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(54) METHOD AND APPARATUS FOR MANUFACTURING MULTILAYER FILTER MATERIAL.

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Description

The present invention relates generally to a method and apparatus for manufacturing webs of multilayer filter materials on the wire of a multichannel inclined wire former and is directed, more particularly, to a novel method and apparatus for producing filter paper for use in air and oil filters which have a high filtration capability.

It is known that to filter particles from gases or fluids, filter materials which are made of layers of different densities should be used in order to achieve a longer service life of the filter.

Methods and apparatuses for the manufacture of multilayer filter papers are known.

Multilayer filter papers can be made by forming the individual layers on the wires of individual web formers and couching them together or by laminating.

U.S. patent No. 2,928,765 describes a process for the manufacture of a double-layered air filter paper on a web former using an inclined wire. The process comprises the steps of forming a coarse-pored layer by flowing a first slurry of fibers onto the inclined wire and forming a fine-pored layer by immediately thereafter flowing a second slurry of fibers onto the wire.

DE-AS No. 1220716 describes an apparatus for the manufacture of multilayer fibrous webs wherein the stocks are supplied to the inclined wire of a web former through a plurality of horizontally arranged individual channels.

When the multilayer filter material is formed on an inclined wire and the slurries or fibers for the different layers are applied one immediately after the other before drainage and consolidation, an intermingling of the fibers at the interfaces between the layers is achieved. Due to the presence of the mixed zones, the filtration results of the filter material are positively influenced.

When the multilayer filter is produced by couching together individual layers formed on the wires of individual web formers, no such intermingling of the fibers between the layers is caused.

Depending on the use of the filter material, different filtration properties are required. The porosity grade and the basis weight are chosen so that, as regards the efficiency and the service life of the filter material, optimal values are achieved.

The object of the present invention is to provide a new and improved method and apparatus for the manufacture of webs of multilayered filter material, by means of which filter webs having better properties than webs hitherto formed, and which can more easily be adapted to meet a variety of requirements as regards the capacity, efficiency, bulkiness, lifetime, basis weight etc. of the filter material, can be produced.

Other objects, features and advantages of the invention will be readily apparent from the following description of a representative embodiment thereof, taken in conjunction with the accompanying drawing although variations and modifications may be effected without departing from the spirit and scope of the novel concept embodied in the following detailed description of the invention.

The method of the present invention comprises the steps of delivering stock to an inclined wire portion and optionally to a horizontal or a substantially horizontal wire portion of a forming wire, and forming layers of fibers in consecutive forming zones in each of which a layer of fibers, superimposed on the layer formed in the preceding forming zone, is to be formed. It is a characteristic feature of the method according to the invention that the layers are formed in forming zones the length of which gradually increases on the inclined wire portion in the direction of travel of the forming wire. Preferably the layers are formed in forming zones of gradually decreasing inclination.

The present invention is also directed to an apparatus for manufacturing webs of multilayer filter material, comprising a web former provided with a forming wire having at least one inclined wire portion and a horizontal or substantially horizontal wire portion, and a multichannel headbox in which the flow channels are arranged one above the other in such a way that the upper wall of one channel forms the lower wall of the flow channel above it, said flow channels leading to subsequent forming zones in each of which a layer of fibers, superimposed on the layer formed in the preceding forming zone, is to be formed. It is a characteristic feature of the apparatus according to the invention that the length of the forming zones on the inclined wire increases gradually in the direction of travel of the forming wire. Preferably the inclination of the wire of the inclined wire portion decreases gradually.

According to a preferred embodiment of the invention, the inclined wire is supported by drainage rolls.

In the following description, by way of example, reference will be made to the accompanying drawings, in which

Fig. 1 is a schematic elevational sectional view showing a former for use in the practice of the present invention,

Fig. 2 is an enlarged fragmentary elevational sectional view showing one of the drainage zones shown in Fig. 1,

Fig. 3 is a longitudinal section of the drainage roll shown in Fig. 2,
Fig. 4 is an enlarged fragmentary elevational sectional view showing the transition region between the inclined wire and the horizontal wire portion,
Fig. 5 illustrates the flow control system of a forming zone, and
Fig. 6 shows another embodiment of the invention.

Fig. 1 illustrates a web former 2 adapted for producing a multilayered filter paper. It comprises a forming fabric such as a wire 4 running in an endless loop around a breast roll 6 and a plurality of return rolls, guide rolls and stretch rolls 8 in a manner known per se. The wire comprises an inclined wire portion 10 and a horizontal or substantially horizontal wire portion 12. A headbox 14 is by means of partition walls 16_1 - 16_n divided into individual flow channels 18_1 -18_n facing the inclined wire.

Each flow channel has an upper wall and a lower wall and the upper wall or lip 16_n of one channel 18_{n-1} forms the lower wall or lip of the flow channel 18_n on top of it.

The inclined wire portion is supported by a plurality of drainage rolls 20_1- 20_n, which define a plurality of flat forming zones 22_1 - 22_n the inclination angle α of which decreases in the traveling direction A of the wire. The location and length of each forming zone corresponds generally to the location and length of the portion 24_1 -24_n of the wire on which fibers from a flow channel 18_1 -18_n is deposited. Thus, each flow channel leads to a flat forming zone having a different inclination angle which can be changed if required.

The drainage roll 20 is shown more in detail in Figs 2 and 3. The roll comprises a rotatable shaft 30 on which a plurality of discs 32 are disposed a distance apart from each other. A plurality of longitudinal rods 34 are attached to the rims of the discs spaced apart from each other so as to form a roll having a very low flow resistance. In operation, the roll allows the wire to move towards the roll center every time the gap between a successive pair of rods passes under the wire, which causes oscillation of the wire, whereby the formation and dewatering of the fiber layers on the wire are positively influenced.

Under the wire, there is a plurality of vacuum or suction drainage boxes 26 in each of which a plurality of support elements 28 such as deflector or hydrofoil or foil blades may be disposed. The drainage rolls 20 are also disposed in the drainage boxes.

The flow to each flow channel is separately controlled in relation to the wire speed by means of a flow regulator circuit in order to achieve a desired ratio between stock flow and wire speed as shown in Fig. 5, which illustrates the control system for one of the flow channels. The drainage at each forming zone is regulated according to the flow of the corresponding flow channel by means of flowmeters controlling the flow through each drainage box acting on a vacuum control in the drainage box. The level in the drainage boxes is kept constant by means of a level regulating circuit. The flow of stock through line 36 to flow channel 18 is measured by a flow meter 38. The flow of white water from the drainage boxes 26 is measured by flow meters 40. The level of the white water in the drainage boxes is controlled by level controller 42 and valves 44. A vacuum pump 46 is connected to the drainage boxes. A pressure controller 48 is connected to the drainage box. A flow controller 50 is connected to vacuum controller 48 and flow controller 40. An equilibrium is maintained between the volume flow of stock to the flow channel and the volume flow of white water from the drainage boxes, i.e. the quantity of liquid which is passing through the wire. The quantity of stock which can be applied is limited by the drainage resistance of the fiber mat on the wire.

The flow channel 18_{n+1} leading to the horizontal wire portion is controlled as a conventional headbox by controlling the pressure in such a way that a desired ratio between the stock flow and wire speed is achieved. Also the flow channel 18_n must be controlled in accordance with the velocity of the outlet flow as a portion of this flow leads to the horizontal wire portion.

The filter paper is built up of a plurality of layers. Each layer is superimposed on the layer formed in the preceding forming zone. As the drainage resistance of the fiber mat increases from one forming zone to the next, the dewatering pressure has to increase correspondingly. However, as the inclination of the wire decreases in the traveling direction of the wire, the length of the forming zones increase towards the end of the inclined wire portion. This means that the available drainage time increases which compensates for the increasing drainage resistance.

At least a substantial part of the sheet will be formed on the inclined wire. The uppermost layer, which has the highest density and which normally is on the exit side of the filter paper, is formed on the horizontal wire from stock delivered by a flow channel 18_{n+1} disposed on top of flow channel 18_n. The stock for the last layer, as well as for all the other layers, is deposited on a sheet which is not yet fully formed, as shown in Fig. 4, so that there is caused an intermingling of the fibers at the interface. In the transition region between the inclined wire 10 and the horizontal wire 12 there is still fiber suspension from the last inclined formation zone 22_n.

The stock delivery system comprises a plurality of stock chests 52_1 - 52_n. Each stock chest is connected to a stock pump 54_1 - 54_n through lines 56_1 - 56_n and 58_1 - 58_n which form stock circuits by means of which at least a portion of the stock withdrawn from each stock chest can be returned to it.

The white water from forming zone 22, is collected in a first white water pit 60_1. The white waters from the other forming zones 22_2 - 22_n are collected in a second white water pit 60_2. Alternatively each forming zone could be provided with its own white water pit. Each flow channel is connected to a mixing pump 62_1 - 62_n through a stock delivery line 64_1 - 64_n. The mixing pump 62_1 is connected to the first white water pit through a white water return line 66_1 and the mixing pumps 62_2 - 62_n are connected to the second white water pit through white water return lines 66_2 - 66_n so as to form a plurality of flow circuits. The inlet of the first mixing pump 62_1 delivering stock to the first flow channel 18_1 is connected to each of the stock circuits through connecting lines 68_1 - 68_n. The inlet of the second mixing pump 62_2 delivering stock to the second flow channel 18_2 is in a corresponding way connected to each of the stock circuits through lines (not shown) etc. In each of the connecting lines, there is a valve 70_1-70_n by means of which stock from one or more elected stock chests can be delivered to one or more selected flow channels. This provides for a high flexibility of the operation of the multilayer filter paper machine.

Fig. 6 shows another embodiment of the invention in which the inclination angle α is constant. The angle β between the upper wall or lip 16 and the wire 4 decreases gradually in the direction of travel A of the wire so as to increase the length of the formation zone 24 towards the end of the inclined wire portion without increasing the lip opening H.

The invention is typically put into practice in the production of 3-layered filter paper, two layers of which are formed on the inclined wire portion and the third on the horizontal portion of the forming web. Alternatively, all layers can be formed on the inclined wire. It is clear that the method of the invention can be carried out by using a curving wire instead of an inclined wire comprising a plurality of flat sections as in the embodiment shown.

Claims

1. A method of manufacturing webs of multilayer filter material, comprising
   - delivering stock to an inclined wire portion and optionally to a horizontal or substantially horizontal wire portion of a forming wire,
   - forming layers of fibers in consecutive forming zones in each of which a layer of fibers, superimposed on the layer formed in the preceding forming zone, is to be be formed, **characterized** in that the layers are formed in forming zones the length of which is gradually increasing on the inclined wire portion in the direction of travel of the forming wire.

2. A method according to claim 1, **characterized** in that stock is supplied as jets forming an angle with the inclined wire, which gradually decreases.

3. A method according to claim 2, **characterized** in that the layers are formed in forming zones of gradually decreasing inclination.

4. A method according to claim 1, 2, or 3, **characterized** in that the least porous layer of the multilayer filter material is formed on the horizontal or substantially horizontal wire portion.

5. An apparatus for manufacturing webs of multilayer filter material, comprising
   - a web former provided with a forming wire having an inclined wire portion and a horizontal or substantially horizontal wire portion
   - a multichannel headbox in which the flow channels are arranged one above the other in such a way that the upper wall of one channel forms the lower wall of the flow channel above it, said flow channels leading to subsequent forming zones in each of which a layer of fibers, superimposed on a layer formed in the preceding forming zone, is to be formed, **characterized** in that the length of the forming zones on the inclined wire increases gradually in the direction of travel of the forming wire.

6. An apparatus according to claim 5, **characterized** in that the angle between the upper walls of the flow channels and the inclined wire decreases gradually.

7. An apparatus according to claim 5 or 6, **characterized** in that the inclination of the wire of the inclined wire portion decreases gradually.

8. An apparatus according to claim 6, **characterized** in that each consecutive flow channel leads to a forming zone of different inclination.

9. An apparatus according to claim 6, **characterized** in that at least one of the flow channels leads to a forming zone comprising two or more sections of different inclination.

10. An apparatus according to any of claims 5 - 9, **characterized** in that it comprises three flow channels leading to the inclined wire portion.

11. An apparatus according to any of claims 5 - 10, **characterized** in that a flow channel leading to the horizontal wire portion is disposed on top of the uppermost flow channel leading to the inclined wire portion.

12. An apparatus according to claim 11, **characterized** in that it comprises two flow channels leading to the inclined wire portion and one flow channel leading to the horizontal or substantially horizontal wire portion.

13. An apparatus according to any of claims 5 - 12, **characterized** in that the inclined wire is supported by drainage rolls.

14. An apparatus according to claim 13, **characterized** in that the drainage rolls are disposed in suction boxes.

Patentansprüche

1. Verfahren zur Herstellung von Vliesbahnen aus mehrlagigem Filtermaterial, bestehend aus
   - Auftragung von Faserstoff auf einen geneigten Siebabschnitt und optional auf einen horizontalen oder im wesentlichen horizontalen Siebabschnitt eines Formiersiebs,
   - Formieren von Faserschichten in aufeinanderfolgenden Formierzonen, in deren jeder eine der in der vorhergehenden Formierzone überlagerte Faserschicht gebildet werden soll, **dadurch gekennzeichnet**, daß die Schichten in Formierzonen gebildet werden, deren Länge auf dem geneigten Abschnitt in Laufrichtung des Formiersiebs stufenweise zunimmt.

2. Verfahren gemäß Anspruch 1, **dadurch gekennzeichnet,** daß Faserstoff als Strahlen aufgetragen wird, die einen gegenüber dem geneigten Sieb stufenweise abnehmenden Winkel bilden.

3. Verfahren gemäß Anspruch 2, **dadurch gekennzeichnet,** daß die Schichten in den Formierzonen mit stufenweise abnehmender Neigung gebildet werden.

4. Verfahren gemäß Anspruch 1, 2 oder 3, **dadurch gekennzeichnet,** daß die letzte poröse Schicht des mehrlagigen Filtermaterials auf dem horizontalen oder im wesentlichen horizontalen Siebabschnitt gebildet wird.

5. Vorrichtung zur Herstellung von Vliesbahnen aus mehrlagigem Filtermaterial, bestehend aus
   - einem Vliesformer, der mit einem Formiersieb versehen ist, das einen geneigten Siebabschnitt und einen horizontalen oder im wesentlichen horizontalen Siebabschnitt aufweist
   - einem mehrkanäligen Stoffauflauf, wo die Strömungskanäle auf solche Weise übereinander angeordnet sind, daß die obere Wand eines Kanals die untere Wand des darauf befindlichen Strömungskanals bildet, wobei die Strömungskanäle zu nachgeschalteten Formierzonen führen, in deren jeder eine einer in der vorhergehenden Formierzone gebildeten Schicht überlagerte Schicht formiert werden soll, **dadurch gekennzeichnet,** daß die Länge der Formierzonen auf dem geneigten Sieb in der Laufrichtung des Formiersiebs stufenweise zunimmt.

6. Vorrichtung gemäß Anspruch 5, **dadurch gekennzeichnet,** daß der Winkel zwischen den oberen Wänden der Strömungskanäle und dem geneigten Sieb stufenweise abnimmt.

7. Vorrichtung gemäß Anspruch 5 oder 6, **dadurch gekennzeichnet,** daß die Neigung des Siebs des geneigten Siebabschnittes stufenweise abnimmt.

8. Vorrichtung gemäß Anspruch 6, **dadurch gekennzeichnet,** daß jeder der aufeinanderfolgenden Strömungskanal zu einer Formierzone unterschiedlicher Neigung zuführt.

9. Vorrichtung gemäß Anspruch 6, **gekennzeichnet,** daß mindestens einer der Strömungskanäle zu einer Formierzone führt, die aus zwei oder mehreren Abschnitten unterschiedlicher Neigung besteht.

10. Vorrichtung gemäß einem der Ansprüche 5 bis 9, **dadurch gekennzeichnet,** daß sie drei Strömungskanäle umfaßt, die zum geneigten Siebabschnitt führen.

11. Vorrichtung gemäß einem der Ansprüche 5 bis 10, **dadurch gekennzeichnet,** daß ein zum horizontalen Siebabschnitt führender Strömungskanal auf dem obersten zum geneigten Siebabschnitt führenden Strömungskanal angeordnet ist.

12. Vorrichtung gemäß Anspruch 11, **dadurch gekennzeichnet,** daß sie zwei zum geneigten Siebabschnitt führende Strömungskanäle und einen zum horizontalen oder im wesentlichen horizontalen Siebabschnitt führenden Strömungskanal umfaßt.

13. Vorrichtung gemäß einem der Ansprüche 5 bis 12, **dadurch gekennzeichnet**, daß das geneigte Sieb durch Entwässerungswalzen abgestützt ist.

14. Vorrichtung gemäß Anspruch 13, **dadurch gekennzeichnet,** daß die Entwässerungswalzen in Saugkästen angeordnet sind.

Revendications

1. Procédé de fabrication de bandes d'un matériau filtrant multi-couches consistant à :

   délivrer de la pâte sur une portion de toile métallique inclinée et éventuellement sur une portion de toile horizontale ou sensiblement horizontale d'une toile métallique de formation ;

   former des couches de fibres dans des zones de formation consécutives dans chacune desquelles une couche de fibres, superposée à la couche formée dans la zone de formation précédente doit être formée, caractérisé en ce que les couches sont formées dans des zones de formation dont la longueur augmente progressivement sur la portion de toile métallique inclinée, dans la direction du déplacement de la toile de formation.

2. Procédé selon la revendication 1 caractérisé en ce que la pâte est délivrée sous la forme de jets formant un angle avec la toile inclinée, qui décroît progressivement.

3. Procédé selon la revendication 2 caractérisé en ce que les couches sont formées dans des zones de formation d'inclinaison progressivement décroissante.

4. Procédé selon les revendication 1, 2 ou 3 caractérisé en ce que la couche la moins poreuse du matériau filtrant multi-couches est formée sur la portion de toile métallique horizontale ou sensiblement horizontale.

5. Dispositif pour la fabrication d'un matériau filtrant multi-couches comprenant :
   - un système de formation de bandes comportant une toile de formation présentant une portion de toile métallique inclinée et une portion de toile métallique horizontale ou sensiblement horizontale ;
   - une caisse d'arrivée de pâte multi-canaux dans laquelle les canaux d'écoulement sont disposés les uns au dessus des autres de manière que la paroi supérieure d'un canal constitue la paroi inférieure du canal d'écoulement situé au dessus, lesdits canaux d'écoulement conduisant à des zones de formation ultérieures, dans chacune desquelles doit être formée une couche de fibres, superposée à une couche formée dans la zone de formation précédente, caractérisé en ce que la longueur des zones de formation sur la toile inclinée augmente progressivement dans la direction du déplacement de la toile de formation.

6. Dispositif selon la revendication 5 caractérisé en ce que l'angle entre les parois supérieures des canaux d'écoulement et la toile inclinée décroît progressivement.

7. Dispositif selon la revendication 5 ou 6 caractérisé en ce que l'inclinaison de la toile de la portion de toile métallique inclinée décroît progressivement.

8. Dispositif selon la revendication 6 caractérisé en ce que chaque canal d'écoulement consécutif conduit à une zone de formation d'inclinaison différente.

9. Dispositif selon la revendication 6 caractérisé en ce que l'un au moins des canaux d'écoulement conduit à une zone de formation comprenant deux ou plusieurs sections d'inclinaison différente.

10. Dispositif selon l'une quelconque des revendications 5-9 caractérisé en ce qu'il comprend trois canaux d'écoulement conduisant à la portion de toile métallique inclinée.

11. Dispositif selon l'une quelconque des revendications 5-10 caractérisé en ce qu'un canal d'écoulement conduisant à la portion de toile métallique horizontale est disposé sur le dessus du canal d'écoulement supérieur conduisant à la portion de toile métallique inclinée.

12. Dispositif selon la revendication 11 caractérisé en ce qu'il comprend deux canaux d'écoulement conduisant à la portion de toile métallique inclinée et un canal d'écoulement conduisant à la portion de toile métallique horizontale ou sensiblement horizontale.

13. Dispositif selon l'une quelconque des revendications 5-12 caractérisé en ce que la toile métallique inclinée est supportée par des cylindres de drainage 14.

14. Dispositif selon la revendication 13 caractérisé en ce que les cylindres de drainage sont disposés dans des boîtes d'aspiration.

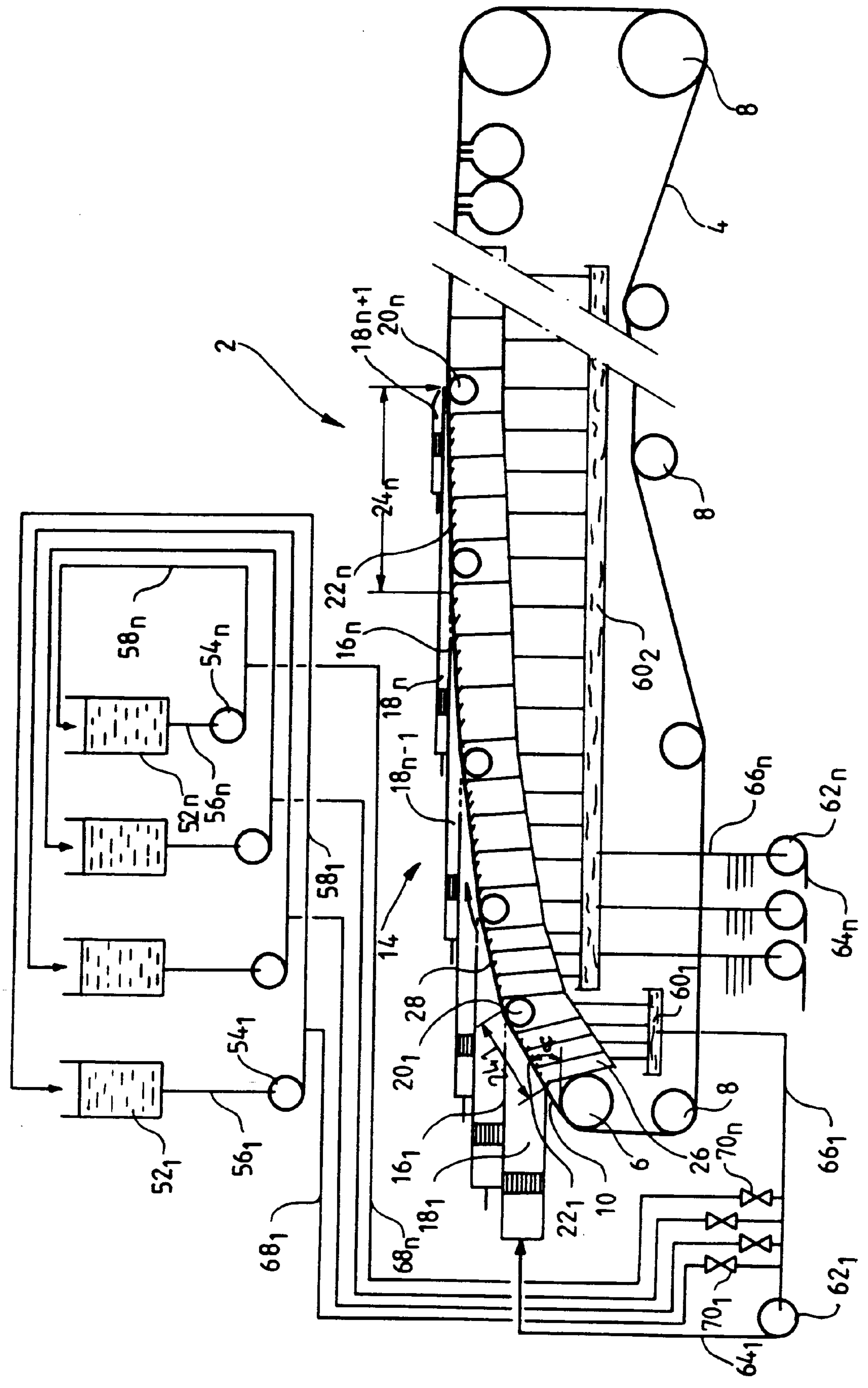

FIG. 1

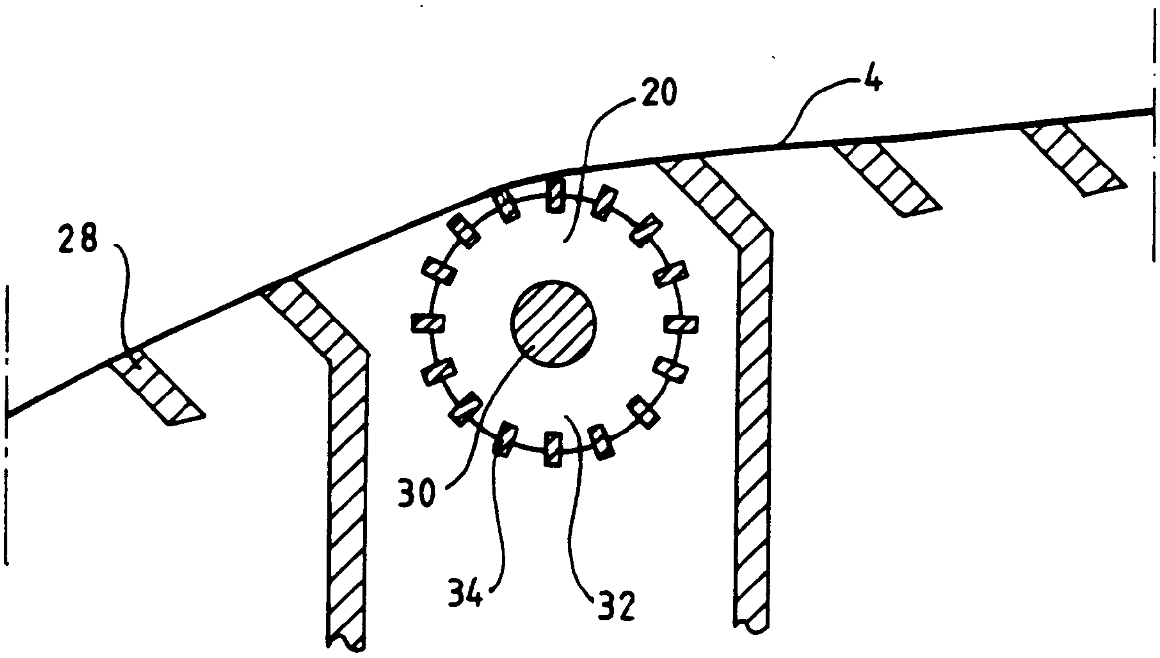

FIG. 2

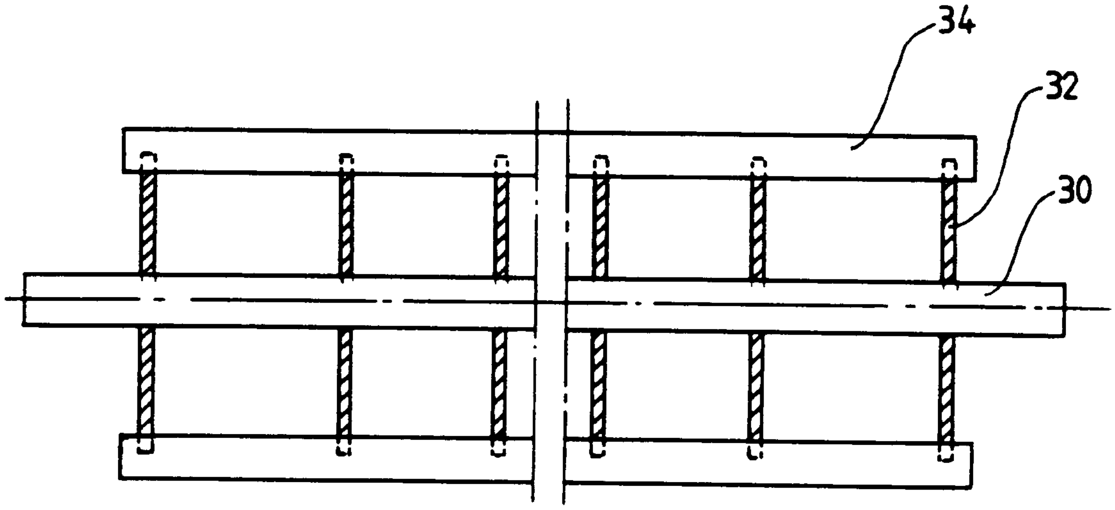

FIG. 3

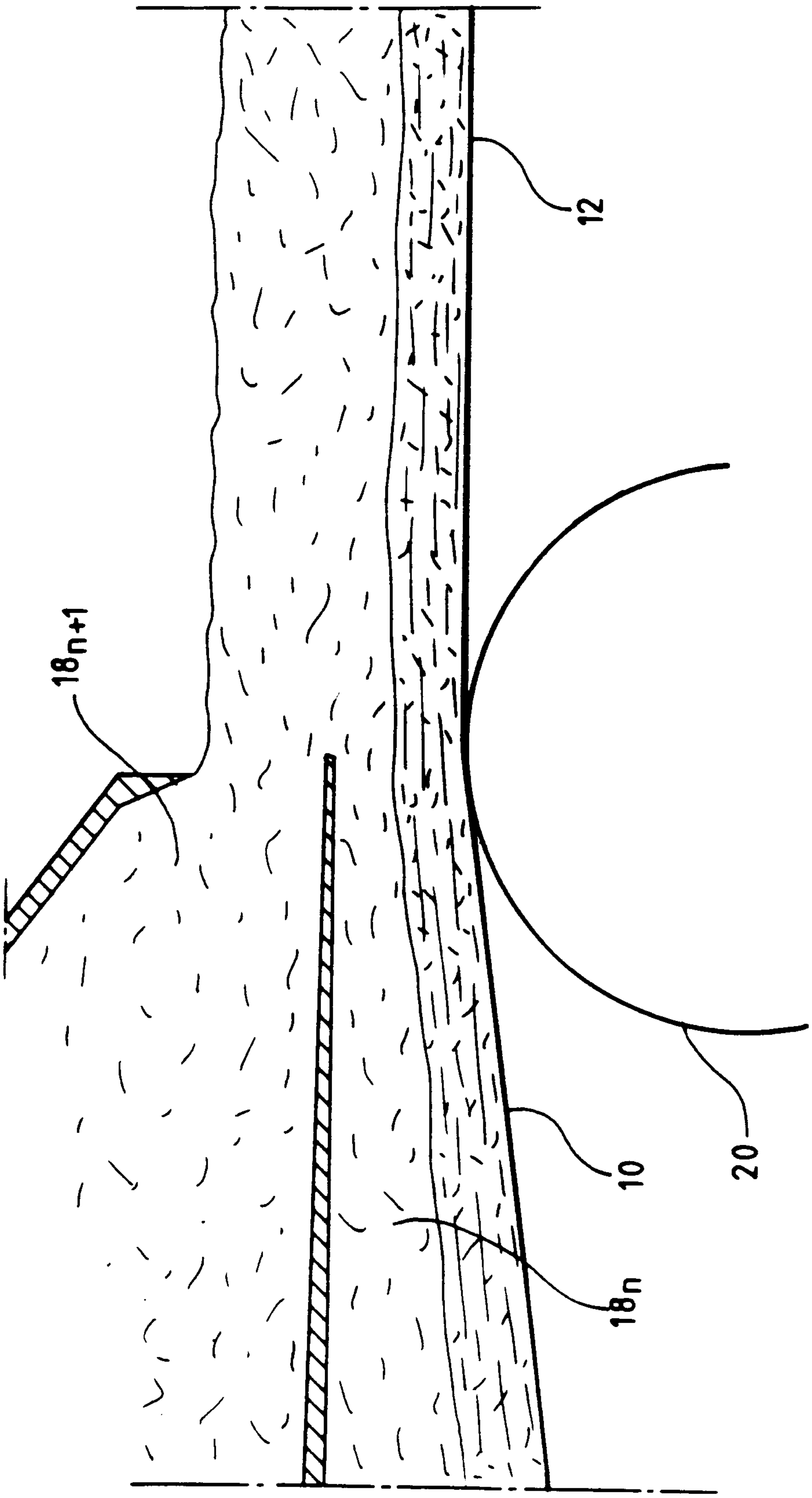

FIG. 4

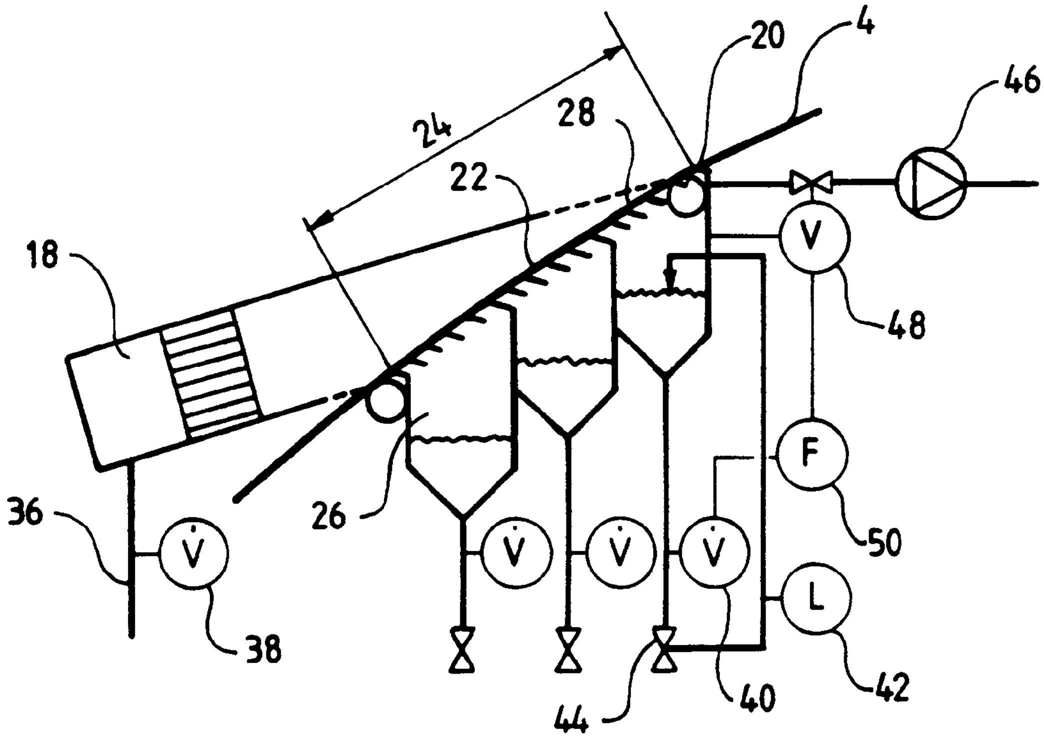
20
4
46
28
24
22
18
48
V
V
F
50
26
36
V
V
V
V
L
38
42
44
40

FIG. 5

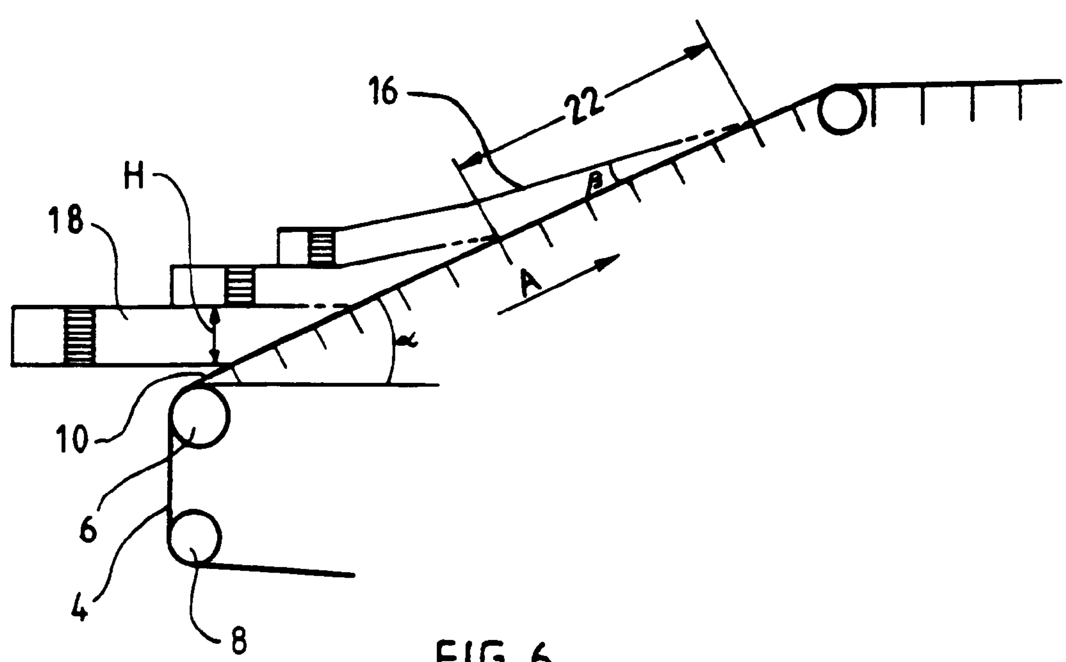
16
22
H
18
β
A
α
10
6
4
8

FIG. 6