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

(11) Publication number: **0 026 036**
A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 80302673.1

(22) Date of filing: 05.08.80

(51) Int. Cl.³: D 04 H 3/04

(30) Priority: 21.09.79 GB 7932822

(43) Date of publication of application: 01.04.81 Bulletin 81/13

(84) Designated Contracting States: CH GB IT LI NL SE

(71) Applicant: IMPERIAL CHEMICAL INDUSTRIES LIMITED
Imperial Chemical House Millbank
London SW1P 3JF(GB)

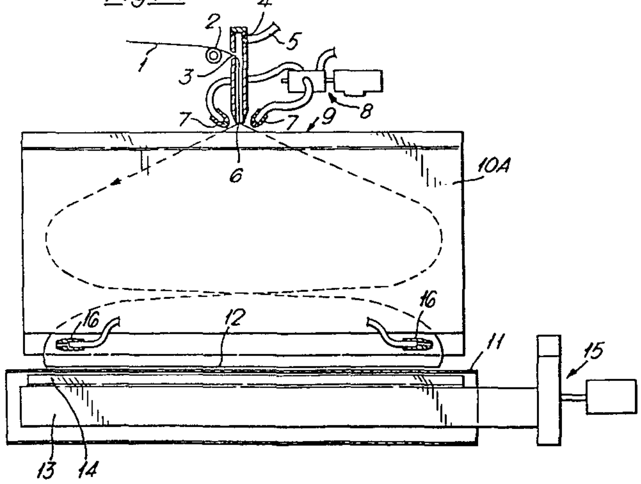
(72) Inventor: Sanderson, Marcus Riley
2 Cautley Drive Killinghall
Harrogate North Yorkshire HG3 2DJ(GB)

(74) Representative: Hulse, Raymond et al,
Imperial Chemical Industries Limited Legal Department: Patents Thames House North Millbank
London SW1P 4QG(GB)

(54) Process and apparatus for laying down a fibrous strand in an ordered manner.

(57) An apparatus for laying down a fibrous strand in an ordered manner comprising means (2) for supplying a fibrous strand (1), means (4) for forwarding the strand (1), means (7) for imparting an oscillatory motion to the forwarding strand (1), two closely spaced plates (10, 10A) providing a path for the oscillating strand (1) extending between the oscillatory means (7) and a moveable collecting surface (11) whereon the strand (1) is laid characterised in that the apparatus is provided with gas jet means (16) located between the oscillatory means (7) and the collecting surface (11) for deflecting the oscillating strand in such a manner that the amplitude of the oscillating strand (1) is increased.

Fig. 1.



EP 0 026 036 A1

PROCESS AND APPARATUS FOR LAYING DOWN A FIBROUS STRAND IN AN ORDERED MANNER

This invention relates to the production of fibrous webs having a high degree of orientation of the fibrous strands comprising the web, comprising forwarding a strand towards a collecting surface and imparting an oscillatory motion to the strand at a point above the collecting surface.

Fibrous webs have been made from staple fibres by carding or by random air laying processes, the former process imparting some degree of isotropic arrangement of the fibres. Fibrous webs have also been made by collecting a mat of synthetic continuous filaments in which the filaments are more or less randomly intermingled in the mat. However in order that a fabric made from one or more webs should have properties which resemble more closely the properties of conventional woven or knitted fabrics it is considered desirable to introduce a high degree of orientation of the fibrous material comprising the web, as for example, a high degree of parallelism in staple fibre yarns or filamentary strands oriented in, for example, the machine or cross directions or in both these directions. Methods which have been proposed for introducing the desired orientation into a web of filamentary strands include those in which the extruded multi-filamentary strands are forwarded and drawn by means of air jets and the issuing filaments are given an oscillatory motion before freely falling onto a collecting brattice or support. UK specification 1 244 753 describes such a method wherein gas oscillating jets are applied to already drawn filaments. It has also been proposed in Japanese patent publication 75 007 178 to oscillate the outlet of the forwarding jet to impart the desired oscillatory motion to the emerging filaments. These methods have not in practice proved entirely satisfactory in producing webs of as high a degree of parallelism and order as desired. Thus it is an object of this invention to provide a method in which movement of a strand in the laying down of a web is more fully controlled so as to approach more nearly the desired high degree of parallelism and order.

In Patent Application 40027/78 we have described a process for the production of an ordered web from at least one fibrous strand, comprising forwarding a strand towards a collecting surface, imparting an oscillatory motion to the strand at a point above the collecting surface, the strand being passed between two closely spaced planar plates which are substantially parallel to each other and to the plane of strand oscillation, the plates extending from the place of oscillation down to the collecting surface. The strand is laid in substantially straight lines on the collecting surface, successive lengths of strand being laid substantially parallel to previous lengths of strand. Also in Patent Application 7928435 (filed 15.8.79) we have described a modification of the process described in Patent Application 40027/78, in which shaped rather than planar plates are used so allowing the strand to be laid in non-straight lines on the collecting surface.

According to the present invention we provide a process for the production of an ordered web from at least one fibrous strand comprising forwarding a strand towards a moving collecting surface and imparting an oscillatory motion to the strand at a position above the collecting surface, the oscillating strand being passed between two closely spaced plates which extend substantially from the position of oscillation down to the collecting surface whereon the strand is laid on the collecting surface in lines which are substantially equally spaced along their length from preceding lengths of strand characterised in that after the oscillatory motion has been imparted to the strand and before the strand is laid on the collecting surface, jets of gas are applied to the strand in order to increase the amplitude of the oscillating strand.

Also according to the invention an apparatus for laying down a fibrous strand in an ordered manner comprises means for supplying a fibrous strand, means for forwarding the strand, means for imparting an oscillatory motion to the forwarding strand, two closely spaced plates providing a path for the oscillating strand extending between the oscillatory means and a moveable collecting surface whereon the strand is laid characterised in that the apparatus is provided with gas jet means located between the oscillatory means and the collecting surface for deflecting the oscillating strand in such a manner that the amplitude of the oscillating strand is increased.

The term "closely spaced" is used herein to mean less than 75 mm.

The plates used may be spaced apart by a distance of between 0.5 mm and 75 mm. Preferably, however, the plates are spaced apart by a distance of between 1 mm and 10 mm and more preferably are spaced apart by a distance of between 2 mm and 5 mm.

The plates may be planar or may have any other suitable shape including a curvilinear, for example sinusoidal corrugation, shape, a zig-zag shape, a castellated shape or some other shape which serves to lay the strand in a patterned arrangement on the collecting surface.

If desired the plates may have the same shape throughout their height. Alternatively the plates may have two or more different shapes at different heights, the different shapes merging into one another. In one embodiment an upper portion of each plate is planar and the remaining portion has a corrugated for example zig-zag or sinusoidal, shape, the two portions merging into one another.

The plates used may be uniformly spaced apart throughput their height but preferably they are arranged so that the space between them converges in a downward direction. Typically the spacing at the upper end of the plates is selected in the range 2 mm to 75 mm and at the lower end of the plates in the range 0.5 mm to 10 mm as for example from a spacing at the upper end of 4 mm to a spacing of 2 mm at the lower end. This convergence of the space assists the sideways exhaust of air and reduces the possible disturbance of strands on the collector.

Likewise the distance between the lower ends of the plates and the collector is minimised consistent with maximising the efficiency of laying that is to say so as to give maximum control of the strand while it is moving and immediately after it is laid. For higher strand speeds and web widths the function of the plates becomes increasingly important.

It is preferred to use a continuous filamentary strand in the present invention since these may be produced directly from a synthetic polymeric substance as for example by melt spinning. Staple fibre strands, preferably having only a low degree of twist, may also be used and the term "fibrous strand" as used herein includes both these and similar materials.

In producing a multifilamentary strand by melt extrusion of a synthetic polymer it is desirable to draw or orient the filaments to improve their strength and other physical properties. This may be done by forwarding the freshly extruded filaments at a high speed such that when they have cooled sufficiently any further drawing down of the still plastic filaments will cause orientation and alignment of the polymer chains which is set in on further cooling of the filaments to a temperature below the glass transition point. A gas forwarding jet is a convenient means to forward the strand and to produce this orientation. Means to impart an oscillatory motion to the strand may also utilise a compressed gas. Thus jets may be located on opposite sides of the forwarding jet outlet and operated alternately so as to direct the issuing strand first in one direction and then in the opposite direction. Alternatively a single intermittently operated jet may be used to impart the oscillatory motion.

A single or two part rotary valve may be conveniently used to provide the alternate or intermittent operation of the two jets or the single jet and the speed of rotation of this valve provides a simple control over the amplitude of oscillation described by the strand; the rotation speed bearing an inverse relationship to the strand amplitude when other conditions are constant. Thus the length of the courses of the strand laid on the collecting surface may be set within at least the range 0.5-4m by adjustment of rotary valve speed particularly because the use of closely spaced plates between the oscillating jets and the collecting surface allows changes to have their full effect on strand movement. Oscillating jets may have a single orifice or number of orifices in line or preferably a narrow slot for exit of the compressed gas. It is preferred to mount the deflecting jets so that both the angle between the jets, if two are used, and the angle of the or each jet in relation to the issuing strand may be adjusted as a further means of controlling strand oscillation.

While deflecting gas jets are preferred, other devices may be used to impart oscillation to a strand provided they can induce a sufficiently large amplitude of oscillation at the collecting surface. Such alternative devices may be rotating or oscillating opposed pairs of coanda surfaces which are alternatively brought into contact with the issuing strand.

Forwarding jets are well known in the art consisting of entry and exit passages for the strand and means to introduce the forwarding gas. The exit passage may be convergent or divergent but it is preferred to use a parallel passage to maintain the integrity of the issuing strand passing to the place of oscillation.

Because closely spaced plates are provided between the forwarding/oscillating means and the collecting surface the strand will assume a wave form oscillation the amplitude of which will be dependent upon the forces involved and will maintain this wave form until it reaches the collecting surface whereon it is laid in substantially parallel courses the contour of which is dependent on the shape of the plates used.

To ensure that the oscillating strand will assume its maximum amplitude, so as to lay the strans across substantially the whole width of the collecting surface, appropriately positioned gas jets, located between the oscillatory means and the collecting surface are provided. These serve to deflect the strand at a time when it is losing mementum so increasing the amplitude of the strand. This is particularly desirable with strands having a high total decitex, for example in excess of 500, which, because of their high weight, lose momentum sooner. These deflection jets are supplied with compressed gas and may be provided with a single orifice or a number of orifices in line or preferably a narrow slot for exit of the compressed gas.

When planar or non-planar shaped plates are used we conveniently arrange that one of the plates is shorter than the other, by, for example, from 2 to 100 mm and more preferably 5 to 30 mms, the gas jets being positioned immediately below the shorter of the two plates.

Alternatively with either planar or non-planar shaped plates, appropriately positioned windows having, for example, a rectangular shape may be provided towards the lower end of one of the plates so that the gas jets may be applied to the oscillating strand through these windows.

When the plates have an upper portion which is planar and a lower portion which is corrugated, the two portions merging into one another, then it is preferably to provide one of the plates with windows, for example having a rectangular shape, approximately positioned at the lower end of the upper portion, through which the gas jets may be applied to the oscillating strand before it enters the space between the lower portions of the plates.

The method and apparatus of this invention make it possible to lay highly oriented webs in which the strands are laid in parallel courses with an exactitude and precision hitherto impossible. A measure of this exactitude or efficiency may be defined as follows:-

$$\text{Efficiency } E = \frac{\text{Actual web width (m)}}{\text{Length of strand/course (m)}}$$

The denominator may be expressed as:-

$$\frac{\text{strand speed at point of oscillation (m/min)}}{2 \times \text{strand oscillation rate (cycles/min)}}$$

Thus E (%) may be expressed as:-

$$E = \frac{2\ W\ R}{S}\ 100$$

where E is the percentage laying efficiency
W is the actual web width in metres
R is the oscillation rate, cycles/min
and S is the strand speed at oscillation (or issue from the forwarding means) in m/min.

Strand laying efficiency defined in this way is an overall measure of effectiveness and for example in laying webs of continuous synthetic filamentary yarns values of 95% and better are attained and in these webs for all but a few percent of web width at the edges the efficiency is substantially 100%.

Use of this invention is particularly beneficial in the laying of such highly parallel webs of widths in excess of 0.5 m and at high strand speeds. Thus webs of 2.5 m width may be laid at a strand speed of at least 3600 m/min with an overall efficiency of 96% or more.

The laying of strands on the collecting means may be conducted with a very high precision to produce a web of substantially uniform thickness particularly when several strand laying devices are to be used together to produce a single or multi-layer web. Furthermore a variety of webs can be produced by using in sequence a number of pairs of differently shaped plates.

It is preferred to produce webs by moving the collecting surface away from the laying position at a speed related to the speed of strand laying in a direction either transverse to or parallel to the direction of laying. The former direction produces a web with transverse strand courses analagous to the weft of a woven fabric. However when the plates are shaped it will be realised that because the strands are laid in non-straight lines across the collecting surface they will provide the web simultaneously with a component in the warp direction which has not been achieved in a satisfactory manner previously. It will be realised that such a web, because it has a component in both the warp and weft directions, will exhibit unidirectional properties desirable in fabrics for use as apparel textiles. When the collecting surface is moved in a direction parallel to the direction of laying then successive bands of what may be termed warp wise strand courses are produced. However when the plates are shaped these strands will have a component in both the warp and weft directions and a final web exhibiting two directional properties which as mentioned above will be produced and this is desirable in fabrics for use as apparel textiles.

Webs made according to this invention require to be bonded in some manner to convert them into useful fabrics and for this purpose it is preferred to use some form of segmental or spot bonding method so as to preserve the directional properties introduced in making the web. It is further preferred to include in the web at least a proportion of thermoplastic filaments or fibres and to employ a thermal segmental bonding method for making the final fabric. Such segmental bonding methods are described in for example United Kingdom patent specifications 1 245 088, 1 474 101 and 1 474 102. Thermoplastic synthetic filaments or fibres of many kinds are suitable for use in this invention either alone or in a mixture with natural or other non-thermoplastic fibres. It is most preferred that the webs include or are composed of bicomponent synthetic fibres in which one of the components present at least in part at the surface of the fibre or filament is of lower softening or melting point, than the other and forms a strong bond under suitable conditions of heat and pressure. Alternatively or in addition to the foregoing segmental or spot bonding methods other processes may be used as for example, stitch bonding in which the web is held together by chains of stitching using a separate thread or part of the web itself and machinery which is capable of operating at fast production rates.

Synthetic polymeric filamentary strands being non-conductors and hydrophobic tend to accumulate static charges when in frictional contact with processing surfaces and as such charges may disturb the even oscillation or laying of a falling strand care is necessary to eliminate or reduce the accumulation of such charges and it may be necessary to provide discharging means at or near the point of oscillation or to treat the surface of the filaments with an appropriate chemical agent.

It is preferred, when using a gas forwarding jet, that a small amount of the issuing gas is allowed to pass in a gentle current down between the plates to assist the passage of an oscillating strand down to the collecting surface. It is also preferred that the collecting surface is a pervious brattice to allow escape of gas and if necessary the application of suction to the underside at the place of contact with a newly laid strand and thus to ensure its complete contact with the brattice.

The accompanying drawings illustrate the invention and one manner in which it may be performed using compressed gas both for transport and for oscillation of a strand.

Fig 1 is a front elevation of an apparatus in which a strand is being laid transversely onto a foraminous conveyor and

Fig 2 is a side elevation of the apparatus of Fig 1.

Fig 3 is a front elevation of another pair of plates and associated gas jets which may be used with the apparatus depicted in Fig 1 and Fig 2.

Referring to Fig 1 a strand 1 is led by way of a small tension roll 2 into the entry 3 of a forwarding jet 4 which is supplied with compressed gas from a supply port 5 above the strand entry 3. The gas tensions the yarn and forwards it to the outlet 6 close to which on either side are positioned deflection jets 7 which are alternately supplied with pulses of gas from a motorised rotary valve 8. The strand 1 falls from the jet outlet 6 into the convergent entry 9 of two planar plates 10 and 10A which are narrowly spaced apart and which are arranged transversely of and close to an endless foraminous conveyor 11. It will be noted that plate 10A is slightly shorter than plate 10. Gas jets 7 alternately are directed against the emerging strand 1 moving it to the left and then to the right and causing it to oscillate and to assume a sineous path as it falls between plates 10 and 10A. As the strand 1 passes between the plates 10 and 10A the momentum imparted to the strand by the deflection jets 7 is increased by deflection jets 16 supplied with compressed gas.

The jets 16, which are located immediately below the shorter plate 10A, act in a generally horizontal direction so as to deflect the strand thereby increasing its amplitude immediately before it is laid down on the conveyor in successive courses 12 across the conveyor. To assist the regular and complete laying of each strand on the conveyor an exhaust duct 13 is positioned beneath the conveyor 11 and is provided with a narrow slot inlet 14 arranged close to the underside of the conveyor and immediately below the lower edges of plates 10. A fan 15 provides at the inlet 14 suction to draw the strands against the conveyor surface.

In Fig 1 left and right moving lengths of strand 1 are shown moving in somewhat idealised fashion between plates 10 and 10A as solid and broken lines respectively. Examination of the apparatus illustrated in the drawings in the operating condition by means of stroboscopic illumination through a transparent plate shows that the strand takes up a uniform path the form of which alters with changes in forwarding and oscillating speeds.

The plates serve to control and stabilise the movement of the oscillating strand. The width of the plates in the direction of oscillation should be at least equal to and is preferably just a little wider than the maximum width of web to be laid. The height of the plates depends upon the laying conditions used and the form of the strand path established.

Fig 3 illustrates the application of the invention to another pair of plates 10 and 10A having an upper portion which is planar and a lower portion which is sinusoidally corrugated as depicted by troughs 18 and crests 19.

Plate 10A differs from plate 10 in that it is provided with two rectangular windows 17 through which gas jets 16, positioned in a generally horizontal direction, can inject compressed gas in between the plates so as to deflect the strand, thereby increasing its amplitude before it enters between the corrugated lower portions of the plates.

The invention will now be described by way of the following Examples:-

COMPARATIVE EXAMPLE

A strand composed of 192 synthetic filaments and a total decitex of 1100 was led by way of rolls from a package at a speed of 1075 m/min to the entry of a forwarding jet supplied with compressed gas at a pressure of 7 psig. A motorised rotary valve supplied with compressed gas at a pressure of 25 psig gave impulses of compressed gas in turn to each of two deflector jets, fitted immediately below the forwarding jet and symmetrically in relation thereto at an included angle of 165° between the jets. Each deflector jet received compressed gas from the rotary valve for 42% of the valve revolution. The valve rotated at a speed of 388 rpm. The strand emerging from the forwarding/deflecting device was passed between a pair of plates 1.6 m wide and 40.5 cm high. The tops of the plates were 1 cm below the exit from the spray device and the plates were spaced 6 mm apart at the top and 3 mm apart at the cottom. The bottoms of the plates were 3 cm above a horizontally disposed foraminous conveyor. The plates and spray device were placed at an angle of 10° to the vertical plane. An area of suction under the conveyor was in use. The total strand width laid down was 89-92% of the theoretical, calculated from the yarn and rotary valve speeds. This 8-11% loss in laid width is made up to 3-4% at reversals due to the strand stiffness and the remainder being due to waviness and occasional loops in the laid strand.

EXAMPLE ACCORDING TO THE INVENTION

The Comparative Example was followed in its entirety except that one of the plates was 6 cm shorter than the other plate and that deflection gas jets, positioned as shown in Figs

1 and 2, were provided.

On account of the deflection gas jets a laid strand width of 96 to 97% of the theoretical width was achieved.

CLAIMS

1. A process for the production of an ordered web from at least one fibrous strand comprising forwarding a strand (1) towards a moving collecting surface (11) and imparting an oscillatory motion to the strand at a position above the collecting surface (11), the oscillating strand (1) being passed between two closely spaced plates (10, 10A) which extend substantially from the position of oscillation down to the collecting surface (11) whereon the strand (1) is laid (12) on the collecting surface (11) in lines which are substantially equally spaced along their length from preceding lengths of strand characterised in that after the oscillatory motion has been imparted to the strand (1) and before the strand (1) is laid on the collecting surface (11), jets of gas (16) are applied to the strand (1) in order to increase the amplitude of the oscillating strand (1).

2. An apparatus for laying down a fibrous strand in an ordered manner comprising means (2) for supplying a fibrous strand (1), means (4) for forwarding the strand (1), means (7) for imparting an oscillatory motion to the forwarding strand (1), two closely spaced plates (10, 10A) providing a path for the oscillating strand (1) extending between the oscillatory means (7) and a moveable collecting surface (11) whereon the strand (1) is laid characterised in that the apparatus is provided with gas jet means (16) located between the oscillatory means (7) and the collecting surface (11) for deflecting the oscillating strand (1) in such a manner that the amplitude of the oscillating strand (1) is increased.

3. An apparatus as claimed in claim 2 characterised in that one of the plates (10A) is shorter than the other plate (10), the gas jets (16) being positioned immediately below the shorter plate (10A).

4. An apparatus as claimed in claim 2 characterised in that one of the plates (10A) is provided with windows (17) through which the gas jets (16) may be applied to the oscillating strand (1).

5. An apparatus as claimed in claim 4 characterised in that the plates (10, 10A) have an upper portion which is planar and a lower portion which is corrugated, the windows (17) being positioned at the lower end of the upper portion so that the gas jets (16) may be applied to the oscillating strand (1) before it enters the space between the lower portions of the plates.

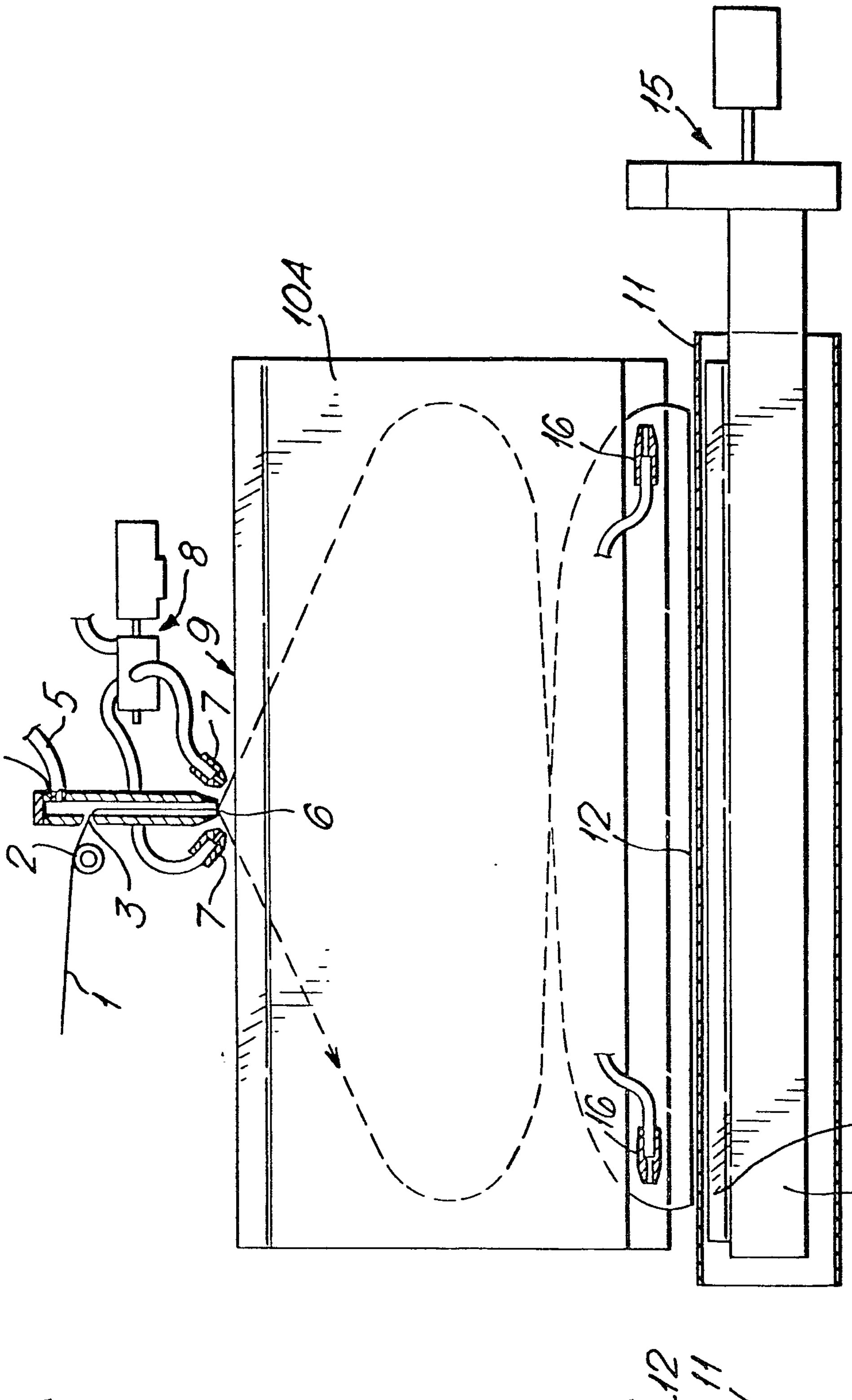


Fig. 1.

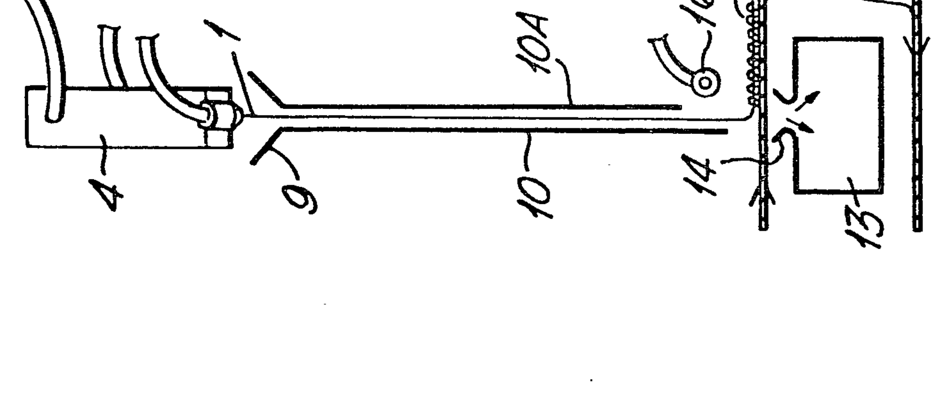
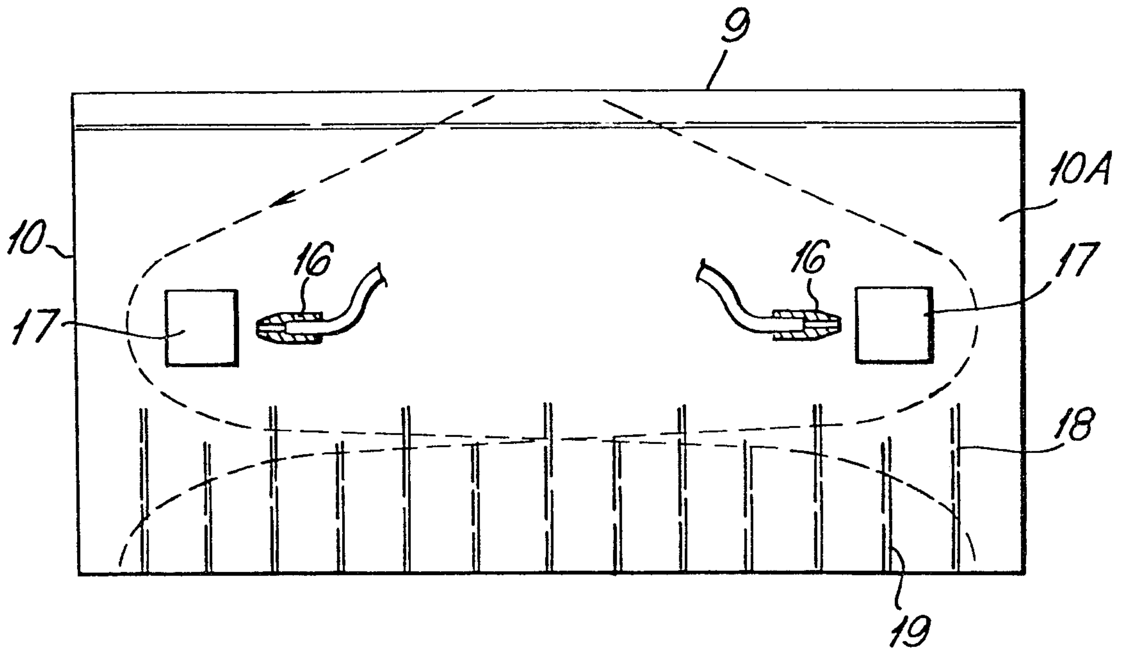


Fig. 2.

Fig. 3.



0026036

European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 80 30 2673

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	D 04 H 3/04
A	FR - A - 2 407 288 (I.C.I.) * Pages 15,16; figure 1 * ---	1	
A	US - A - 3 039 170 (P.F. MARSHALL) * Figure 1; claim 1 * ---	1	
A	US - A - 3 039 169 (P.J. FRICKERT et al.) * Figure 1; claim 1 * ---	1	TECHNICAL FIELDS SEARCHED (Int. Cl.³) D 04 H 3/04 3/02
A	FR - A - 2 083 599 (STAMICARBON) * Figures 1,3 * ---		
A	AT - B - 292 178 (BUNZL & BIACH) * Figures 1,2 * ---		
A	AU - B - 495 506 (CELANESE) * Figures 14,15 * -----		

CATEGORY OF CITED DOCUMENTS

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

&: member of the same patent family, corresponding document

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

Place of search	Date of completion of the search	Examiner
THE HAGUE	14-10-1980	ELSEN-DROUOT

EPO Form 1503.1 06.78