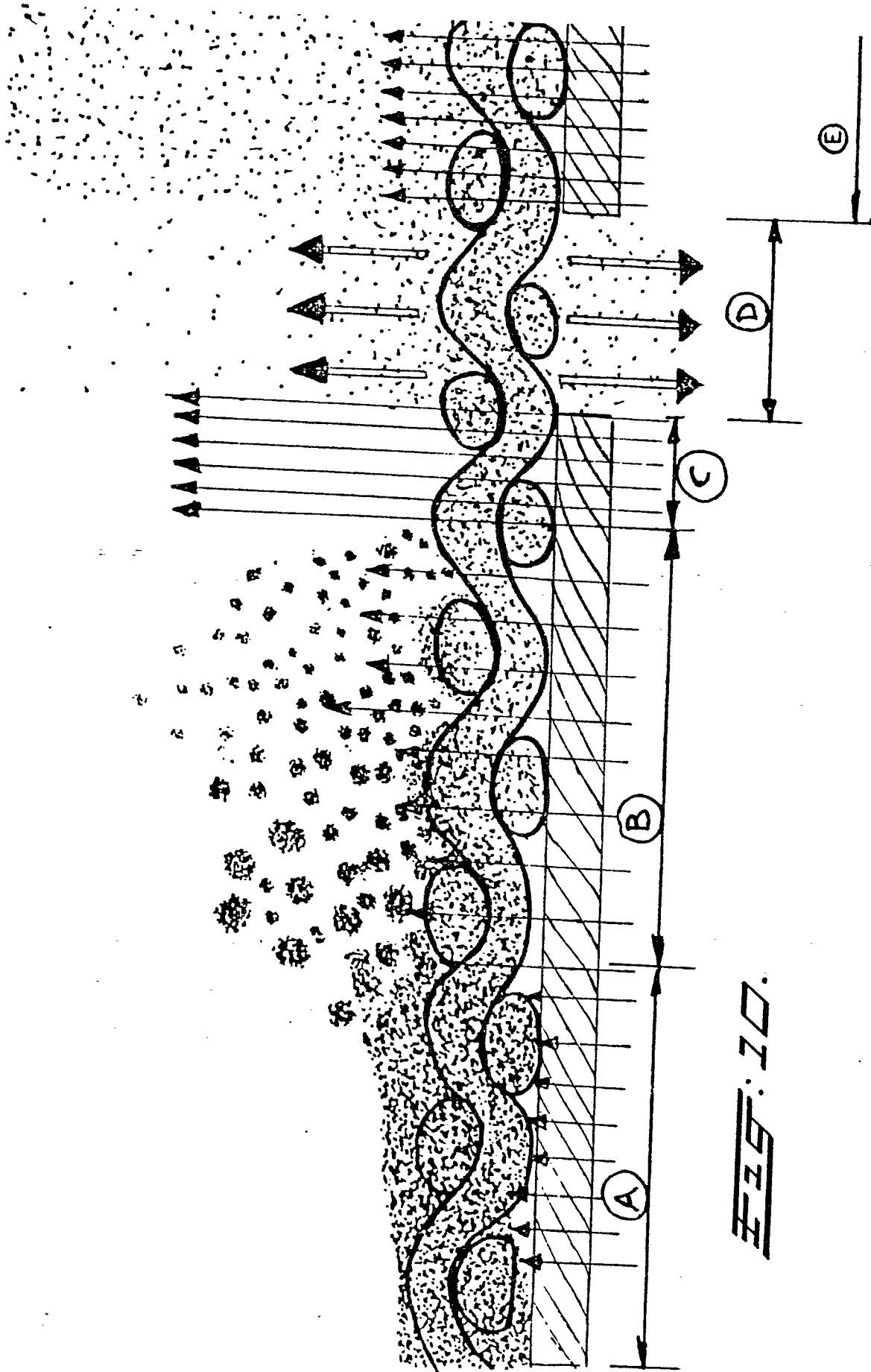


FIG. 6A.

FIG. 6B.

FIG. 6C.





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European Patent
Office

EUROPEAN SEARCH REPORT

0050901

Application number

EP 81 20 1170

DOCUMENTS CONSIDERED TO BE RELEVANT		CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)	
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	FR - A - 2 354 824 (FORSCHUNGS INSTITUT FUR HOLZTECHNOLOGIE) * the whole document * --	1,5-8, 10	D 06 B 1/08 1/16
X	US - A - 4 137 045 (BRUGMAN) * the whole document * --	1-3,8, 9	
	FR - A - 2 255 961 (HOECHST) * the whole document * --	1,8	TECHNICAL FIELDS SEARCHED (Int.Cl.3)
	FR - A - 2 298 635 (HOECHST) * the whole document * --	1,8	D 06 B
	US - A - 3 865 078 (DU PONT) * the whole document * --	1,7,8	
	DE - A - 2 015 787 (BRÜCKNER) * the whole document * --	1,8	CATEGORY OF CITED DOCUMENTS
	GB - A - 760 394 (WOOL INDUSTRIES RESEARCH ASSOCIATION) * the whole document * -- ./.	1,8	X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons
<p><i>A</i> The present search report has been drawn up for all claims</p>			&: member of the same patent family, corresponding document
Place of search	Date of completion of the search	Examiner	
The Hague	25-01-1982	PETIT	



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0050901

Application number

EP 81 20 1170

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DOCUMENTS CONSIDERED TO BE RELEVANT		Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Category	Citation of document with indication, where appropriate, of relevant passages		TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
	<p><u>FR - A - 2 377 470 (RIMAR)</u></p> <p>* the whole document *</p> <p>-----</p> <p><u>FR - A - 2 348 302 (TISSMETAL)</u></p> <p>* the whole document *</p> <p>-----</p>	<p>1,8,10,11</p> <p>1,8,9</p>	