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(54) **Apparatus for forming a man-made vitreous fibre web**

Apparat, um ein künstliches Glasfaser-Web zu bilden

L'appareil pour former un web de fibre vitreux artificiel

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(56) References cited:

| | |
|---|---|
| WO-A-91/19684 | WO-A-92/12940 |
| WO-A-96/18585 | WO-A-96/36573 |
| WO-A1-92/06047 | WO-A1-92/12941 |
| WO-A1-96/38391 | US-A- 3 709 670 |
| US-A- 4 210 432 | US-A- 5 009 030 |

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## Description

[0001] This invention relates to the production of man-made vitreous fibre (MMVF) batts, and in particular relates to apparatus by which the construction of the faces of the batt may be optimised independently from optimisation of the construction of the core of the batt.

[0002] A conventional method for making an MMVF batt comprises centrifugally fiberising a mineral melt to form a cloud of MMV fibres entrained in air by using a centrifugal spinner located in a stream of air, and collecting the fibres on a permeable conveyor as a web having first and second opposed edge regions by sucking the air from the cloud through the conveyor while the conveyor is travelling in a first direction, and
cross lapping the web so as to make the batt.

[0003] There are various types of centrifugal spinners for fiberising mineral melts. Many comprise a disc or cup that spins around a substantially vertical axis. It is then conventional to arrange several of these spinners in-line, i.e. substantially in the first direction, for instance as described in GB-A-926,749, US-A-3,824,086 and WO-A-83/03092. Usually the same melt is fed to all the spinners so that a substantially homogeneous product is made. However it is known to deposit organic fibres on the faces of the product from FR-A-1,321,446 and it is also known to add binder or other materials into the cloud of fibres. US 5 009 020 discloses production of a layered product using successive centrifugal discs. It is noted in US-A-3,824,086 that arranging the spinners in two rows, side by side, has the disadvantage of non-conformity along the overlapping centre line.

[0004] Different centrifugal spinners are those which comprise at least one fiberising rotor mounted for rotation about a substantially horizontal axis. Such spinners can have a single rotor or a pair of rotors onto which the melt is applied and from which fibres are formed, but more usually the spinners are cascade spinners in which the melt is fed onto a first rotor and is thrown from that onto second, third and optionally fourth rotors in sequence, with fiberisation occurring on the second and subsequent rotors, and often also on the first.

[0005] The properties of the fibres formed on each spinner depend upon the fiberising parameters on that spinner, namely the conditions on that spinner which influence fibre formation.

[0006] One important fiberising parameter consists of the nature of the melt which is fed to that spinner, in that fibre formation is influenced by varying the physical properties of the melt (especially viscosity, which is dependent on both temperature and chemical composition), and fibre characteristics are varied by varying the chemical analysis of the melt.

[0007] Another fiberising parameter is the rate of feed of melt to that spinner. In general, longer fibres and stronger wool can be obtained at lower melt feeds than at higher (all other parameters being unchanged).

[0008] Another fiberising parameter is the position of the fiberising rotor or at least one of the rotors with respect to the position of the feed of melt to the spinner. For instance the melt is usually poured down on to the rotor or the first rotor in the spinner, and the angle the melt stream makes with the surface of that rotor influences the performance of the spinner. Similarly, when there are subsequent rotors, the position of each rotor relative to the others can influence performance.

[0009] Another fiberising parameter is the acceleration field generated by the rotor, or the fields generated by the rotors (when there is more than one rotor). The acceleration field depends on the diameter of a rotor and its speed of revolution.

[0010] There is usually a stream of air associated with the or each fiberising rotor whereby the fibres are entrained in this air as they are formed off the surface of the rotor. This stream of air has a flow field, and the flow field of the or each stream of air associated with a spinner is another important fiberising parameter.

[0011] In conventional processes, a single cascade or other spinner is arranged to fiberise the mineral melt and the fibres are entrained in air as a cloud of the fibres. The fibres are collected on a permeable conveyor as a web having first and second opposed edge regions and a centre region by sucking the air from the cloud through the conveyor.

[0012] The web is frequently of variable structure or properties and for this and other reasons it is conventional practice to cross lap the web so as to make a batt whereby a first face section of the batt is formed mainly of the first edge region of the web and the opposed second face section of the batt is formed mainly of the opposed second edge region of the web, and the batt has a core section between its first and second face sections.

[0013] Usually it is desired that the batt should have as uniform a composition through its thickness as possible, i.e., it is preferred that there should be no deliberate variations between the first face section, the core section and the second face section of the batt.

[0014] For some purposes, a batt is required which has variable properties through its thickness, but traditionally this is made by forming a substantially homogeneous batt and then treating it so as to modify its surface properties. For instance it is known to apply extra binder to one face and/or it is known to split one face section from the main batt, to treat the face section and then recombine it with the main batt, and it is known to laminate a thin batt to a thicker batt having differing properties.

[0015] It is known to vary the fiberising conditions on a single spinner by varying the fiberising parameters. Examples are in US-A-3,159,475 and 4,210,432, EP-A-080,963, WO-A-92/10436, WO-A-92/12940 and WO-A-96/18585. In some of these processes the variation is conducted during the process whilst in others the variation is conducted before the start of a process, by selecting the fiberising parameters appropriately.

**[0016]** Although conventional processes use a single cascade or other spinner, there have been some proposals in the literature to provide first and second spinners in substantially side-by-side relationship, and optionally a third spinner between the first and second spinners. The fibres from all three spinners form a single cloud of fibres entrained in air and when this cloud is collected on the conveyor as a web the first and second spinners form the fibres which predominantly provide the first and second edge regions respectively of the web, and if there is a third (or more than one third) spinner the third spinner (or spinners) provides the fibres which predominantly provide the centre region of the web.

**[0017]** For example, a process has been described using a pair of rotors, one being arranged as a mirror image of the other. The fact that one is a mirror image of the other does not result in there being differing fiberising parameters on the two spinners.

**[0018]** A disclosure of the use of three cascade spinners in side-by-side relationship is in WO-A-92/12940. It teaches that the relative positions of the axes of the various rotors should be controlled in order to optimise fiberisation. There is no suggestion in WO-A-92/12940 that the relative positions of the rotors in one cascade spinner should be different from the relative positions of the rotors in one of the other cascade spinners of the trio which is illustrated. A similar system is disclosed in WO 92/12 941.

**[0019]** Since the objective in the prior art is normally to achieve a web which is as homogeneous as possible, it is logical that the fiberising parameters on each of the spinners should be set to be the same, although varying the concentration of binder or colouring additive across the width is described in EP-A-374,112.

**[0020]** The present invention is concerned with two separate problems.

**[0021]** One problem arises from the fact that, as mentioned above, it will often be desirable to be able to make a batt where an edge section has properties deliberately selected to be different from a core section. For instance in some instances it would be desirable for the fibres in the edge section to have a different average fibre diameter or average fibre length than the fibres in the core section. By this means it is possible to optimise independently the surface properties of the batt and the insulation or other overall physical properties of the batt. At present this problem is solved by splitting the batt depthwise and treating one section different from the others before recombining them, or by surface treating the batt or by laminating separately formed batts.

**[0022]** A second problem arises when we are using two or more spinners arranged in side-by-side relationship to make a single web. Because of the nature of the process and the structure of the collecting chamber, it is difficult to observe accurately what is happening on the individual spinners. However, we are now realising that the performance of the individual spinners in a set of two or more spinners may be relatively independent of each other even though the spinners are intended to be operating in a similar manner. Thus, if two substantially identical spinners are arranged side-by-side having the same rotor diameters and speeds and the same air streams and supplied with the same amount of the same melt, it might have been predicted that the fibre yield and fibre properties off each spinner would be the same. In fact we have now realised that this is not necessarily the case and that two spinners which are intended to be identical and which are intended to be operating under identical conditions can, and often do, in fact give different fibre yield or fibre properties or both.

**[0023]** The reason for this is not clear but is probably associated with the difficulty of establishing in a wholly reliable manner any particular set of process conditions having regard to the high temperatures, high rotor speeds and high air velocities associated with each spinner. Also, since the spinners are necessarily located in different positions with respect to the collection apparatus, this difference in position may contribute to the difference in performance, for instance because of differences in the air flows around each spinner. Whatever the cause, we believe that systematic, or sometimes spontaneous, variation does occur and does reduce the effectiveness of the overall production process.

**[0024]** Accordingly, the invention also includes the realisation that this problem exists and the desirability of solving this problem so as to avoid unwanted and uncontrolled variations in the fiberising performance of the individual spinners in a set of spinners arranged in side-by-side relationship. By this means we could improve efficiency and, for instance, avoid unwanted variations across the width of the web and therefore potentially through the thickness of the batt.

**[0025]** Apparatus which can be used with the apparatus according to the invention for making an MMVF batt comprises first and second centrifugal spinners arranged in substantially side-by-side relationship, and one or more third centrifugal spinners between the first and second spinners, wherein each centrifugal spinner comprises at least one fiberising rotor mounted for rotation about a substantially horizontal axis wherein the or each rotor provides an acceleration field,
means for feeding MMVF melt to each of the spinners,
means for entraining the fibres from each spinner in a stream of air around at least one fiberising rotor of each spinner wherein the stream of air has a flow field and thereby forming a single cloud of fibres entrained in air,
a permeable conveyor for collecting the fibres as a web having first and second opposed edge regions and a centre region and means sucking the air from the cloud through the conveyor whereby the first and second spinners form the fibres which predominantly provide the first and second edge regions respectively, and
means for cross lapping the web to make the batt whereby a first face section of the batt is formed mainly of the first

edge region of the web and the opposed second face section of the batt is formed mainly of the second edge region of the web and the batt has a core section between its first and second face sections,

and in this apparatus there are means for

independent adjustment of at least two of the fiberising parameters on one or different spinners before or during the production of the MMVF batt, wherein the parameters are selected from (a) the physical properties and/or chemical analysis of the melt fed to a spinner, (b) the rate of feed of melt to a spinner, (c) the position of the fiberising rotor, or at least one of the fiberising rotors, on a spinner with respect to the position of the feed of melt to that spinner, (d) the acceleration field or fields on that spinner and (e) the flow field of the or each stream of air associated with a spinner.

**[0026]** A process in which the apparatus according to the invention can be used for making an MMVF batt comprises centrifugally fiberising mineral melt by feeding the melt to first and second centrifugal spinners arranged in substantially side-by-side relationship, and one or more third centrifugal spinners between the first and second spinners, wherein each centrifugal spinner comprises at least one fiberising rotor mounted for rotation about a substantially horizontal axis wherein the or each rotor provides an acceleration field,

entraining the fibres from each spinner in a stream of air around at least one fiberising rotor of each spinner wherein the stream of air has a flow field and thereby forming a single cloud of fibres entrained in air,

collecting the fibres on a permeable conveyor as a web having first and second opposed edge regions and a centre region by sucking the air from the cloud through the conveyor whereby the first and second spinners form the fibres which predominantly provide the first and second edge regions respectively, and

cross lapping the web to make the batt whereby a first face section of the batt is formed mainly of the first edge region of the web and the opposed second face section of the batt is formed mainly of the second edge region of the web and the batt has a core section between its first and second face sections,

and in this process the

centrifugal fiberisation on one or more spinners is controllable independently from the centrifugal fiberisation on one or more other spinners by independent adjustment on different spinners of at least two fiberising parameters before or during the production of MMVF batt so as to vary one or more web edge region or web core region properties selected from (1) mean fibre diameter, (2) mean fibre length, (3) shot content, (4) tensile strength of wool, (5) density and (6) chemical analysis, the fiberising parameters being selected from (a) the physical properties and/or chemical analysis of the melt fed to a spinner, (b) the rate of melt flow to a spinner, (c) the position of the fiberising rotor, or at least one of the fiberising rotors, on a spinner with respect to the position of the feed of melt to that spinner, (d) the acceleration field or fields on a spinner and (e) the flow field of the or each stream of air associated with a spinner.

**[0027]** Thus, in the process, at least two fiberising parameters are different on different spinners.

**[0028]** The invention can be used in processes in which at least two parameters are adjustable on one of the spinners, and one or all of the other spinners are not adjusted during the process. Indeed, these other spinners may be constructed so that adjustment of the parameters on these is difficult to achieve (i.e., the spinners and their melt flow are not constructed easily to allow such adjustment).

**[0029]** In other processes and apparatus adjustment of at least two parameters is achieved by adjusting one parameter on one spinner and another parameter on a second spinner. Adjustment of any parameter on any other spinners may be difficult to achieve. Further adjustment of second or subsequent parameters may be difficult to achieve on the adjustable spinners, but is usually possible.

**[0030]** Usually, however, it is possible to adjust at least one parameter and usually at least two parameters and often all the parameters, on at least two (and usually all) of the spinners. Often, at least two parameters on a spinner are adjusted during the process, with the other spinner or spinners remaining unadjusted or optionally being adjusted in respect of one or more of their parameters.

**[0031]** It is necessary in practice to adjust at least two parameters (either different parameters on two different spinners or at least two parameters on one or more spinners) because we have realised that adjustment of a single parameter in a multi-spinner process does not give adequate flexibility of control, to achieve the careful control of the process which is desired in the invention. For instance if the yield of one spinner is inadequate, merely adjusting the parameter relating to the amount of melt added to the spinner does not achieve the desired efficiency that we require. Instead, it will be necessary in practice to adjust at least one other parameter, for instance one or more of the acceleration fields or air flow fields, to compensate for the changes that will arise when the parameter relating to the amount of melt is adjusted.

**[0032]** The adjustment of at least two parameters can be conducted primarily with the intention of obtaining a uniform or more uniform web. For instance, the adjustment can be conducted primarily with the intention of varying the yield across the width of the web, for instance so as to obtain edges which have a higher fibre weight than they might otherwise be, for instance so that the fibre weight and shot content of the web is substantially uniform across the width of the web.

**[0033]** Thus, this allows, for the first time, optimisation of the operation of known triple spinner processes.

**[0034]** The spinners used may be any centrifugal spinners having one or more fiberising rotors mounted for rotation about a substantially horizontal axis.

**[0035]** Generally, however, each spinner is a cascade spinner. Thus preferably each spinner which is used for forming the web is a cascade spinner comprising a first rotor mounted for rotation about a substantially horizontal axis and at least one further rotor mounted for rotation about a substantially horizontal axis and positioned to receive melt thrown off the first rotor and to throw it off as fibres.

**[0036]** Usually there is a first rotor off which some fibres may be formed but which serves predominantly to accelerate the melt and to throw the melt onto the second rotor, a second rotor which conducts fiberisation and throws melt onto a third rotor, and either all the melt on the third rotor is fiberised or the third rotor conducts fiberisation and throws melt onto a fourth rotor off which all the melt is fiberised. Fiberisation on at least the second and subsequent rotors, and optionally on the first rotor, is conducted into a stream of air which has a flow field which can influence fibre formation.

**[0037]** Suitable cascade spinners are described in GB-A-1,559,117, WO-A-92/06047, WO-A-92/12939 and WO-A-92/12940.

**[0038]** One way of varying the fibre properties on different spinners is by varying the amount of melt, and this is particularly significant when the spinners are cascade spinners. It is therefore desirable to be able to control very accurately the amount of melt which is discharged to each individual spinner. It is generally preferred to provide a single melt to all the spinners from a single furnace, and it is then convenient to provide an appropriate gutter arrangement whereby the melt can flow from the furnace to each of the spinners. It is difficult to control accurately the flow of melt once it is flowing along a gutter towards a spinner and in particular it is difficult to do this when a single rigid gutter system is being used to supply melt to three or more spinners. For instance, the provision of adjustable weirs in the outlets from the gutter tends to be inconvenient.

**[0039]** We have now developed an apparatus for forming man-made vitreous fibres from a plurality of cascade spinners and which allows individual optimisation of the flow of melt to each of the spinners. This apparatus therefore allows for the amount of melt to one spinner to be controllable different from the amount of melt supplied to one or more of the other spinners.

**[0040]** According to the invention, we provide apparatus for forming MMV fibres comprising
first, second and third centrifugal (usually cascade) spinners arranged in side by side relationship, and
a rigid gutter assembly for receiving melt from a furnace at a receipt position and for feeding melt from first, third and second discharge position to the first, third and second spinners respectively, wherein the gutter assembly has first and second gutter arms extending in generally opposite directions transversely away from the receipt position towards the first and second discharge positions respectively and a third arm extending generally in a forward direction from the receiving position to the third discharge position,
and the apparatus includes means for independently tilting the gutter about a substantially horizontal axis that extends in a generally transverse direction and about a substantially horizontal axis that extends in a generally forward direction, whereby the rate of flow at each of the first, second and third discharge positions can be controlled independently of the rate of flow at each of the other positions.

**[0041]** Generally the gutter assembly is substantially T shaped, with the stem of the T acting as the third gutter arm and extending in the forward direction, and the gutter is mounted for pivoting about a substantially horizontal (forward) axis substantially parallel to the stem of the T and for pivoting about a substantially horizontal axis substantially perpendicular to the forward axis. By referring to the forward direction we mean a substantially horizontal direction substantially perpendicular to the transverse direction, which extends between the first and second discharge positions.

**[0042]** Although this gutter is a preferred apparatus for independent control of the rate of feed of a single melt to three spinners, it is also possible to use other means for controlling the rate of feed of melt to one or more of the spinners independent of adjustment of the rate of feed of melt to the other spinners. Suitable apparatus is described in WO-A-98/35916.

**[0043]** In order that a single apparatus can be used for making a variety of products ranging from products which are deliberately uniform across the width of the web to two or more products having deliberate variation across the width of the web (and through the thickness of the batt) it is necessary that each of the spinners should be independently controllable by independent selection of at least two of the defined fiberising parameters. Preferably at least one, and generally all, the centrifugal spinners are independently controllable by independent selection of at least two of the fiberising parameters. Preferably at least one spinner, and preferably all the spinners, is independently controllable by independent selection of three, four or five of the defined parameters.

**[0044]** The independent selection may be conducted before the start of a process. For instance one of the spinners may be constructed in such a way that it inherently produces fibres different from the others. For instance if the spinners are cascade spinners, one or more of the spinners can be a three rotor spinner while one or more of the other spinners can be a four rotor spinner. Usually, however, all the spinners have the same number of rotors, and in particular usually either all the spinners have three rotors or, more preferably, they all have four rotors.

**[0045]** One or more of the spinners may be constructed to have different sizes of rotor or rotors from one or more of the other spinners. For instance one or more of the spinners may be constructed as described in WO-A-92/06047 while one or more of the other spinners may be constructed with particular rotor sizes or speeds as described in WO-A-92/12939 or WO-A-92/12940.

**[0046]** Preferably, however, the independent control of the spinners comprises independent selection of two or more fiberising parameters at the start of a particular process run or even during a process run. Thus, at the start of a run the fiberising parameters may be selected to a combination which is chosen having regards to the desired end product, or variation may be made during a run. When variation in two or more process parameters is made during a run, this control and independent selection in the invention may be made in response to spontaneous or other unwanted variations in fibre production. For instance, it may be observed that the fibre yield from one of the spinners is decreasing spontaneously, in which event one or more of the fiberising parameters is adjusted to restore the yield to the desired value.

**[0047]** More usually, however, variation during a production run is made so as to change the nature of the product which is being made. For instance it is possible, by the invention, to change production rapidly from one type of product to another.

**[0048]** The adjustment of at least two of the fiberising parameters may be conducted automatically or manually. For instance the desired edge region or core region properties may be programmed into a control system operating the overall apparatus whereupon the fiberising parameters are adjusted automatically to achieve the required properties. A suitable control system is described in EP 97309674.6.

**[0049]** One of the fiberising parameters which may be adjustable relates to the melt itself. The parameters can include its physical properties (generally its viscosity) and/or its chemical analysis. The viscosity is influenced both by temperature and by the chemical analysis of the melt, and the viscosity influences the fiberisation process.

**[0050]** Thus, if the spinners are otherwise similar but the melt has a different viscosity when it reaches one spinner from when it reaches another spinner, fibre quality will differ. If there is a deliberate difference in viscosity, as the melt reaches the spinners, the difference is, usually at least 10cps, often at least 20 or 30cps. It can be as much as 200cps or more.

**[0051]** If there is a difference in melt temperature, as the melt reaches the spinners it is usually at least 10°C, for instance at least 20°C and it can be as much as 50°C or even 100°C. If there is a difference in chemical composition this can be a relatively minor difference, for instance a difference of at least 1% or at least 2% by weight (measured as oxides) of at least one component in the melt but it may be much more, for instance a difference of at least 5% or 10% or more in one or more of the components in the melt.

**[0052]** Another difference in fiberising parameters that can be used involves differences in the rate of melt flow, especially when the spinners are of otherwise substantially identical construction. For instance if all the spinners are of substantially the same construction increasing (or reducing) the rate of feed (kilos per minute) to one of the spinners by, for instance at least 5% or even at least 10%, and often up to 30 to 60% or more, can make a significant difference in fibre quality from that spinner.

**[0053]** Another difference in fiberising parameters that can be used involves selecting the position of the fiberising rotor, or at least one of the fiberising rotors, with respect to the position of the feed of melt to the spinner. For instance, the entire spinner can be displaced laterally so as to alter the angle at which the melt strikes the first rotor by at least 5° or 10°, from an angle approaching 90° to an angle which is considerably less. Alternatively, the entire spinner can be pivoted about a horizontal axis, for instance as described in US-A-3,159,475, typically through at least 5°, or the individual rotors can be moved vertically and/or horizontally with respect to each other. One or more of the spinners may be oscillated around a vertical axis or may be adjusted at a fixed angle to the length direction of the direction of movement of the cloud of fibres so as to direct the cloud in a chosen direction. Suitable process and apparatus for adjusting the position of the or each spinner is described in EP-A-825965.

**[0054]** However the invention can be used in processes in which the variation in the fiberising parameter involves terminating the supply of melt to one or more of the spinners, provided that at least two of the spinners still receive melt for fiberisation. Thus the invention can be used in processes in which the supply of melt to one of the spinners (usually the third spinner) is terminated and when there are four spinners the invention includes processes in which the supply of melt to one or to two of the spinners is terminated, and so forth. This can have the advantage that the terminated spinner may still be used as a vehicle for ejecting primary and optionally secondary air and/or cooling water and/or binder forwards off the spinners, but without adding any fibres to the load which is being collected as the web.

**[0055]** Another fiberising parameter that can be varied is the acceleration field or fields. This is defined as the acceleration field on the surface of the rotating rotor and as the centripetal acceleration a of an element of the wheel surface having the radius r [m] and rotating with the angular velocity $\omega$ [$s^{-1}$] :

$$a = r\omega^2 \, [ms^{-2}],$$

where $\omega = 2\pi n/60$, and n = revolutions per minute.

**[0056]** This variation can be achieved by replacing one rotor by a rotor having a differing diameter (as discussed above) but in the invention it is usually achieved by varying the speed of rotation. When each spinner has more than one rotor, the variation can be made on each of the rotors or on only one or some of the rotors.

**[0057]** When reliance is being placed on variation in acceleration field, the increase is usually at least 10% and often at least 20%, and it can be up to 50% or more. For instance when the spinners each consist of a single rotor, the acceleration field on one of them may be at least 10% more than on another, whilst if the spinners are cascade spinners the acceleration fields on the first or second rotors, or on one or more of the subsequent rotors, will generally be at least 10% more on one of the spinners than on the corresponding rotors on one or more of the other spinners.

**[0058]** It is preferred in cascade spinners to provide the stream of air on each fiberising spinner by a primary air stream that flows substantially in contact with part or all of the periphery of the or each of the further rotors, and optionally also in contact with part or all of the periphery of the first rotor. For instance there can be an air slot having a diameter substantially the same as the diameter of the rotor and arranged to feed the primary air stream across the periphery of the rotor. Generally this primary air is supplemented by a secondary air stream that flows around the primary air stream.

**[0059]** The primary air stream may emerge from guide means that are adjacent the periphery of the or each rotor and which are positioned to direct the air stream coaxially or, usually, at an angle $\alpha$ of 5 to 60° between the velocity vector and the axial direction in such a manner that generally the tangential component is co-rotational with the rotor.

**[0060]** The guide means on one or more rotors on one spinner are often arranged so as to impose a greater tangential component to the primary air stream on one or more of the rotors on one or more of the other spinners, generally by an amount of at least 5°. When there is a third spinner, the greatest angle is generally on this. Generally the greatest tangential angle on the third spinner is at least 5° bigger than the greatest tangential angle on the first and second spinners and is usually at least 20°. However in some embodiments it is preferred to have higher angles on the first and second spinners since this tends to promote the production of fibres having high tensile strength.

**[0061]** In order to minimise the cloud of fibres hitting the walls of the collection chamber in which the cloud is conveyed to the conveyer, it may be desirable to arrange for the guide means for the primary air stream to be arranged at different angles at different parts of any particular rotor so as to be able to optimise, having regard to the construction of the collecting chamber, the tangential angle for maximising tensile strength while minimising the extent of impact of the cloud of fibres on to the walls of the collecting chamber.

**[0062]** The variation in fiberising conditions can therefore be in the flow field of the air stream. The air stream may consist solely of a primary air stream or it may consist of primary and secondary air streams, with the second air stream surrounding the primary air stream. Thus the velocity vector of the primary air at a particular point on one of the spinners can be greater, usually at least 10% greater and often 30 to 80% greater, than the velocity vector of the primary air stream at a substantially corresponding point another spinner, and/or the velocity vector of the secondary air stream at a particular point may be at least 10% greater, and often 30 to 80% greater, than the velocity vector of the secondary air stream at substantially corresponding point on another spinner.

**[0063]** Often there is an adjustable primary air stream, together with a secondary air stream which maybe provided by, inter alia, an auxiliary air stream positioned below the spinner and which provides a relatively strong air stream forwards and upwards to influence the flow field in the collecting chamber and to minimise the loss of wool in the pit which is conventionally positioned in front of and below the spinner to collect shot.

**[0064]** The velocity vector for the primary air stream (and/or for the secondary air stream) may be varied merely by varying the rate of flow of air up to and past the spinner, for instance when some or all of the air flows coaxially with the spinner and parallel to the axis of the spinner however it can be desirable to impose a tangential component on this air stream, as it approaches the spinner. Preferably a tangential component is imposed, as described above, on the primary air stream close to the periphery of the or each spinner, so as to modify fibre forming conditions at the surface of the periphery of the or each rotor in the spinner.

**[0065]** By varying this angle the velocity vector can be varied. For instance the angle of a velocity vector of one particular value at a particular point on one spinner may be at least 5° different from the angle of a velocity vector of the same value at a corresponding point on another spinner as a result of there being a difference of at least 5° between the orientation of the air stream on one spinner and the orientation of the air stream at a corresponding position on another spinner.

**[0066]** Each spinner can be mounted independent of all the other spinners and each can be constructed and mounted as shown in WO-A-96/38391. For instance each spinner can be constructed with its own associated substantially tubular duct as shown in Figure 6 of WO-A-96/38391. These two ducts may merge into a collecting chamber constructed generally as described in WO-A-96/38391. Reference should be made to that for full disclosure of the construction of the substantially tubular duct, the spinner and the entire apparatus.

**[0067]** Instead of mounting the individual spinners each in its own associated substantially tubular duct, preferred processes mount the spinners in a single duct which will have a generally oval shape so as to allow for the side-by-side positioning of the spinners in the duct. Apart from being oval rather than substantially circular, the other details of the duct and the apparatus may be substantially as described in WO-A-96/38391. Thus guides may be provided on the inner face of the wall of the duct and these guides can be shaped or adjustable to provide different non-axial movement to different axial segments of air flowing past the spinners and thus becoming the secondary air discussed above.

**[0068]** The conveyor must be sufficiently wide to receive the fibres from the spinners. Often the sides of the conveyor are defined by walls of a collecting chamber, but air streams or any other suitable arrangement for confining the clouds of fibres can be used. The velocity vector of the primary gas streams then preferably has both an axial component and a corotational tangential component.

**[0069]** The web which is formed on the conveyor is subjected to cross lapping to form the batt. This can be by a swinging pendulum technique or by any other technique by which it is possible to lay lengths of web on one another transverse to the direction of travel of the batt, so that all the first edges of the web tend to form one face of the batt and the second edges of the web tend to form the opposite edge of the batt. An example of a cross lapping system which does not involve a pendulum cross lapper is given in WO-A-97/32069.

**[0070]** The web may be a continuous length in which event it will adopt a zig-zag configuration in the batt. When the cross lapping is achieved in this manner, the angle of each lap to the transverse direction is usually below 15° and preferably below 10°. Usually at least 4, and preferably 8 or more laps, for instance up to 20 laps, of the web are laid upon one another in order to form the total thickness of the batt. As a result of having, for instance, at least 6 laps laid upon one another and extending from one face of the batt to the other, it is insured that the first face section is formed mainly (e.g., at least 80% by weight) of fibres from the first opposed edge of the batt and the second face section is formed from fibres of the second opposed edge of the batt, and the batt is integral in that it is not formed by bonding one batt on to another batt.

**[0071]** The core is formed mainly of fibres from the central region of the batt, with the outer parts of the core merging into a zone formed of the same fibres as on the first and second opposed edges respectively.

**[0072]** As a result of varying at least two of the fiberising parameters it is possible to exercise control over the fibre and other properties across the web. As indicated, the fibre properties of interest may consist mainly of the yield (grams mineral material per unit area), especially when the web is desired to be as uniform as possible but mere variation in yield will normally result in change in fibre properties unless a compensatory.change in another parameter is made.

**[0073]** Usually, however, the purpose of varying the two or more fiberising parameters is to achieve varying properties which are generally selected from mean fibre diameter, mean fibre length, shot content or chemical analysis, in the one or more of the web edge regions or web core region. Thus, the web may have an A-B configuration or an A-A-B or an A-B-A or an A-B-C configuration in its width, and similarly the batt may have any such configurations in its thickness.

**[0074]** The mean fibre diameter of the core section of the batt and/or the central region of the web may be different from the mean fibre diameter of a face. For instance the core may have a mean fibre diameter which is less than 90% or more than 110% (for instance 20 to 90% or 110 to 200%) of the mean fibre diameter of a face section.

**[0075]** Instead of or in addition to the fibre quality being manifested by differences in fibre diameter, it may be manifested by differences in fibre length, and again the core section of the batt and/or the central region of the web may have a fibre length below 90% or above 110% (for instance 50 to 90% or 110 to 200%) of the mean fibre length of a face.

**[0076]** Another manifestation of the different fibre quality is in the shot content. Shot consists of all particles having a diameter above 63μm. The core section of the batt or the central region of the web may have a shot content below 90% or above 110% (for instance 50 to 90% or 110 to 200%) of the shot content of a face.

**[0077]** It is often preferred for the core region to have a mean fibre diameter and/or a shot content at least 10% (and usually 20-60%) less the value for either or both face sections and/or for the face sections to have a fibre length which is at least 10% less (and usually 20-60% less) than the core section. This gives optimum insulation properties to the core (by maximising fineness) and allows for strength or other properties to be optimised in either or both face sections (by maximising fibre length). Expressed alternately, the core section has a fibre length at least 10% (often 20-60%) less than the face sections.

**[0078]** Another manifestation of the difference in fibre quality is tensile strength of the batt. This can vary across the thickness of the batt, with core typically being below 90% or above 110% (typically 50-90% or 110 to 150%) of the tensile strength of a face.

**[0079]** Another manifestation of differences in fibre quality is density. Density is total weight per unit volume of material which is collected into the batt and the core. Typically the production off one of the spinners is at least 5% more or less than the production off one or more of the other spinners, even though they may be of substantially identical construction and set to operate, in theory, under the same conditions, and this can lead to variations in density.

**[0080]** Each face section having the defined fibre quality usually occupies at least 5% of the batt thickness extending inwardly from the outermost face, and the core section (when different) usually occupies at least 20% of the thickness. There is a transition in properties between the sections, e.g., between a face section and the core section. Often each face section occupies at least 10% of the thickness but usually not more than 30 to 40% when there is a different core section. The core section (when present) can be as much as 80% of the thickness when the face sections are thin but is often not more than 30 or 40%.

**[0081]** The melt can be any fiberisable mineral melt and so can be glass, slag or rock. Often it is slag or rock, for instance having above 15% by weight alkaline earth metal oxide and below 10% by weight alkali metal oxide in its analysis. For instance it can be a conventional slag or rock melt or a high-aluminium melt such as is described in WO-

A-96/14274 or a low-aluminium melt such as is disclosed in the prior art discussed in WO-A-96/14274.

**[0082]** Binder or other additives may be added to the cloud of fibres by known means. The amount of binder or other additive may be the same for each spinner or it may be different.

**[0083]** The batt can be in any conventional configuration, for instance a mat or slab, and can be cut and/or shaped (e.g. into pipe sections) during or after curing the binder.

**[0084]** Products made using the invention may be formulated for any of the conventional purposes of MMV fibres, for instance as slabs, sheets, tubes or other shaped products that are to serve as thermal insulation, fire insulation and protection or noise reduction and regulation, or in appropriate shapes for use as horticultural growing media, or as free fibres for reinforcement of cement, plastics or other products or as a filler.

**[0085]** The invention is illustrated in the accompanying drawings in which

Figure 1 is a perspective view of apparatus suitable for use with the apparatus of the invention
Figure 2 is a perspective view of a gutter assembly suitable for feeding the three cascade spinners in Figure 1
Figure 3 is a vertical section through the resultant batt.
Figure 4 is a perspective view of another apparatus suitable for use with the apparatus of the invention.

**[0086]** Referring to Figure 1, three cascade spinner 1, 3 and 2 respectively have rotors 4 off which fibres are thrown centrifugally in conventional manner. The fibres from spinner 1 collect primarily in the web 7 on the conveyer 5 along the edge region R1, while the fibres from the spinner 2 collect primarily along the opposed edge region R2, and the fibres from spinner 3 collect predominantly along the central region R3. Regions R1 and R3 merge with one and other over a diffuse zone 6 and the regions R2 and R3 likewise merge with one and other over a diffuse zone 6.

**[0087]** If required, binder or other material different from MMVF may be injected preferentially from one or more of the spinners, for instance solely through spinner 3, so that the central region R3 has a concentration of that additive significantly greater than the concentration in regions R1 or R2.

**[0088]** The web 7 is then cross lapped by a pendulum cross lapper 8 and the cross lapped product is a batt which is collected on a conveyer 9.

**[0089]** The batt (see Figure 3) has an upper face section 10 formed predominantly of the region R1 of the web and a lower face section 11 formed predominantly from region R2 of the web, and a central core section 12 formed predominantly from region R3 of the web.

**[0090]** The face and core sections 10 and 12 and 12 and 11 merge with one another along indistinct merging zones 13 and are integral with one another.

**[0091]** Figure 4 is a view from behind of apparatus similar to the apparatus shown (from in front) in Figure 1 except that appropriate ducting is shown. This ducting can be as described above by reference to WO-A-96/38391.

**[0092]** Thus a housing 50 is substantially oval and has the shape of 3 cylinders which merge with another and surrounds the spinners 1, 3 and 2. It leads into a single, wide, oval housing 51 which defines the sides and top of the spinning chamber. The remainder of the apparatus can be as shown in Figure 1. The web 7 can be, for example, 2 to 6 metres (often about 4 metres) wide.

**[0093]** Referring to Figure 2, the gutter assembly used for feeding the melt to the spinners 1, 3 and 2 respectively is shown in Figure 2, in which the cross-hatched area represents the flow of melt.

**[0094]** The gutter assembly comprises a T-shaped gutter 20 which has a stem or arm 24 leading in a forward direction towards a discharge 23 which discharges melt onto the spinner 3. It has side arm sections 25 and 26 extending transversely from the point 27 where the melt 28 flows down onto the gutter. Side arm 25 leads to discharge section 21 for discharging melt onto the spinner 1 while arm 26 leads to discharge section 22 for discharging melt onto spinner 2.

**[0095]** A plate 29 bridges the stem section 27 and defines a lowermost opening 30 through which melt can flow along the stem 24 and is fixed rigidly to the arms 25 and 26 and the stem 24, as a unitary rigid assembly of the T shaped assembly and of the arm stem and arm gutters and the plate 29.

**[0096]** The entire gutter assembly is mounted on a substantially horizontal axis shown by the line 31 on a fixed housing by bearings 32. Rods connect the bearings 32 with an arm 33 which is fixed to the plate 29 at a bearing 34 and which can be made to move (so as to pivot around the axis 31) by means of a control piston 35 which is fixed to a fixed point 36. Accordingly, expansion or contraction of the piston 35 causes the gutter assembly to pivot about the horizontal axis 31.

**[0097]** Another control piston 37 is connected by bearing 38 to the plate 29 and through a hinged arm 39 to the rod 33. Expansion or contraction of the piston 37 will therefore cause the gutter assembly to pivot about the axis shown by the line 40 and which is substantially horizontal and substantially perpendicular to the axis shown by the line 31.

**[0098]** Accordingly, by control of pistons 35 and 37 it is possible independently to control the relative vertical position of the open ends of the stem 24 and arms 25 and 26, thereby allowing independent control of the rate of flow of melt through each of the discharge points 21, 22 and 23.

**[0099]** The following are examples processes that can be operated using the apparatus of the invention.

**[0100]** In each of the following examples, the apparatus comprised three cascade spinners, each having four rotors arranged side by side and with independent control of the melt stream, all as described above by reference to the drawings.

**[0101]** Each of the rotors could be changed, with appropriate adjustment of their relative spacings, and the acceleration fields could be varied on each rotor by varying the diameter and/or by varying the speed of rotation. The first rotor always had a size within the range 100 to 250mm, the second rotor within the range 250 to 300mm, and the third and fourth rotors within the range 250 to 400mn. The three spinners, in side-by-side relationship, were each supplied with primary air streams and the fibres formed off the spinners were carried forward and collected in a single spinning chamber either 2.5 or 4 metres wide.

**[0102]** The rotors and their speeds of rotation were selected to provide 4 different combinations of Acceleration Fields identified below as Modes A to D, as follows.

| | Mode A Km/sec$^2$ | Mode B Km/sec$^2$ | Mode C Km/ssec$^2$ | Mode D Km/sec$^2$ |
|---|---|---|---|---|
| 1st Rotor | 40 | 60 | 75 | 120 |
| 2nd Rotor | 40 | 75 | 150 | 220 |
| 3rd Rotor | 80 | 120 | 200 | 320 |
| 4th Rotor | 95 | 130 | 270 | 350 |

**[0103]** In each of the following examples, the results are tabulated. The melt flow is the amount in tons per hour fed on to the first rotor of each spinner. The primary air is the air which emerges through the slots immediately adjacent the periphery of each rotor, and the secondary air is the air which is forced through the spinners at other positions, not immediately adjacent to the rotors.

**[0104]** The slots which are adjacent the periphery of the fourth rotor are fitted with a stator which includes blades positioned at varying angles, as described in WO-A-92/06047. The values quoted for DE are the range of angles extending from D to E shown in Figure 1 of WO-A-92/06047 while the values for EF are the angles in the region E to F shown in Figure 1 of WO-A-92/06047, both on the fourth rotor. However, it can also be advantageous to have the same variations around the third rotor.

**[0105]** The ignition loss is determined by combustion in conventional manner.

Example 1

**[0106]** The spinners are adjusted with respect to one another so that they comply with the following parameters.

| | Spinner No.1 | Spinner No.3 | Spinner No.2 |
|---|---|---|---|
| Meltflow | 3,5 t/h | 5 t/h | 3,5 t/h |
| Melt temperature | 1500-1520°C | 1500-1520°C | 1500-1520°C |
| Acceleration field | Mode B | Mode C | Mode B |
| Velocity primary air | 80 m/sec. | 120 m/sec. | 80 m/sec. |
| Amount primary air | 5500 m$^3$/h | 7500 m$^3$/h | 5500 m$^3$/h |
| Amount secondary air | 2000 m$^3$/h | 5000 m$^3$/h | 2000 m$^3$/h |
| Stator angles | DE 0-18°<br>EF 18-27° | DE 0-24°<br>EF 24-42° | DE 0-18°<br>EF 18-27° |
| Ignition loss | 2,2% | 1,8% | 2,2% |

**[0107]** This product is a low-density product of optimal quality with good compression and insulation properties corresponding to lambda class 040 with a density of 28 kg/m$^3$.

Example 2

**[0108]** The parameters in this example are adjusted as follows.

| | Spinner No.1 | Spinner No.3 | Spinner No.2 |
|---|---|---|---|
| Melt flow | 4 t/h | 4 t/h | 4 t/h |
| Melt temperature | 1500-1520°C | 1500-1520°C | 1500-1520°C |
| Acceleration field | Mode A | Mode B | Mode A |
| Velocity primary air | 100 m/sec. | 120 m/sec. | 100 m/sec. |
| Amount primary air | 7500 $m^3/h$ | 7500 $m^3/h$ | 7500 $m^3/h$ |
| Amount secondary air | 4000 $m^3/h$ | 4000 $m^3/h$ | 4000 $m^3/h$ |
| Stator angles | DE 0-18°<br>EF 18-27° | DE 0-24°<br>EF 24-42° | DE 0-18°<br>EF 18-27° |
| Ignition loss | 4,2% | 3,3% | 4,2% |

**[0109]** This product is a heavy product which is resistant to pressure on both sides.

Example 3

**[0110]** The apparatus is adjusted as follows.

| | Spinner No.1 | Spinner No.3 | Spinner No.2 |
|---|---|---|---|
| Meltflow | 5 t/h | 4 t/h | 3 t/h |
| Melt temperature | 1500-1520°C | 1500-1520°C | 1500-1520°C |
| Acceleration field | Mode A | Mode B | Mode B |
| Velocity primary air | 100 m/sec. | 120 m/sec. | 100 m/sec. |
| Amount primary air | 7500 $m^3/h$ | 7500 $m^3/h$ | 7500 $m^3/h$ |
| Amount secondary air | 4000 $m^3/h$ | 4000 $m^3/h$ | 4000 $m^3/h$ |
| Stator angles | DE 0-18°<br>EF 18-27° | DE 0-24°<br>EF 24-42° | DE 0-18°<br>EF 18-27° |
| Ignition loss | 4,2% | 3,3% | 3,0% |

**[0111]** This product is a heavy product resistant to pressure on the surface but has one flexible side which can absorb irregularities in the substrate on which the product is to be mounted, for instance as roof board. The selection of parameters gives a systematic uneven distribution of the wool in the web and this results in a distribution in the final product in which the upper third of the product has a higher density than the remainder of the product. The unsymmetrical strengths through the thickness of the product is promoted by variation in the amount of binder, with the maximum binder being in the upper layer (containing maximum fibre) and minimum binder in the lower layer, which is flexible and formed of finer fibres.

**[0112]** If desired, further variations in the thickness, for instance as regards density and strength, can be achieved by subjecting the product to conventional treatments.

Example 4

**[0113]** The conditions on the spinners in this example are adjusted so that the greatest melt flow is on the central spinner and the greatest acceleration field and primary air amounts are also applied on this central spinner.

| | Spinner No.1 | Spinner No.3 | Spinner No.2 |
|---|---|---|---|
| Meltflow | 2,5 t/h | 7 t/h | 2,5 t/h |
| Melt temperature | 1500-1520°C | 1500-1520°C | 1500-1520°C |
| Acceleration field | Mode A | Mode C | Mode B |
| Velocity primary air | 80 m/sec. | 120 m/sec. | 80 m/sec. |
| Amount primary air | 5500 $m^3/h$ | 7500 $m^3/h$ | 5500 $m^3/h$ |
| Amount secondary air | 3000 $m^3/h$ | 4000 $m^3/h$ | 3000 $m^3/h$ |
| Stator angles | DE 0-18°<br>EF 18-27° | DE 0-24°<br>EF 24-42° | DE 0-18°<br>EF 18-27° |
| Ignition loss | 1,2% | 1,8% | 1,2% |

**Claims**

**1.** Apparatus for forming a man-made vitreous fibre web comprising
first, third and second centrifugal spinners (1, 3, 2) arranged in side by side relationship,
a rigid gutter assembly (20) for receiving melt from a furnace at a receiving position (28) and for feeding melt from first, third and second discharge (21, 23, 22) positions to the first, third and second spinners (1, 3, 2) respectively, and in which the gutter assembly has first and second gutter arms (25, 26) extending in generally opposite directions transversely away from the receiving position to first and second discharge position respectively and a third arm (24) extending generally in a forward direction from the receiving position to the third discharge position,
and means for independently tilting the gutter about a substantially horizontal axis that extends in a generally transverse direction and about a substantially horizontal axis that extends in a generally forward direction, whereby the rate of flow at each of the first, second and third discharge positions can be controlled independently of the rate of flow of melt at each of the other positions by the independent tilting of the gutter.

**2.** Apparatus according to claim 1 in which the gutter is substantially T-shaped wherein the stem of the T extends in the forward direction and the gutter is mounted for pivoting about a substantially horizontal axis substantially parallel to the stem of the T and for independent pivoting about a substantially horizontal axis substantially perpendicular to the axis which is substantially parallel to the stem of the T.

**Patentansprüche**

**1.** Vorrichtung zum Bilden einer Bahn aus künstlichen glasartigen Fasern, umfassend:

erste, dritte und eine zweite Zentrifugalschleudervorrichtungen (1, 3, 2), die nebeneinander angeordnet sind,
ein starres Rinnensystem (20) zur Aufnahme von Schmelze aus einem Ofen an einer Aufnahmestelle (28) und zum Zuführen von Schmelze von einer ersten, einer dritten und einer zweiten Abgabestelle (21, 23, 22) an die ersten bzw. die dritten bzw. die zweiten Zentrifugalschleudervorrichtungen (1, 3, 2),
und wobei das Rinnensystem einen ersten und einen zweiten Rinnenarm (25, 26), die sich in allgemein entgegengesetzten Richtungen quer von der Aufnahmestelle weg zur ersten bzw. zweiten Abgabestelle erstrecken, und einen dritten Arm (24), der sich allgemein in Vorwärtsrichtung von der Aufnahmestelle zur dritten Abgabestelle erstreckt, umfasst,
und Mittel zum unabhängigen Kippen der Rinne um eine im Wesentlichen horizontale Achse, die sich allgemein in Querrichtung erstreckt, und um eine im Wesentlichen horizontale Achse, die sich allgemein in Vorwärtsrichtung erstreckt, wodurch die Strömungsgeschwindigkeit an der ersten, der zweiten und der dritten Abgabestelle jeweils unabhängig von der Strömungsgeschwindigkeit der Schmelze an jeder der anderen Stellen durch das unabhängige Kippen der Rinne unabhängig gesteuert werden kann.

**2.** Vorrichtung nach Anspruch 1, wobei die Rinne im Wesentlichen eine T-Form aufweist, wobei der Stamm des T sich in Vorwärtsrichtung erstreckt und die Rinne zum Drehen um eine im Wesentlichen horizontale Achse im Wesentlichen parallel zum Stamm des T und zum unabhängigen Drehen um eine im Wesentlichen horizontale Achse im Wesentlichen senkrecht zur Achse, die im Wesentlichen parallel zum Stamm des T ist, montiert ist.

## Revendications

**1.** Appareil pour former une bande de fibres vitreuses synthétiques comportant :

une première, une troisième et une deuxième roues de centrifugation (1, 3, 2) disposées les unes à côté des autres,
un assemblage de gouttières rigides (20) pour recevoir une matière fondue d'un four à une position de réception (28) et pour alimenter la matière fondue des première, troisième et deuxième positions d'évacuation (21, 23, 22) respectivement aux première, troisième et deuxième roues de centrifugation (1, 3, 2),
et dans lequel l'assemblage de gouttières comporte un premier et un deuxième bras de gouttière (25, 26) s'étendant dans des directions en général opposées s'éloignant transversalement de la position de réception vers les première et deuxième positions d'évacuation respectives et un troisième bras (24) s'étendant dans une direction en général vers l'avant depuis la position de réception vers la troisième position d'évacuation,
et un moyen pour incliner indépendamment la gouttière autour d'un axe sensiblement horizontal qui s'étend dans une direction en général transversale et autour d'un axe sensiblement horizontal qui s'étend dans une direction en général vers l'avant, le débit d'écoulement à chacune des première, deuxième et troisième positions d'évacuation pouvant être contrôlé indépendamment du débit d'écoulement de la matière fondue à chacune des autres positions en inclinant indépendamment la gouttière.

**2.** Appareil selon la revendication 1, dans lequel la gouttière a une forme sensiblement en T, dans lequel la tige du T s'étend dans la direction vers l'avant et la gouttière est montée pour tourner autour d'un axe sensiblement horizontal sensiblement parallèle à la tige du T et pour tourner indépendamment autour d'un axe sensiblement horizontal sensiblement perpendiculaire à l'axe qui est sensiblement parallèle à la tige du T.

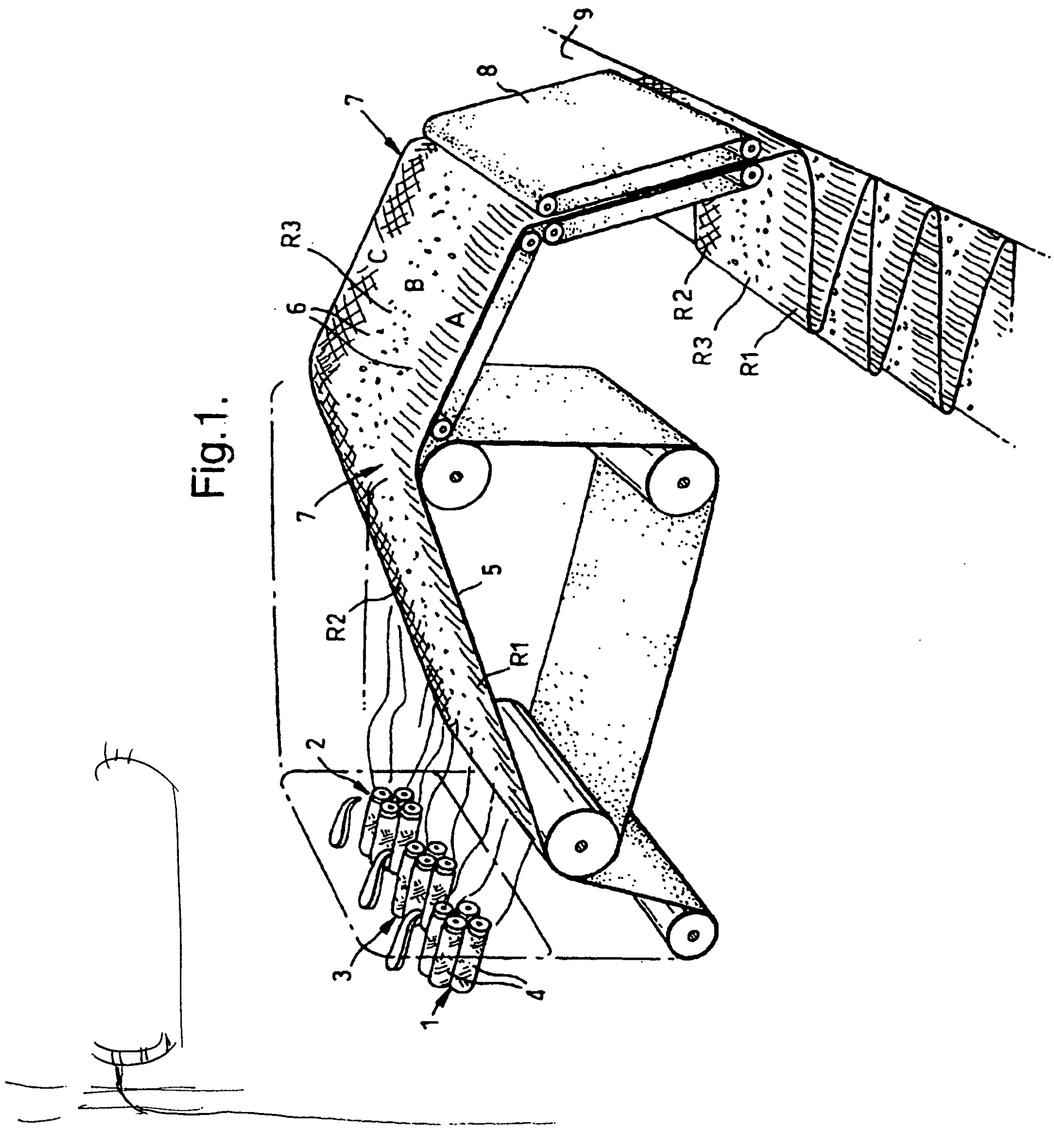

Fig.1.

Fig.2.

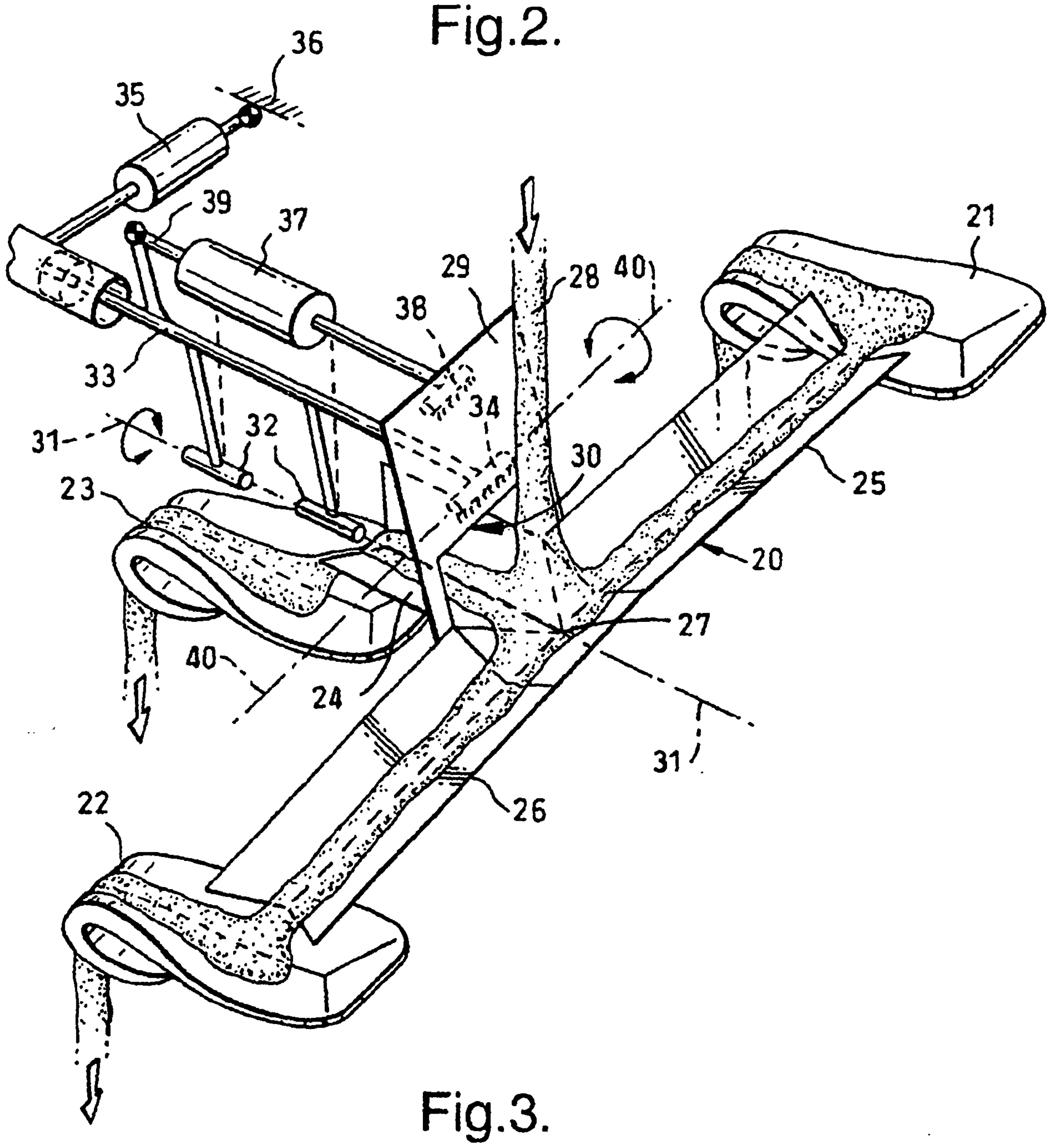
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Fig.3.

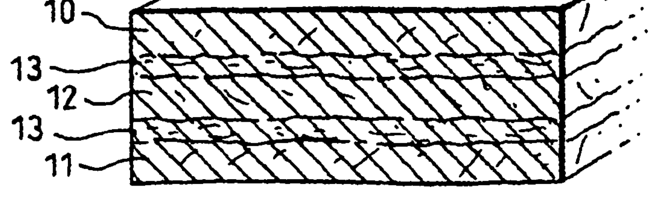
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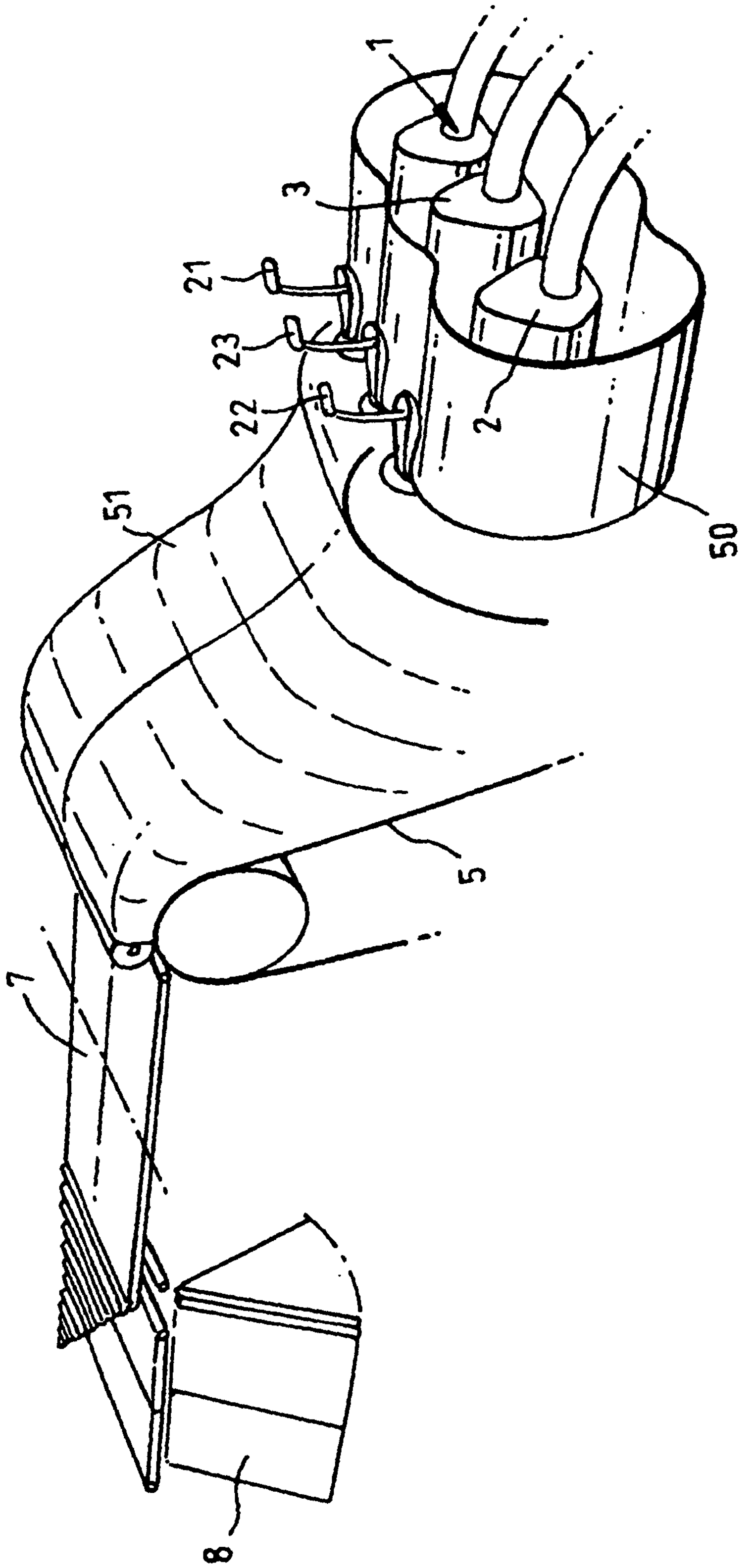
Fig.4.



## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- GB 926749 A **[0003]**
- US 3824086 A **[0003]**
- WO 8303092 A **[0003]**
- FR 1321446 A **[0003]**
- US 5009020 A **[0003]**
- US 3159475 A **[0015] [0053]**
- US 4210432 A **[0015]**
- EP 080963 A **[0015]**
- WO 9210436 A **[0015]**
- WO 9212940 A **[0015] [0018] [0037] [0045]**
- WO 9618585 A **[0015]**
- WO 9212941 A **[0018]**
- EP 374112 A **[0019]**
- GB 1559117 A **[0037]**
- WO 9206047 A **[0037] [0045] [0104]**
- WO 9212939 A **[0037] [0045]**
- WO 9835916 A **[0042]**
- EP 97309674 A **[0048]**
- EP 825965 A **[0053]**
- WO 9638391 A **[0066] [0067] [0091]**
- WO 9732069 A **[0069]**
- WO 9614274 A **[0081]**