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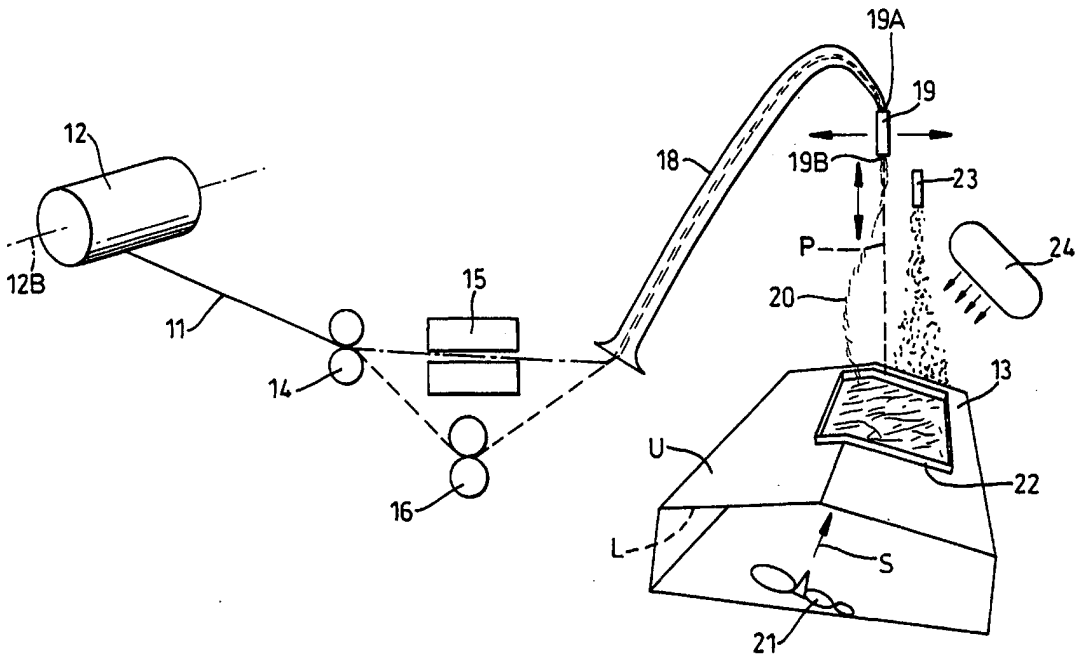

(57) Abstract

A method of fabricating a moulding component such as a fiber pre–form from a roving (11) comprises the steps of drawing the roving (11) from a supply station, separating constituent filaments or strands of the roving (11) to form a stream of fibres, spraying the fibres and a polymerisable binder from respective nozzles (19) onto a screen (13) and providing for the polymerisable binder to polymerise following the dispensing onto the screen (13). A process for manufacturing a moulding component according to said process is also described.

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PROCESS, AND APPARATUS, FOR MANUFACTURE OF A COMPONENT

This invention relates to a process, and apparatus, for manufacture of a component. In particular it is concerned with the manufacture of a component of dry glass fibre preformed shape as used by the glass fibre reinforced ('grp') industry (sometimes referred to as the fibre reinforced ('frp') industry).

Hitherto glass fibre in the form of glass fibre mats have been prepared from sheet material drawn from a fibre glass mat roll and cut to a pattern shape to generally fit a forming mould. The mould is then filled with resin so as to impregnate the glass fibre glass mat and subsequently to produce a reinforced plastic moulding. To ensure fibre covers the whole moulding surface a degree of excess fibre mat is placed over the moulded shaped edges. This results in fibre wastage since excess has to be trimmed following the mould step as a secondary moulding operation to achieve the final form of the moulded component. This excess is in addition to wasteful off cuts derived when cutting the pattern shapes from the glass fibre mat roll in the initial mat insertion into the mould.

In the last 40 years there have been many attempts to find a more economic method of producing dry fibre mats exactly to moulding size without generating waste fibre. Such mats are commonly known as preforms, preformed or preshaped (dry unimpregnated) ideally net size to the shape of the final moulded part. Such an ideal net or near net size fibre preform would be best suited to grp/frp closed mould moulding processes such as:

cold press moulding,
resin transfer moulding,
vacuum injection or infusion moulding and
reaction injection moulding.

However other processes could also benefit from such preforms.

Preform manufacture has tended to followed one or other of two approaches.

The first has been towards preforming glass fibre mats. The second towards manufacturing preforms from continuous glass fibre rovings. This latter approach although dating back to the mid fifties has had little impact.

although dating back to the mid fifties has had little impact. Most work has been in connection with the first approach but it is believed that current processes making use of mat are wasteful with wastage from off-cuts ranging from between 15 to 30%. Such waste cannot usually be re-cycled. In addition commercially available pre-formable mats are from 2.5 to 3 times as expensive as rovings.

Glass fibre rovings as a product are factory supplied in reels referred to as 'bobbins' or 'cheeses'. The fibre forms a continuous winding of multiple strands and each bobbin has a weight of about 30 kg. In this form glass rovings are acknowledged as being the cheapest form of raw stock glass fibre.

Previous developments involving continuous roving to generate the pre-form have focus on pre-cutting or chopping the fibres into short lengths just prior to dispensing them onto a shaped preform screen. This allows the fibres to randomly fall upon the forming screen and, assuming the rate of delivery is reasonably constant with even dispensing, an acceptable isotropic fibre preform is produced.

According to a first aspect of the present invention there is provided a method of fabricating a moulding component such as a pre-form from a roving comprising the steps of:

1 drawing the roving from a wound bobbin thereof;

2 separating predominantly by shearing constituent filaments or strands of the roving to a greater or lesser extent from one another to form a stream of fibres;

3 causing the stream of fibres to be passed along a duct to an nozzle where the fibres are entrained in a supply of gas, such as air,

4 dispensing entrained fibres from the nozzle for deposition on a screen serving to define a boundary region of the required moulding component;

5 displacing the nozzle relative to the screen to provide for fibres to be dispensed over an extend region of the screen;

6 depositing on at least some fibres in the stream a polymerisable material prior to, or simultaneously with, the deposition of the stream on the screen; and

7 providing for the polymerisable material to polymerise following the dispensing onto the screen.

According to a first preferred version of the present invention for the dispensing step there is provided a screen which is foraminous to enable air in the stream to pass through the screen while causing deposition of fibres on the screen.

According to a second preferred version of the first aspect of the present invention or the first preferred version thereof the drawing step involves the use of motorised pinch rollers.

According to a third preferred version of the first aspect of the present invention or any preceding preferred version thereof the separating step involves the use of an air comb or roller comb.

According to a fourth preferred version of the first aspect of the present invention or any preceding preferred version thereof the step of displacing the nozzle relative to the screen is undertaken along rectilinear co-ordinates axis substantially parallel to the screen or along a further co-ordinate axis substantially perpendicular to the screen.

According to a fifth preferred version of the present invention or any preceding preferred version thereof the step of deposition of the polymerisable material occurs by way of a spray nozzle located above the screen.

According to a sixth preferred version of the present invention or any preceding preferred version thereof the step of providing for the polymerisable material to polymerise involves the use of ultra violet light.

According to a second preferred version of the present invention there is provided apparatus for fabricating a moulding component as a pre-form from a roving comprising:

1 carrier unit for supporting a bobbin of glass fibre roving;

2 a roller unit providing for a fibre strand to be withdrawn from a bobbin supported by the carrier unit;

3 fibre separating means such as an air comb or a roller comb for acting on fibre strand from the motorised roller unit so as to cause the strand to broken up by a predominantly shearing action up into constituent filaments or strands of the

roving to a greater or lesser extent so as to form a stream of fibres in an outlet region of the separating means;

4 a duct whereby the stream of fibres in the outlet region of the separating means is caused to pass from the outlet region to a supply region;

5 a nozzle and means for urging a supply or air or gas through the nozzle such that fibres at the supply region are entrained in a supply of the gas and can be dispensed from the nozzle along a path towards a working area;

6 a screen located in the working area and, at least in that region of the screen which intersects the path, substantially at right angles to the path;

7 means for displacing the nozzle relative to the screen to provide for fibres to be dispensed over an extended region of the screen;

8 binder dispensing means for depositing on at least some fibres in the path a polymerisable material prior to, or simultaneously with, a deposition of the fibres from the path on the screen; and

9 means for causing polymerisable material on the fibres to polymerise following the dispensing of the fibres onto the screen.

According to a first preferred version of the second aspect of the present invention the screen is foraminous with holes of a size enabling air flowing along the path from the nozzle to pass through the screen with a resulting deposition of fibres from the path originally entrained in the path onto the screen.

According to a second preferred version of the present invention or the first preferred version thereof the means for displacing the nozzle relative to the screen provides for the nozzle to be displaced along rectilinear co-ordinates axis substantially parallel to the screen and/or along a further co-ordinate axis substantially perpendicular to the screen and to the rectilinear co-ordinate axis.

According to a third preferred version of the second aspect of the present invention or any preceding preferred version thereof the binder dispensing means incorporates a spry nozzle positioned above the screen.

According to a fourth preferred version of the second aspect of the present invention or any preceding preferred version thereof the means for causing the polymerisable material to polymerise includes a source of ultra violet light.

According to a third aspect of the present invention there is provided a moulding component fabricated by a process according to the first aspect or any preferred version thereof.

According to a fourth aspect of the present invention there is provided a moulding component fabricated by apparatus process according to the second aspect or any preferred version thereof.

The invention provides for a continuous glass rovings to be reeled off a bobbin and fired as a continuous fibre onto a shaped screen to set into position along with a small percentage of resin binder to produce the desired preform. The invention eliminates the need to chop or cut the roving because the fibres are dispensed as a continuous thread. One consequence is that there is no requirement for a motorised cutting or chopping device in the system. Furthermore as the fibre is randomly dispensed on to the forming screen in a continuous from the final preform dry consolidated shape produces higher fibre strength in the final moulded part.

An exemplary embodiment of the invention will now be described with reference to the accompanying drawing of a process for producing a pre-formed component.

Broadly the process comprises dispensing multi-filament and stranded glass fibre 11 from a bobbin 12, causing it to be separated into filaments and strands and then to direct the separated strands onto a preform screen 13.

The process will now be described in more detail.

PRIMARY DISPENSING

Bobbin 12 is mounted on a horizontal axis 12B by means of bearings allowing free rotation of the bobbin 12. Strand 11 is drawn off the bobbin 12 by way of a set 14 of motorised pinch rollers with elastomeric surfaces.

FIBRE SEPARATION

From pinch roller set 14 strand 11 is passed through a separation stage to cause the roving filaments and strands to become separated from one another by a

predominantly shearing action in which the neighbouring fibres in the strand are subjected to a scuffing or relative rubbing action. Control of the effect of shearing action on the fibre is desirable as the material used to form the preform component later in the process. The fibre produced can be varied from a fine filament to a heavy strand texture. Fibre separation in this case is achieved in either of two ways. The first involves by running the strand through an air comb fibre separator 15. The second involves the use of a second set 16 of pinch rollers having angled axis of rotation providing for the fibres in the strand to be scuffed apart.

NOZZLE DISPENSING

Form the separation stage (whether comb separator 15 or pinch rollers 16 the fibre is caused to flow along a light and flexible duct 18 lined with a low friction material to an air powered nozzle 19. The nozzle 19 is operated to have a sub atmospheric pressure at inlet 19A and a pressurised air flow at its outlet 19B. Fibre 20 is entrained into, and is swept through, the nozzle 19 to generally follow a flow path P for entrained fibre particles. The nozzle outlet 19B is directed towards the upper side U of shaped screen 13 which is foraminous. The holes in the screen 13 are of a size such that air arriving on the screen 13 along flowpath P tends to through the holes to the lower side L of the screen while preventing the passage of fibres which as a consequence are left on the upper side U of the screen 13. The preform screen 13 is laid out substantially normal to the path P. The fibre deposition on the screen 13 from flow path P is randomised due to the random turbulent flow issuing from the nozzle outlet 19B and entering the flowpath P. The area of the screen 13 covered by the fibre deposition is dependent on two major factors: the distance of the screen 13 below the nozzle 19; and the velocity of the nozzle air flow. This is on the assumption that the supply of fibre to the nozzle 19 is not limited by the primary dispensing or fibre separation stages upstream of the nozzle 19.

PREFORM GENERATION

Assuming the nozzle 19 and the screen 13 are positioned so that only a small area of the screen is covered if the nozzle 19 and/or the screen 13 remain stationary then by moving either the nozzle or the screen or both while the nozzle dispenses fibre the required area of the screen may be covered progressively. By controlling the speed at which the nozzle traverse the screen in the shown x-axis and y-axis directions for a

constant delivery of fibre from the nozzle 19 the density of the randomly dispensed fibres can be controlled. Motion of the nozzle 19 in the z-axis can be used to govern the area of instant deposition by the nozzle. It also serves to provide for control of deposition in relation to the fibre size entrained in the air flow from the nozzle 19.

Various modes of movement of nozzle 19 may be used. As the nozzle 19 has of slight mass it can be readily moved at high speed while dispensing and can be readily manipulated. Apart from, or as an alternative to linear translation the nozzle 19 can be provided with means for angular displacement to vary the angle at which the path P strikes the screen 13.

The screen 13 being fabricated from perforated metal sheet can also be readily orientated to allow the stream of dispensed fibre from the nozzle 19 to land normally to the surface area being contacted. In an alternative embodiment the nozzle outlet 19B and screen 13 can be controlled by means providing for optimised operation so that regardless of the required shape of the manufactured component to be formed on the screen 13 the nozzle outlet 19B are aligned in a manner to produce optimised product.

SCREEN AIR FLOW

To aid the deposition of fibre strands onto the screen 13 and to reduce the risk of fibre being deposited outside the screen boundary a draught of air S is made to flow beneath the screen 13. This draught S is readily achieved by a fan 21 with ducting for encouraging air flow only through the preform shape. Short vertical fences 22 located on the upper side of the screen and extends round the edge of the preform. Apart from limiting the ability of the deposited fibre to extend outside the required preform boundary the fences 22 can be set at an angle to produce a funnel effect for the air entrained fibre and also to provide for a fibre rich boundary edge for the preform.

In existing preform manufacturing systems there are two main methods used to provide a binder for the mat material.

In the first the pre-formable fibre mat is seeded with a thermoplastic binder which when heated will allow the fibre mat to be pressed into a shape and allowed to cool. This serves to set the preform fibre mat into the required shape.

In the second fibre is directed at a screen similar to that described earlier. The fibre is in chopped form and is mixed with a water soluble thermoset binder. on e the preform has been deposited on the screen it needs to be dried and then cured with heat to hold the preform in its desired shape. This approach requires significant energy consumption.

In the present invention a different approach is adopted. A thermoset binder is used but it is not mixed with water. Instead a binder is used having sensitivity to ultra violet light. The binder is misted onto the screen 13 by means of a nozzle 23 at the same time as the fibre is deposited. The material deposited on the screen is then subjected to ultra violet light from lamp 24. The binder polymerises under the action of the UV light to set the deposited fibre in the preform shape within a few seconds.

A preform is usually required to have a degree of 'lift' that is to say to provide resilience when pressed and a thickness fractionally greater than the mould cavity in which the preset is to be used. In the case of the present invention thickness control is to a great extend regulated by the quantity of fibre deposited per unit area. This is determined by the rate of fibre flow through the nozzle and the traverse speed in the X and Y axial directions.

By way of example if a fibre preform needs to have a unit area weight of 1 kg/square metre and to fit a 3 mm mould cavity. If the preform manufactured by the described process results in a correct unit area weight and a thickness of 4 mm it would probably be considered acceptable. However a thickness of 6 mm would not be satisfactory as it would be considered as having too high a 'loft'.

In order to control the height of the 'loft' of a deposited random fibre a transparent/ translucent film can be placed over the screen once the deposition of the fibre and binder have been completed. By adjusting flow beneath the screen the film can be drawn down onto the deposited material so as to consolidate it against the screen to the required depth. The use of a transparent/translucent film allows ultra violet illumination to act on the material so as to cure the binder. The loft control film may be automatically positioned over each screen and automatically removed after the curing stage. The film can be located on a light frame for each screen preform deposition.

CLAIMS

1 A method of fabricating a moulding component such as a pre-form from a roving comprises the steps of:

1 drawing the roving from a wound bobbin thereof;

2 separating predominantly by shearing constituent filaments or strands of the roving to a greater or lesser extent from one another to form a stream of fibres;

3 causing the stream of fibres to be passed along a duct to an nozzle where the fibres are entrained in a supply of gas, such as air,

4 dispensing entrained fibres from the nozzle for deposition on a screen serving to define a boundary region of the required moulding component;

5 displacing the nozzle relative to the screen to provide for fibres to be dispensed over an extend region of the screen;

6 depositing on at least some fibres in the stream a polymerisable material prior to, or simultaneously with, the deposition of the stream on the screen; and

7 providing for the polymerisable material to polymerise following the dispensing onto the screen.

2 A process as claimed in any preceding claim wherein the screen is foraminous to enable air in the stream to pass through the screen while causing deposition of fibres on the screen.

3 A process as claimed in Claim 1 or Claim 2 wherein the drawing step involves the use of motorised pinch rollers.

4 A process as claimed in any preceding claim wherein the separating step involves the use of an air comb or roller comb.

5 A process as claimed in any preceding claim wherein the step of displacing the nozzle relative to the screen is undertaken along rectilinear co-ordinates axis substantially parallel to the screen or along a further co-ordinate axis

substantially perpendicular to the screen.

6 A process as claimed in any preceding claim wherein the step of deposition of the polymerisable material occurs by way of a spray nozzle located above the screen.

7 A process as claimed in any preceding claim wherein the step of providing for the polymerisable material to polymerise involves the use of ultra violet light.

8 A process as hereinbefore described with reference to the accompanying drawing.

9 Apparatus for fabricating a moulding component as a pre-form from a roving comprises:

1 carrier unit for supporting a bobbin of glass fibre roving;

2 a roller unit providing for a fibre strand to be withdrawn from a bobbin supported by the carrier unit;

3 fibre separating means such as an air comb or a roller comb for acting on fibre strand from the motorised roller unit so as to cause the strand to broken up by a predominantly shearing action up into constituent filaments or strands of the roving to a greater or lesser extent so as to form a stream of fibres in an outlet region of the separating means;

4 a duct whereby the stream of fibres in the outlet region of the separating means is caused to pass from the outlet region to a supply region;

5 a nozzle and means for urging a supply or air or gas through the nozzle such that fibres at the supply region are entrained in a supply of the gas and can be dispensed from the nozzle along a path towards a working area;

6 a screen located in the working area and, at least in that region of the screen which intersects the path, substantially at right angles to the path;

7 means for displacing the nozzle relative to the screen to provide for fibres to be dispensed over an extended region of the screen;

8 binder dispensing means for depositing on at least some fibres in the path a polymerisable material prior to, or simultaneously with, a deposition of the fibres from the path on the screen; and

9 means for causing polymerisable material on the fibres to polymerise following the dispensing of the fibres onto the screen.

10 Apparatus as claimed in Claim 9 wherein the screen is foraminous with holes of a size enabling air flowing along the path from the nozzle to pass through the screen with a resulting deposition of fibres from the path originally entrained in the path onto the screen.

11 Apparatus as claimed in Claim 9 or Claim 10 wherein the means for displacing the nozzle relative to the screen provides for the nozzle to be displaced along rectilinear co-ordinates axis substantially parallel to the screen and/or along a further co-ordinate axis substantially perpendicular to the screen and to the rectilinear co-ordinate axis.

12 Apparatus as claimed in Claim 9, 10 or 11 wherein the binder dispensing means incorporates a spry nozzle positioned above the screen.

13 Apparatus as claimed in any of preceding claims 9 to 12 wherein means for causing the polymerisable material to polymerise includes a source of ultra violet light.

14 Apparatus as herein before described with reference to the accompanying drawings.

15 A moulding component fabricated by a process as claimed in any of preceding claims 1 to 8.

16 A moulding component fabricated by apparatus process as claimed in any of preceding claims 9 to 14.

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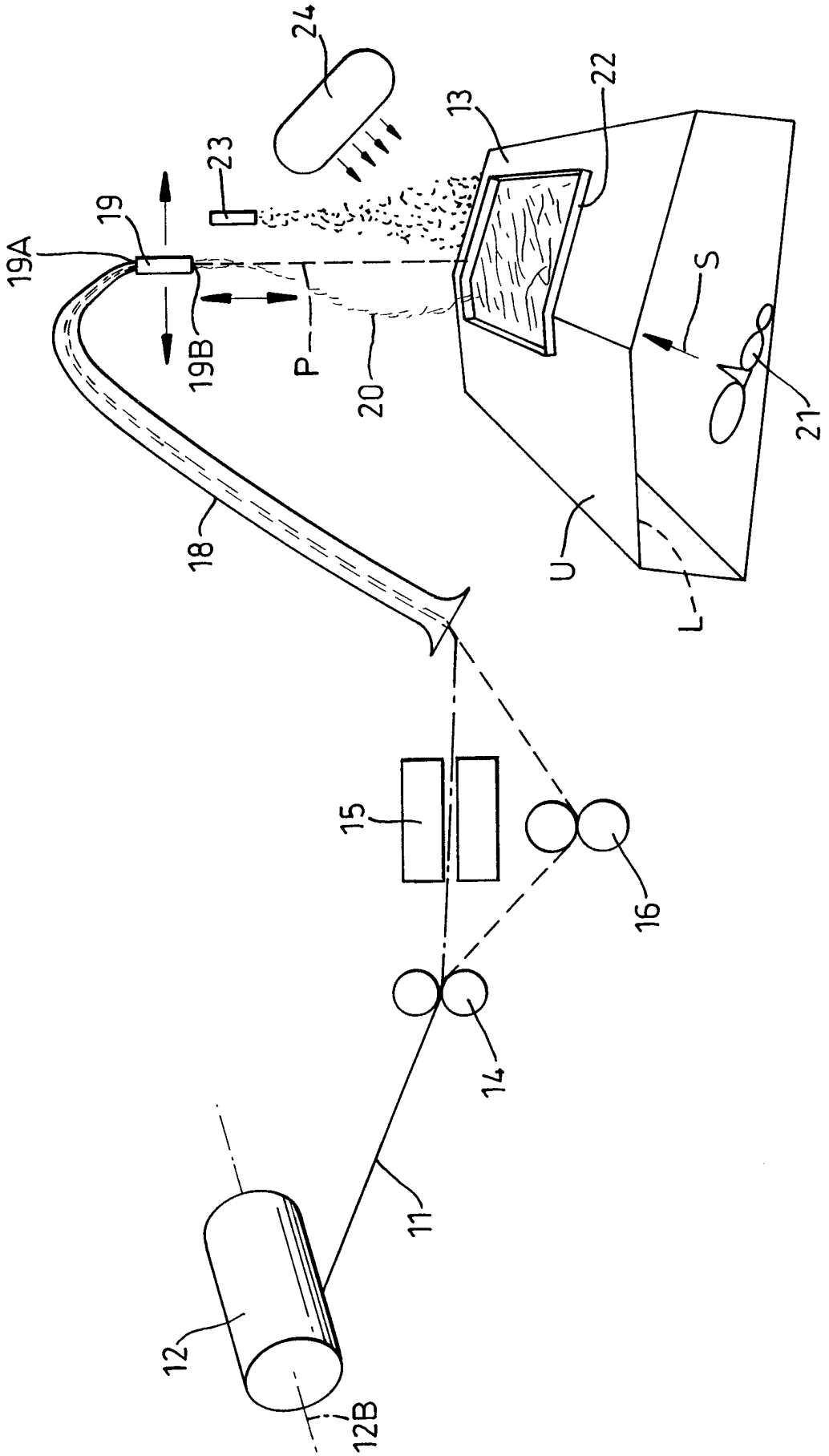

INTERNATIONAL SEARCH REPORT

Int. ional Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B29C70/30 B29B11/16

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)
IPC 6 B29C B29B

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 3 840 941 A (NEVEU J) 15 October 1974 see the whole document	1,3,4,9, 15,16
A	US 4 600 423 A (STOTLER DAVID V ET AL) 15 July 1986 see the whole document	1,2,4,5, 9-11,15, 16

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 3 734 803 A (LIPSCOMB W ET AL) 22 May 1973 see column 2, line 3 - line 6 see column 3, line 66 - column 4, line 33; figure 1	1,2,9,10
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Information on patent family members

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