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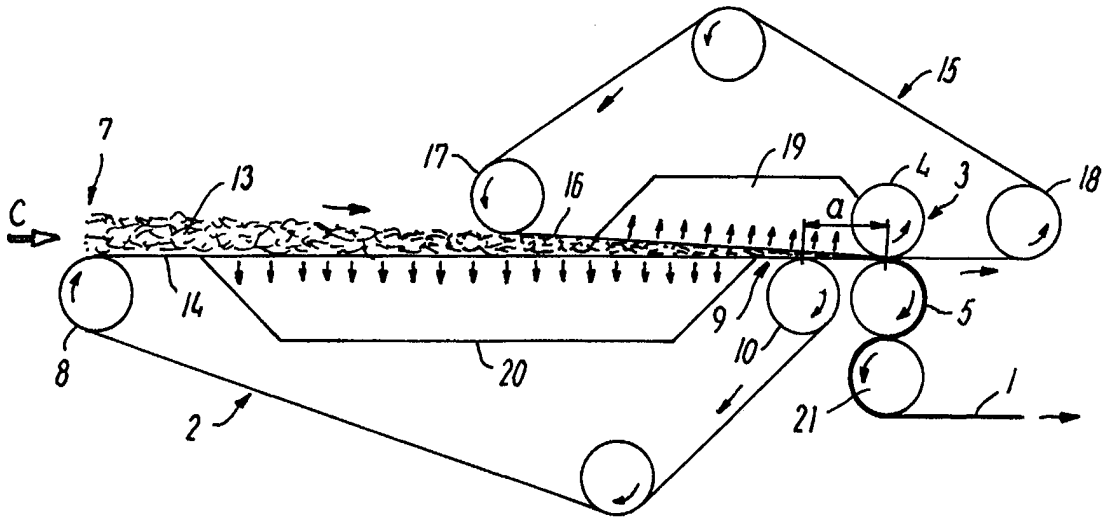

(57) Abstract

A plant for producing a non–woven, web–formed fibre product (1). The plant comprises a first forming wire (2) with an inlet and outlet end (7, 9) and an upper web (14) which, at the inlet end (7) takes up a carded or air–laid layer of fibre (13) and transports it to the outlet end (9). The plant also includes a roller (3) with an upper and lower roller part (4, 5) for compressing the fibre layer (13), and a second wire (15), positioned above the first wire (2), with a lower part (16) which is extending across the roller (3), and a suction box (19) which is placed above this web (16). In the section (a) between the outlet end (9) of the first forming wire (2) and roller (3), the fibre layer (13) is firmly sucked onto the under side of the lower part (16) of the second wire (15) via the suction box (19). The fibre layer is thus stabilised so that the plant can, at a considerably faster production speed than corresponding conventional sytems, produce a non–woven, web–formed fibre product of high quality with an evenly distributed fibre density and uniform surface.

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PLANT FOR PRODUCING A NON-WOVEN FIBRE PRODUCT

The invention concerns a plant for producing a non-woven, web-formed fibre product, and comprising a forming wire with an inlet and outlet end, and an upper wirepart which, at the inlet end, picks up a carded or air-laid layer of fibres and transports it to the outlet end, and a roller with an upper and lower roller part for compressing the fibre layer.

A wide variety of different fibres are used to produce fibre products, for example, cotton fibre, cellulose fibre, synthetic fibre, and combinations of these fibres.

In general, a loosely continuous layer of fibres is put on the forming wire with a card or a fibre distributor in a thickness of e.g. 25 mm. From the forming wire, the fibre layer continues to a roller, where it is rolled into a thinner layer with a thickness of e.g. 0.1 mm. This rolled down fibre layer then passes through one, or several rollers which, depending on type and application, warm and crosslink the fibres, roll on a pattern, and cool down the fibre layer.

There is an open section between the outlet end of the forming wire and the roller, where the now freely hanging fibre layer is not supported. The layer must therefore be tightened in order for it to be sufficiently stabilised for being fed into the roller without break-downs or production faults occuring. This tightening means that the fibre layer is stretched and becomes thinner. However, the layer has a natural tendency to be stretched most in those areas where it is, already, thinnest. The structure of the finished product therefore varies in density and strength, and the surface appears uneven and blotchy. This means that the product cannot satisfactorily meet today's high quality requirements as regards the quality and appearance of such products.

Even if the fibre layer is stretched while it passes this open section, the freely hanging layer continues to be very unstable, and this lack of stability limits the production speed of conventional systems. There are thus no known systems of this type which can operate at production speeds of over 200 m/min.

The fibre layer has a large content of air which, during the compression process in the roller flows out via, amongst others, the freely hanging fibre layer. When the production speed exceeds a certain limit, the air flow has such a force that the relatively loosely connected fibres in the freely hanging fibre layer are not able to resist the air pressure sufficiently. In this case, the fibre layer could more or less be blown apart by the air, thus making further rolling difficult and reducing the quality of the finished product.

In order to rectify this drawback, an attempt has been made to precompress the fibre layer already during transport on the wire by using a second wire, inclined towards the transport direction, and placed above the fibre layer of the first wire. The fibre layer is, in this way, successively pressed together between the two wires during transport to the outlet end of the first wire. However, it has become apparent that after this purely mechanical compression, the fibre layer has a tendency to spring back into shape to such an extent when passing this open section, that the following heat treatment process for binding the fibres together has not been able to run satisfactorily.

The object of the invention is to show a plant of the kind mentioned in the opening paragraph for producing a non-woven, web-formed fibre product of high quality and having an evenly distributed fibre density and a uniform surface, at a higher production speed than otherwise known today.

The novel and unique features whereby this is achieved, is the fact that the plant moreover comprises a second wire having a lower part extending through the roller, together with a suction arrangement placed above this part. The differential pressure formed by this arrangement presses the fibre layer firmly up against the lower part of the second wire which thus acts as an effective support for the fibre layer while it runs between the outlet end of the forming wire and the roller. This means that the fibre layer now passes through this open section in a stable condition thus enabling the plant according to the invention to operate at much higher production speeds than corresponding conventional systems. Another advantage of this new plant is that the fibre layer is pre-compressed by the differential pressure above the fibre layer. This reduces its thickness, which means that it is easier for the fibre layer to be caught by the roller. The differential pressure also counteracts the damaging effect of the flowing air from the compressing process in the roller.

When the lower part of the second wire is extending right across to the outlet end of the first wire, and the suction arrangement, at the same time, is extending between the outlet end of the first wire and the upper roller part of the roller, an optimal effect of the design is obtained as the fibre layer is supported throughout the entire distance between the outlet end of the first wire and the roller.

By allowing a section of the lower part of the second wire to extend over part of the fibre layer on the upper part of the first wire, the fibre layer can advantageously be precompressed during transport to the outlet end of the first wire.

According to one embodiment, the lower part of the second wire is allowed, during operation, to run at the same, or almost the same speed as the upper part of the first wire. This is an

advantage when a fibre structure is required which has a trim corresponding to that of the fibres placed on the inlet end of the first wire.

According to another embodiment, the first and second wire part run at different speeds, which means that the fibre layer between the two wires is subjected to a carding type of process. This can even out the fibre structure and assist in the pre-compression of the fibre layer.

The suction arrangement above the lower part of the second wire can be a fixed suction box which, during operation, is evacuated by means of a vacuum source. This construction is very simple and cheap.

However, the suction arrangement can also be a rotating, perforated drum. The advantage of this arrangement is that the circumference of the drum can follow the lower part of the second wire so closely that the negative pressure in the drum can be optimally used to support the fibre layer.

As with conventional systems, the upper part of the roller can be a roll and this roll can advantageously be connected to a vacuum source during operation, and can have a perforated wall. The air which is pressed out of the fibre layer during the compression process is, to a great extent, sucked into the upper roller instead of blowing out and damaging the fibre layer in front of the roller.

The roller can entirely be made of an elastomer such as, for example, rubber. The roller can also, for example, be made of steel having an outer rubber coating. The elastomer is deformed elastically during the compression process by the reaction pressure from the fibre layer. When the roll turns past the compressing area, the elastomer is again

straightened. Thereby, the fibre layer is loosened from the roll and can easily slip off the roll after passage.

As the fibre layer is supported and fed by the lower part of the second wire which, during operation, runs through the roller, a stationary, smooth rolling sheet can be used as the upper roller part instead of a roll. This rolling sheet is simple and inexpensive to produce and maintain.

When the sheet is perforated and extending in under the suction arrangement, the fabric and thus the fibre layer is supported very effectively in the area between the outlet end of the first wire and the roller.

To promote the pre-compression of the fibre layer during transport on the upper part of the first wire, an additional suction box can be placed under the first wire. By allowing two suction boxes to overlap each other, air in the fibre layer is effectively sucked out, and at the same time a considerable pre-compression is obtained.

In an especially advantageous embodiment, the plant can include a third forming wire having an upper part which follows the underside of the lower part of the second wire along a section and at a distance above the roller. Between this section and the roller, a second suction arrangement can be positioned above the lower part of the second wire. With this design, the plant can be adapted for the production of two different products.

In one case, the fibre layer can, during operation, run around the lower roll of the roller and one or several subsequent treatment rollers and then be further transported by the third wire. In this way, the fibre layer is continuously supported. This means that the plant can be used for the production of

fibre products which, at least during this part of the process, do not have any real strength and cohesion.

Another product can be of such a type that the fibre layer does not need to run around any separate treatment rolls. After the roller, the fibre layer is immediately sucked onto the under side of the lower part of the second wire. In this way, it is effectively supported until support is taken over by the upper part of the third wire.

The invention will be explained in greater details below, describing only exemplary embodiments with reference to the drawing, in which

Fig. 1 shows a conventional plant for producing a non-woven, web-formed fibre product with a forming wire and a roller with an upper and lower roll,

Fig. 2 shows a first embodiment of a plant according to the invention which has a first forming wire and a second forming wire with a suction box, together with a roller having an upper and lower roll,

Fig. 3 shows a second embodiment of a plant according to the invention which has a first forming wire and a second forming wire with a suction box, together with a roller with an upper, perforated roll and a lower roll,

Fig. 4 shows a third embodiment of a plant according to the invention which has a first forming wire and a second forming wire with a suction box, together with a roller with an upper stationary rolling sheet and a lower roll,

Fig. 5 shows a fourth embodiment of a plant according to the invention which has a first forming wire and a second forming wire with a suction box, together with a roller with an upper,

stationary rolling sheet extending in under the suction box, and a lower roll,

Fig. 6 shows a fifth embodiment of a plant according to the invention which has a first forming wire and a second forming wire with a suction arrangement in the form of a perforated drum, together with a roller having an upper and lower roll, and

Fig. 7 shows a sixth embodiment of a plant according to the invention which has a first forming wire, a second forming wire with a suction box and a third forming wire with a suction box, together with a roller with an upper and lower roll.

Figure 1 shows a conventional plant for producing a non-woven, web-formed fibre product 1. In principle, the plant comprises a forming wire 2 and a roller 3 which comprises upper and lower rotational rolls 4, 5. These are placed at a distance from each other which, in the main, corresponds to the required thickness of the finished product 1. During operation, the forming wire and the rolls run in the direction indicated by the arrows. In the example shown, there is also a pre-compression wire 6 positioned above the first wire at a downwards inclination in relation to the transport direction of the first wire.

During operation, the forming wire 2 runs at an inlet end 7 over a roller 8, and at an outlet end 9 over a second roller 10. The pre-compression wire 6 runs over a first roll 11 positioned in an area between the inlet and outlet ends of the forming wire, and a second roll 12 at the outlet end of the forming wire.

When the plant is in operation, a card (symbolised with the arrow C in the drawing) applies a layer of loose fibres 13

onto the upper part 14 of the forming wire at the inlet end 7. It should be noted that other methods can, within the scope of the invention, be used to apply the fibres to the forming wire, for example, it can be air-laid using a fibre distributor.

The geometry of respectively roller rolls 4, 5 and the wire rolls 10,12 means that there is, between the outlet end 9 of the forming wire and the roller 3, an open section a which provides no support for the fibre layer. When passing this section, the fibre layer therefore hangs down freely between the outlet end of the forming wire and the roller. At the same time, it moves at a relatively high speed under the influence of the air resistance from the surrounding air. During the compression process in the roller, air is also pressed out of the fibre layer. This air blows with considerable force across the freely hanging fibre layer and this, together with the air resistance, causes the fibre layer to shake. When the speed exceeds a limit of between 100 and 200 m/min, the fibre layer shakes so much that its passage in the roller becomes erratic and incidental. This can cause operational failures and faulty production.

In order to stop this shaking, the freely hanging fibre layer is tightened by making the roller run slightly faster than the forming wire. This means that the thin areas of the fibre layer become even thinner, giving the final product a poor quality. The density and strength of the product become irregular and its surface blotchy.

The expelled air from the compression process in the roller flows, amongst others, into the freely hanging fibre layer which thus is blown up into a thicker and looser continuous layer with an increased tendency to shake.

The gap between rolls 4, 5 of roller 3 is often very narrow. Systems of this type are used, amongst others, for the production of fibre products having a thickness of e.g. 0.1 mm. It is naturally very difficult to introduce a 25 mm fibre layer into a gap which is designed for very thin products, and therefore, in the example shown, the thickness of the fibre layer is reduced in advance during transport on the forming wire using the pre-compression wire 6. After being compressed in this way, the fibre layer has a tendency to spring back into shape when passing the open section between the forming wire and the roller. This means that the advantage of pre-compressing the fibre layer is partially lost.

Fig. 2 shows a first embodiment of the plant according to the invention. Basically, this plant is built up in the same way as the plant shown in figure 1, which means that the parts used in both of the systems have been given the same reference number.

In addition to the forming wire 2, which in the following will be called the first wire 2, is a second wire 15 with a lower part 16 which, along a section, abuts on the upper side of fibre layer 13. The second wire 15 runs over a first roll 17 positioned in an area above the first wire 2 and a second roll 18 positioned after the roller 3. During operation, the part 16 runs right across the gap between the two rolls 4 and 5 of the roller. In addition, a suction box 19 is placed above the lower part 16 of the second wire. During operation, this box is connected to a vacuum source (not shown). A second suction box 20 which, during operation is connected to a vacuum source (not shown), is placed under the upper part 14 of the first wire. The two suction boxes overlap each other.

In principle, the plant works in the same way as the conventional plant shown in fig. 1. A card C places a fibre layer 13 on the first wire 2 at the inlet end 7, after which

the wire transports the fibre layer towards the outlet end 9. The second wire inclines downwards in the transport direction and therefore functions, in this section, as a pre-compression wire. The pre-compression process is promoted by sucking air out of the fibre layer by means of the suction boxes 19 and 20.

The suction box 19 positioned above the lower part 16 of the second wire, is extending to the upper roll 4 of the roller and thus over the open section a between the first forming wire 2 and roller 3. When passing this sectopm, the fibre layer is firmly pressed up towards the under side of the lower part of the second wire by the pressure differential between the pressure in the suction box and the pressure of the surrounding air. In this way, the fibre layer is effectively supported, thus eliminating the disadvantage of the conventional plant mentioned above and illustrated in fig. 1.

The fibre layer now no longer needs to be stretched in order to avoid shaking and the finished product is therefore of a high quality. In addition, the expansion of the fibre layer in the open section is counteracted by the outer effect of the differential pressure on the surface of the fibre layer and the continuous fibre layer is safely guided into the roller gap. This means that operational failure and faulty production are no longer likely to occur.

The lower roll 5 of the roller can be designed as a heat roll which can heat the product 1, thus crosslinking its fibres. In the example shown in fig. 2, the product 1 subsequently runs around a third roll 21 which, for example, can be a patterned roll (not shown). In other cases, additional rolls can be added (not shown) which, in themselves, treat the product in a manner known per se.

Fig 3 shows a second embodiment of the plant according to the invention. In all respects but one, this design corresponds to that shown in figure 2 and will therefore not be described in further detail here. The one aspect which differs is that the upper roll 22 of roller 3 now has a perforated wall and is connected to a vacuum source (not shown) during operation. The advantage of this design is that it sucks up the air which is forced out of the fibre layer when it is compressed in the roller. In this way, the air does not disturb the incoming fibre layer. As shown, the suction box 19 is extending right across the perforated roll 22, and thus can also be evacuated via the suction box.

Figure 4 shows a third embodiment of the plant according to the invention. This version also corresponds to the version shown in fig 2. In this case, the upper roll of the roller has, however, been replaced by a smooth rolling sheet 23. The reason why it is now possible to use a stationary plate in this way, instead of a rotating roll is that the lower part 16 of the second wire serves for feeding the fibre layer while it passes the roller 3. This design is very cheap and reliable.

Fig. 5 shows a corresponding fourth embodiment of the plant according to the invention with a variation 24 to the rolling sheet 23 shown in fig. 4. In this case, the rolling sheet 24 is however extending with an extension 25 under the suction box 19, and is therefore equipped with a number of holes 26. These holes allow the negative pressure in the suction box to be transmitted down to the upper side of the fibre layer. The extended rolling sheet supports advantageously the lower part 16 of the second wire before and during the passing of the open section between the first wire 2 and roller 3, thus ensuring the effective stabilisation of the fibre layer during this phase.

Fig. 6 shows the fifth embodiment of the plant according to the invention which corresponds to that shown in figure 2. However, instead of a suction box 19 a rotating drum 27 is used during operation which, along the circumference runs at the same speed as the lower part 16 of the second wire and in close contact with it. There is a screen 28 around the drum 27. This design distinguishes itself in that it prevents the drum, via the gap between the transition to the fibre layer, from filling with air which could prevent the necessary negative pressure in the drum from building up.

Fig. 7 shows the sixth embodiment of the plant according to the invention. This also corresponds to the plant shown in figure 2, but in this case, an underlying third wire 28 is added which runs over a number of rollers of which the figure only illustrates a first roller 29 and a second roller 30.

In this embodiment, the plant can function in two different ways which can be selected to suit the character of the fibre product used.

A solid line shows how a fibre product 1 passes the roller 3, runs around its lower roll 5, and further around another roll 21, for example a patterned roll, for then to be supported by the third wire 28 and transported around the second roll 30 and further on wire 28 in the direction of the arrow. As the product is supported at all times during this process, this function method is especially good for relatively weak fibre products.

Using another function method, the fibre product 1 can also pass straight out after roller 3, without having to run round other rolls, as shown by the dotted line in fig. 7. With regard to supporting the fibre product over the section between roller 3 and the second roller 30 of the third wire, there is, above the lower part 16 of the second wire, a third

suction box 31 which, during operation, is connected to a vacuum source (not shown) and which sucks the fibre product firmly to the under side of wire web 16.

C l a i m s

1. A plant for producing a non-woven, web-formed fibre product, and comprising a forming wire with an inlet and outlet end and an upper web which, at the inlet end, picks up a carded or air-laid layer of fibre and transports it to the outlet end, and a roller with an upper and lower roller part for compressing the fibre layer, **characterized** in that the plant also comprises a second wire with a lower part which is extending right across the roller, and a suction arrangement which is positioned above this web.

2. A plant according to claim 1, **characterized** in that the lower part of the second wire is extending at least to the outlet end of the first wire.

3. A plant according to claim 1 or 2, **characterised** in that the suction arrangement over the lower part of the second wire is extending at least between the outlet end of the first wire and the upper roller part of the roller.

4. A plant according to claim 1, 2 or 3, **characterised** in that a section of the lower part of the second wire is extending across part of the fibre layer on the upper part of the first wire.

5. A plant according to each of the claims 1 - 4, **characterised** in that, during operation, the lower part of the second wire mainly runs at the same, or more or less the same speed as the upper part of the first wire.

6. A plant according to each of the claims 1 - 4, **characterised** in that, during operation, the lower part of the second wire runs at a different speed than the upper part of the first wire.

7. A plant according to each of the claims 1 - 6, **characterised** in that the suction arrangement above the lower part of the second wire comprises a suction box which, during operation, is connected to a vacuum source.

8. A plant according to each of the claims 1 - 7, **characterised** in that the suction arrangement above the lower part of the second wire comprises a rotating perforated drum which, during operation, is connected to a vacuum source.

9. A plant according to each of the claims 1 - 8, **characterised** in that the upper part of the roller is a roll which has a perforated wall and which, during operation, is connected to a vacuum source.

10. A plant according to each of the claims 1 - 9, **characterised** in that the upper part of the roller is a roll made of an elastomer such as, for example, rubber or which has an outer coating of such an elastomer.

11. A plant according to each of the claims 1 - 7, **characterised** in that the upper part of the roller is a stationary, smooth sheet.

12. A plant according to each of the claims 1 - 7, **characterised** in that the upper part of the roller is a perforated sheet extending in under the suction arrangement.

13. A plant according to each of the claims 1 - 12, **characterised** in that a suction box overlapping the suction box of the second wire is placed under the upper part of the first wire.

14. A plant according to each of the claims 1 - 13, **characterised** in that it comprises a third forming wire with

an upper part which follows the under side of the lower part of the second wire along a section and at a distance from the roller, and that there, between this section and the roller, is a second suction arrangement which is positioned above the lower part of the second wire.

AMENDED CLAIMS

[received by the International Bureau on 8 May 1998 (08.05.98); original claims 1 - 14 replaced by amended claims 1 - 13 (3 pages)]

1. A plant for producing a non-woven, web-formed fibre product, and comprising a forming wire with an inlet and outlet end and an upper web which, at the inlet end, picks up a carded or air-laid layer of fibre and transports it to the outlet end, and a roller with an upper and lower roller part for compressing the fibre layer, and the plant also comprises a second wire with a lower part which is extending right across the roller, and a suction arrangement which is positioned above this web, **characterized** in that the lower part of the second wire is extending at least to the outlet end of the first wire.

2. A plant according to claim 1, **characterised** in that the suction arrangement over the lower part of the second wire is extending at least between the outlet end of the first wire and the upper roller part of the roller.

3. A plant according to claim 1 or 2, **characterised** in that a section of the lower part of the second wire is extending across part of the fibre layer on the upper part of the first wire.

4. A plant according to each of the claims 1-3, **characterised** in that, during operation, the lower part of the second wire mainly runs at the same, or more or less the same speed as the upper part of the first wire.

5. A plant according to each of the claims 1-4, **characterised** in that, during operation, the lower part of the second wire runs at a different speed than the upper part of the first wire.

6. A plant according to each of the claims 1-5, **characterised** in that the suction arrangement above the lower part of the second wire comprises a suction box which, during operation, is connected to a vacuum source.

7. A plant according to each of the claims 1-6, **characterised** in that the suction arrangement above the lower part of the second wire comprises a rotating perforated drum which, during operation, is connected to a vacuum source.

8. A plant according to each of the claims 1-7, **characterised** in that the upper part of the roller is a roll which has a perforated wall and which, during operation, is connected to a vacuum source.

9. A plant according to each of the claims 1-8, **characterised** in that the upper part of the roller is a roll made of an elastomer such as, for example, rubber or which has an outer coating of such an elastomer.

10. A plant according to each of the claims 1-6, **characterised** in that the upper part of the roller is a stationary, smooth sheet.

11. A plant according to each of the claims 1-6, **characterised** in that the upper part of the roller is a perforated sheet extending in under the suction arrangement.

12. A plant according to each of the claims 1-11, **characterised** in that a suction box overlapping the suction box of the second wire is placed under the upper part of the first wire.

13. A plant according to each of the claims 1-13, **characterised** in that it comprises a third forming wire with

an upper part which follows the under side of the lower part of the second wire along a section and at a distance from the roller, and that there, between this section and the roller, is a second suction arrangement which is positioned above the lower part of the second wire.

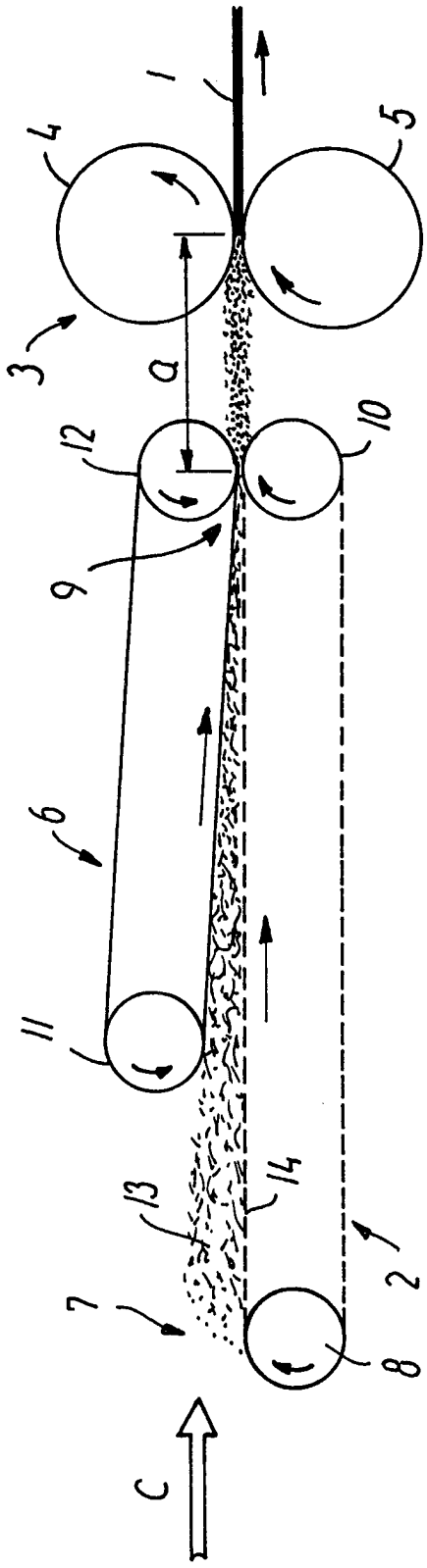

FIG.1

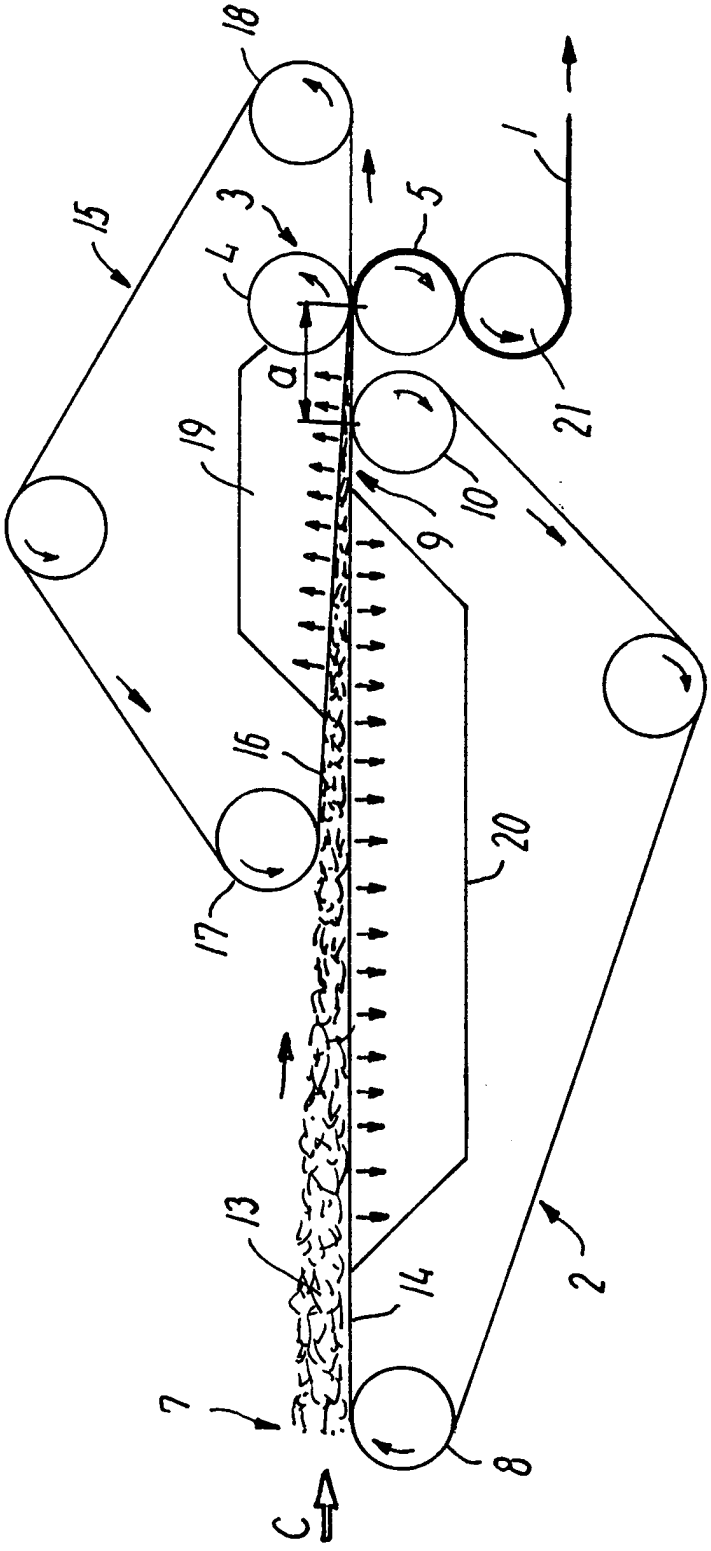

FIG.2

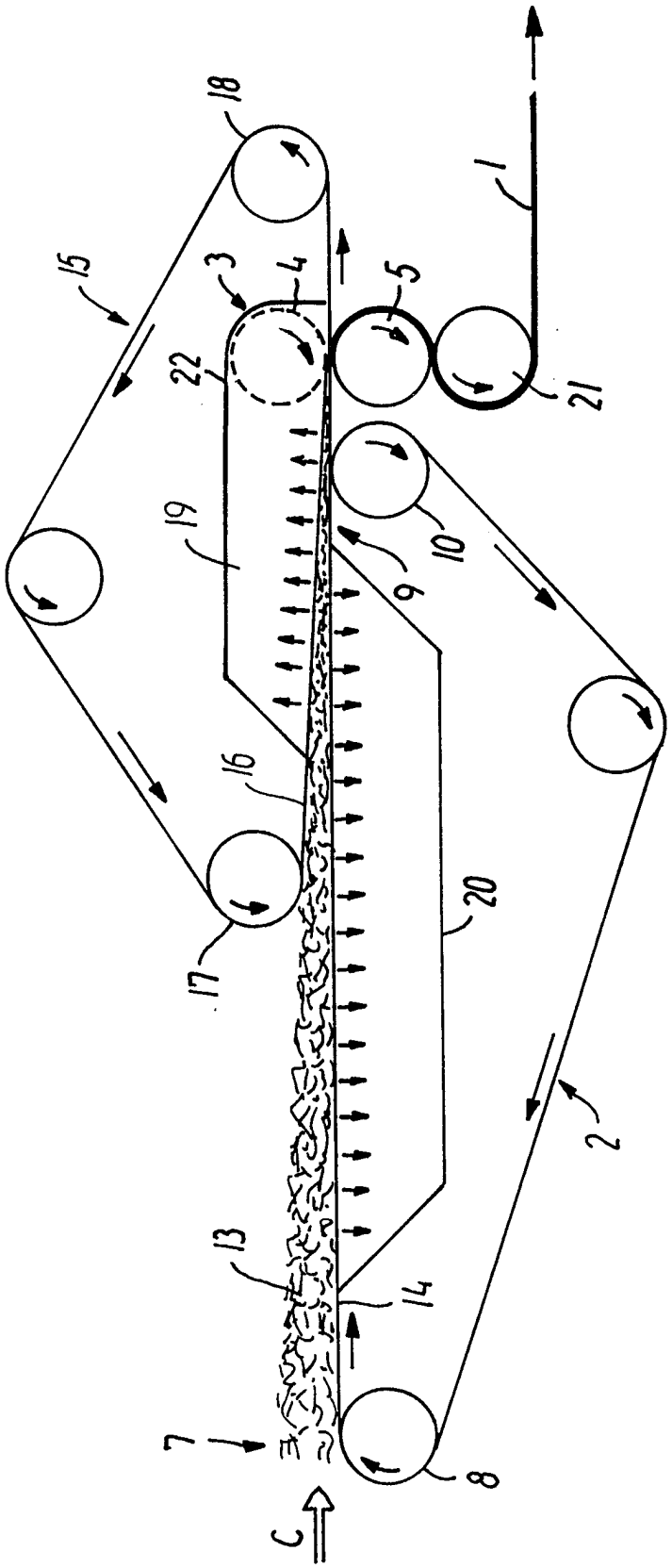

FIG.3

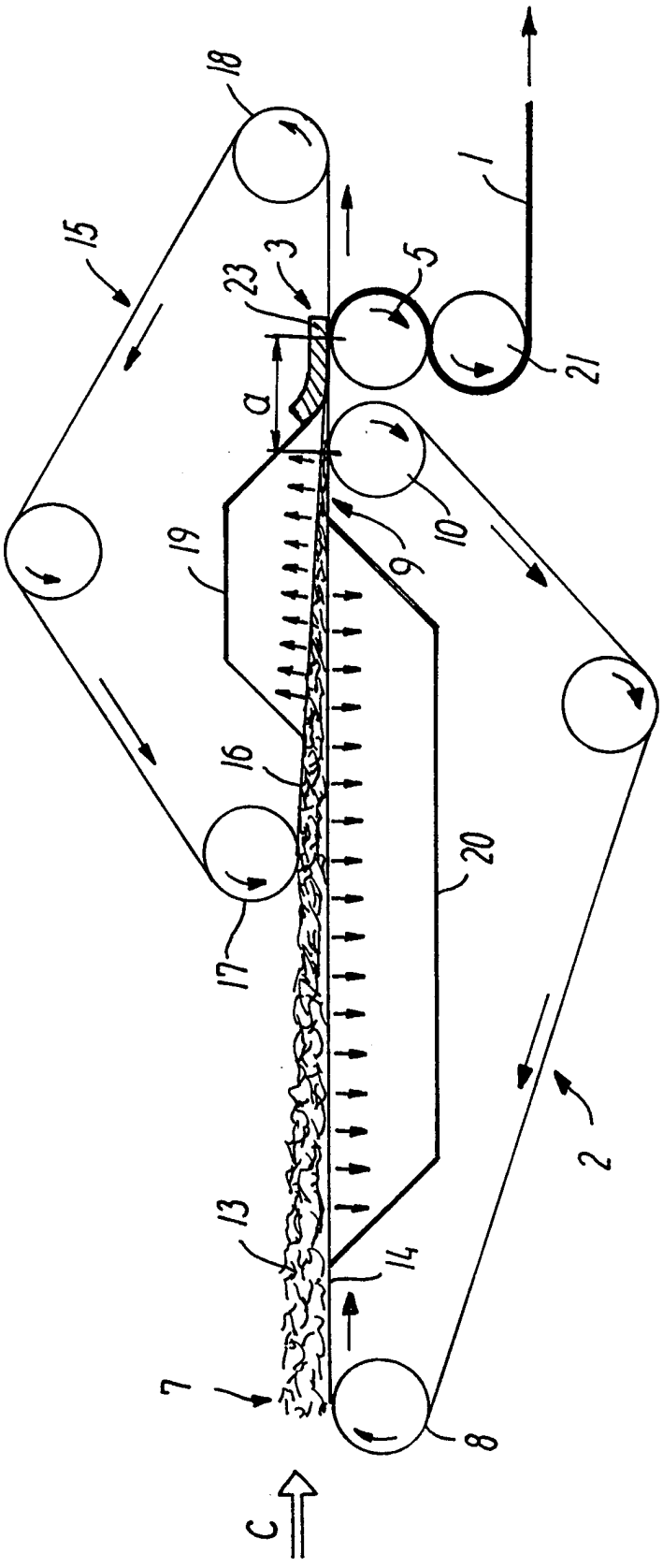

FIG. 4

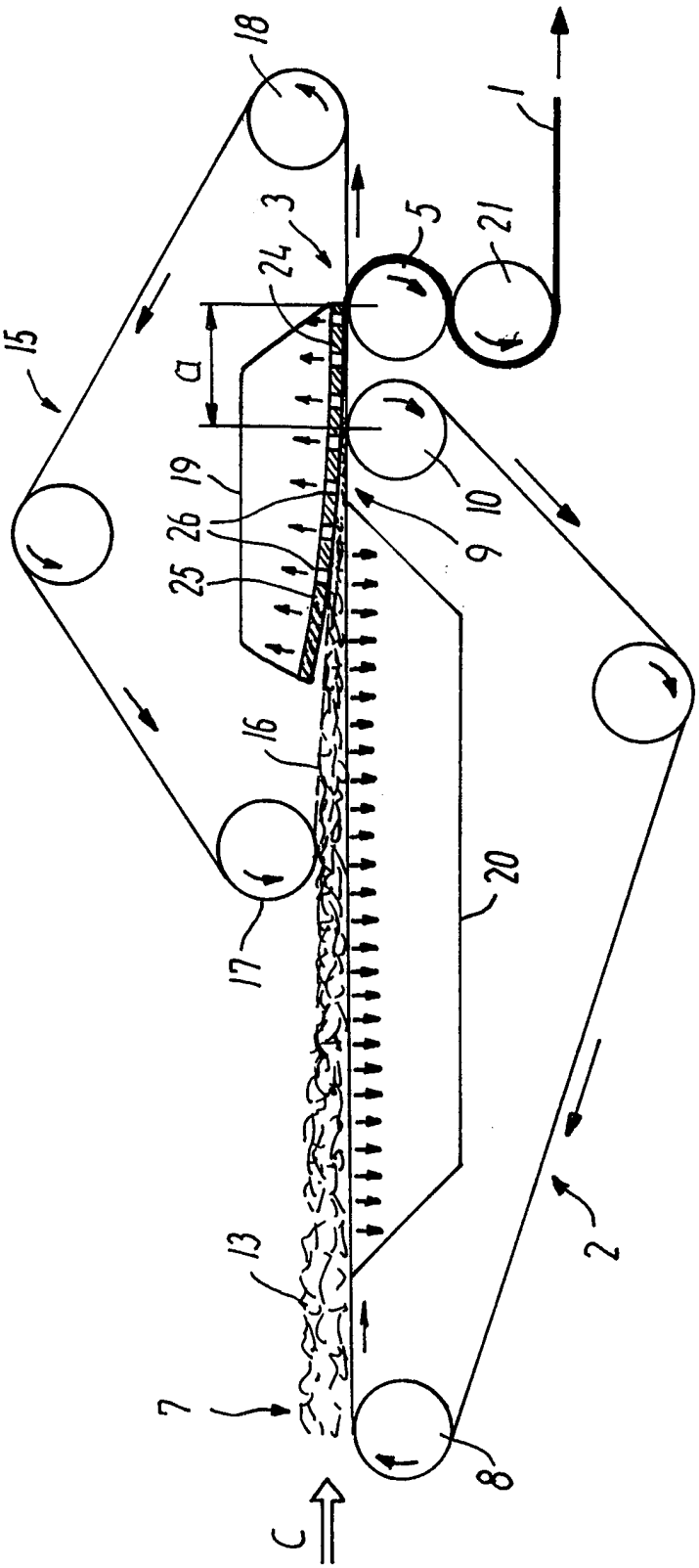

FIG.5

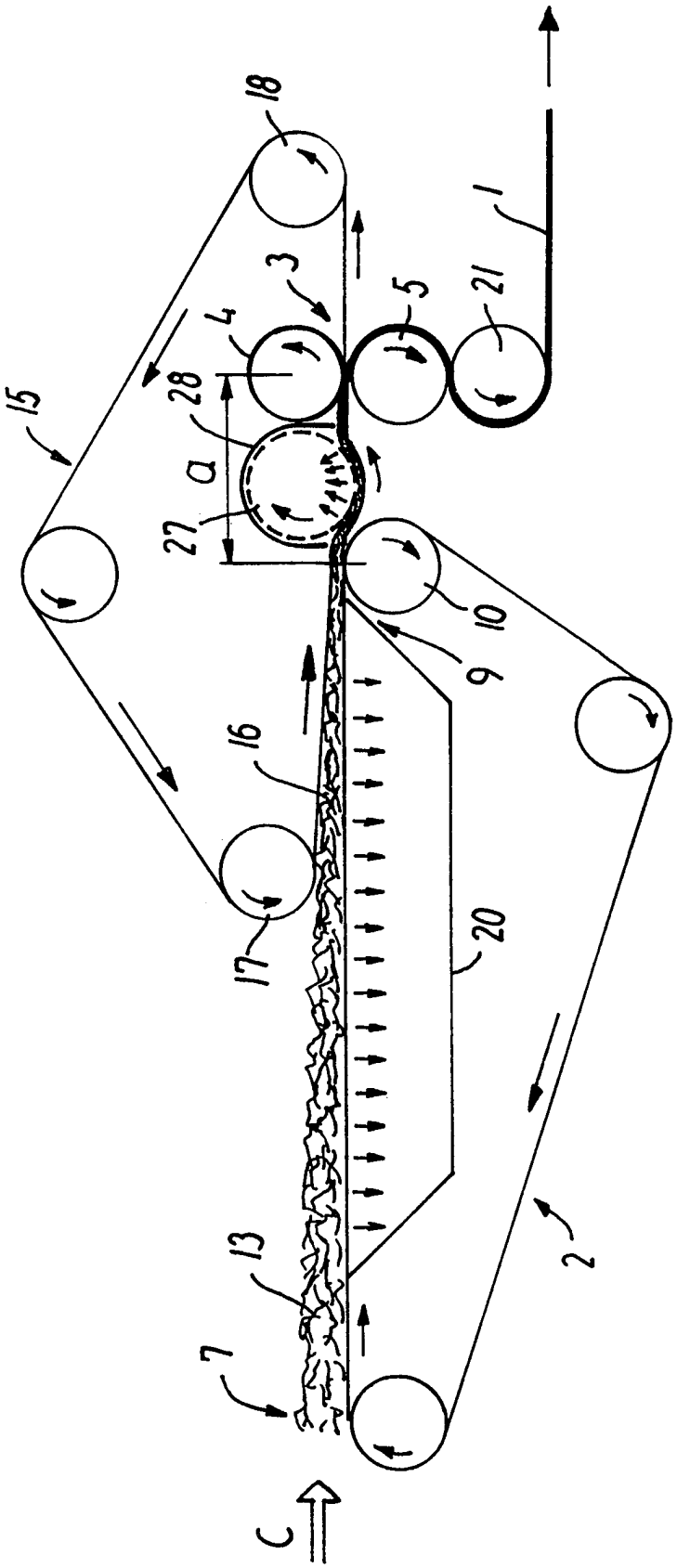

FIG. 6

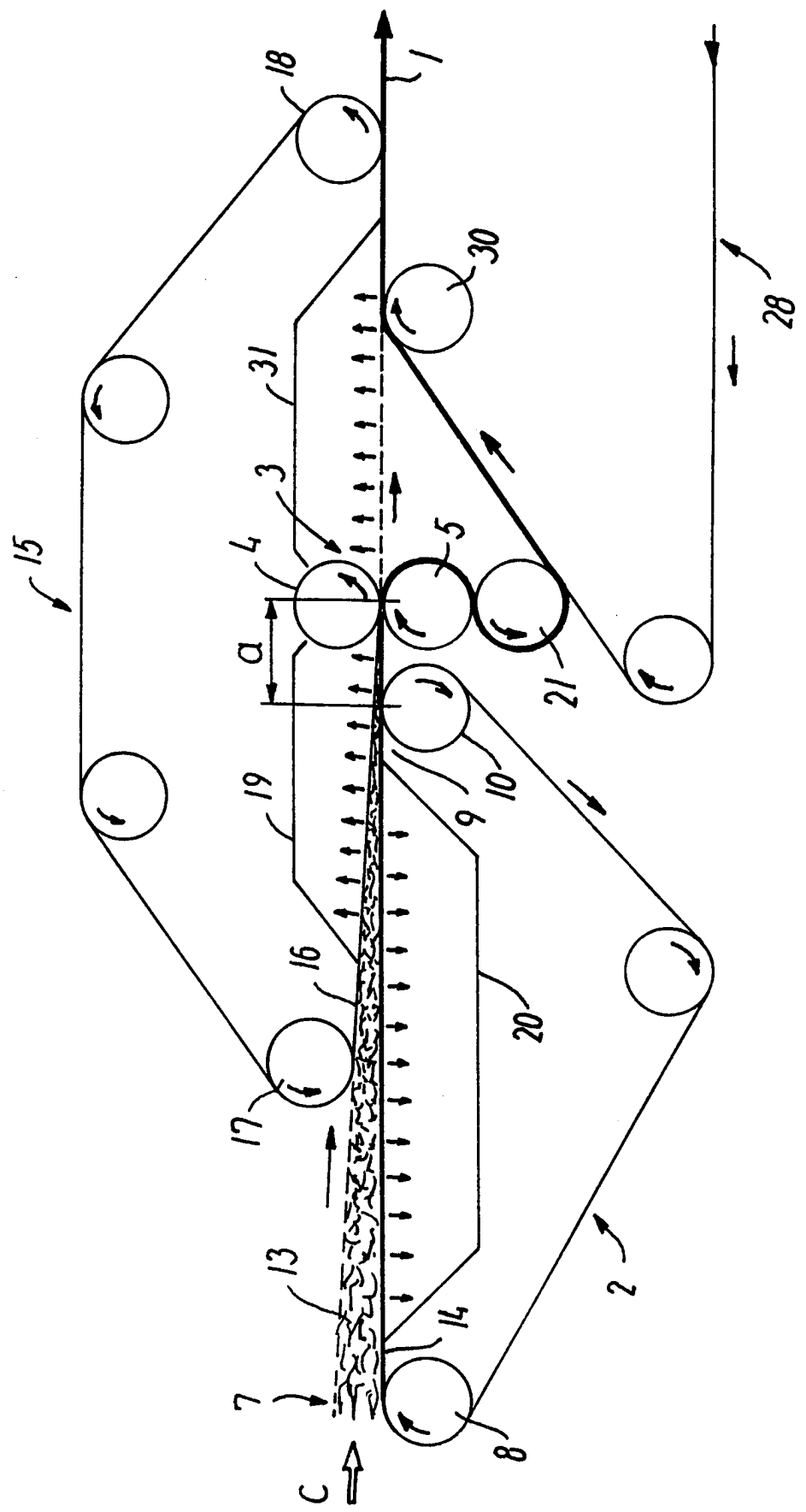

FIG.7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 97/00578

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: D04H 1/72
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: D04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPAT, JAPIO; CLAIMS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4146564 A (J.R. GARRICK ET AL), 27 March 1979 (27.03.79), column 1, line 31 - line 54; column 4, line 18 - line 24, figure 1 --	1
Y	US 4476175 A (J.S. FORRY ET AL), 9 October 1984 (09.10.84), column 7, line 18 - line 38; column 8, line 1 - line 10, figure 1 --	1

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 March 1998	02 -04- 1998
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Catarina Forssén Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/03/98

International application No.
PCT/DK 97/00578

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