P/00/001
Section 29

AUSTRALIA
Patents Act 1990

PATENT REQUEST : STANDARD PATENT

We, being the persons identified below as the Applicant, request the grant of a patent to the person identified below as the Nominated Person, for an invention described in the accompanying standard complete specification.

Applicant:	Tech Textiles International Limited
Address:	Unit 4/5 Crown Way, Walworth Industrial Estate, Andover, Hampshire SP10 5LU, United Kingdom
Nominated Person:	As above
Address:	As above
Invention Title:	Apparatus for Producing Multi-Axial Non-Woven Fabrics
Names of actual Inventors:	Jeffrey Albert VANE & Colin John HALLAM

BASIC CONVENTION APPLICATION DETAILS

Applicant Name:	Tech Textiles Limited
Application Number:	9206512.7
Country:	United Kingdom
Code:	GB
Date of Application:	25 March 1992

Address for service in Australia: ***CARTER SMITH & BEADLE***, 2 Railway Parade, Camberwell, Victoria, 3124, Australia. (Attorney Code CD)

Dated : 2 April 1997

Gary Nock.

CARTER SMITH & BEADLE
Patent Attorneys for the Applicant

AUSTRALIAN PATENT OFFICE 3

TO: *The Commissioner of Patents*
Our Ref: *#16260*

P/00/008
Section 29(1)
Regulation 3.1(2)

AUSTRALIA
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NOTICE OF ENTITLEMENT

We, **Tech Textiles International Limited**, of Unit 4/5 Crown Way, Walworth Industrial Estate, Andover, Hampshire, SP10 5LU, United Kingdom, being the applicant in respect of Application No. 37640/93, state the following:-

a) Jeffrey Albert VANE and Colin John HALLAM are the inventors and the details of the nominated persons's entitlement to the grant of a patent are as follows:-

(i) The invention was made by the inventors in the course of their normal duties with Tech Textiles Limited and therefore Tech Textiles Limited would be entitled to the grant of a patent for the invention. Tech Textiles Limited have assigned their rights in the invention to Tech Textiles Holdings Limited, who have assigned their rights in the invention to Tech Textiles International Limited.

b) The basic application listed in the Declaration under Article 8 of the PCT was filed in the name of Tech Textiles Limited. The nominated person is entitled to claim priority from that application by virtue of an assignment of rights from Tech Textiles Limited to Tech Textiles Holdings Limited and by virtue of a further assignment of rights from Tech Textiles Holdings Limited to the nominated person.

c) The basic application listed in the declaration made under Article 8 of the PCT is the first application made in a Convention country in respect of the invention.

Address for service in Australia: *CARTER SMITH & BEADLE*, 2 Railway Parade, Camberwell, Victoria, 3124, Australia. (Attorney Code CD)

Dated : 2 April 1997

AUSTRALIAN PATENT OFFICE 3

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AU9337640

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(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 678963

(54) Title
APPARATUS FOR PRODUCING MULTI-AXIAL NON-WOVEN FABRIC

International Patent Classification(s)
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(71) Applicant(s)
TECH TEXTILES INTERNATIONAL LIMITED

(72) Inventor(s)
JEFFREY ALBERT VANE; COLIN JOHN HALLAM

(74) Attorney or Agent
CARTER SMITH & BEADLE , Qantas House, 2 Railway Parade, CAMBERWELL VIC 3124

(56) Prior Art Documents
US 2772993
EP 361795
EP 426878

(57) Claim

1. Apparatus for producing multi-axial non-woven fabric, the apparatus comprising an endless series of yarn guides having upper and lower reaches extending widthwise of the apparatus, means for driving said series of yarn guides whereby said upper and lower reaches travel in opposite directions, creel means for supplying yarns to said yarn guides, and means for rotating said creel means in substantially the same direction and at substantially the same speed as said series of yarn guides to prevent tangling of the yarns supplied to the yarn guides, wherein the apparatus further comprises collecting means extending across the width of the apparatus for collecting the yarns issuing from the yarn guides and passing the collected yarns to stitching means which extends across the width of the apparatus for stitching together the yarns laid by said yarn guides, and transport means for transporting the laid yarns through said stitching means.

27. A method for producing multi-axial non-woven fabric as herein defined, the method comprising the steps of:

(a) driving an endless series of yarn guides having upper and lower reaches extending widthwise of the fabric being produced whereby said upper and lower reaches travel in opposite directions;

.../2

(b) supplying yarns to said yarn guides from creel means; and

(c) rotating said creel means in substantially the same direction and at substantially the same speed as said series of yarn guides;

wherein the method comprises the further steps of:

(d) collecting yarns issuing from the yarn guide on collecting means and passing the collected yarns to stitching means which extends across the width of the fabric to be produced;

(e) transporting the laid yarns through said stitching means; and

(f) stitching together the yarns laid by said yarn guides.

32. A multi-axial non-woven fabric made by a method according to claim 27 having yarns extending across the width of the fabric which have been laid to different lengths whereby to vary the width of the fabric.

OPI DATE 21/10/93 APPLN. ID 37640/93
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~~(71) Applicant: TECH TEXTILES HOLDINGS LIMITED [GB/GB]; Unit 4/5 Crown Way, Walworth Industrial Estate, Andover, Hampshire (GB).~~

(71)(72) Applicants and Inventors: VANE, Jeffrey, Albert [GB/GB]; 23 Oakdene, Sunningdale, Ascot, Berkshire SL5 0VU (GB). HALLAM, Colin, John [GB/GB]; Unit 4/5 Crown Way, Walworth Industrial Estate, Andover, Hampshire SP10 5LU (GB).

(74) Agent: CLARKSON, Eric, Potter; St Mary's Court, St Mary's Gate, Nottingham NG1 1LE (GB).

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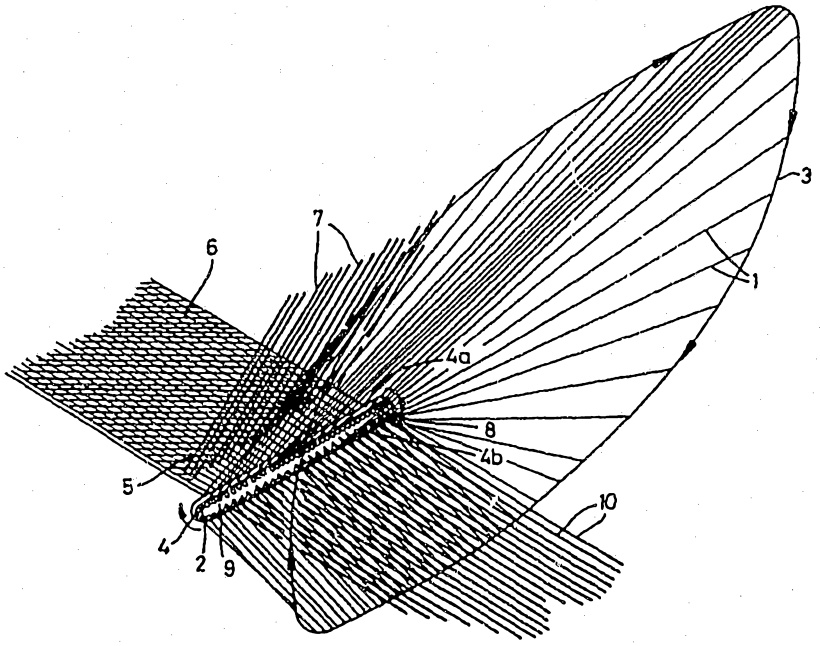
(71) TECH TEXTILES INTERNATIONAL LIMITED
Bowdon House
Ashburton Road West
Trafford Park
Manchester M17 1RA United Kingdom

AUSTRALIAN PATENT OFFICE

Description

(54) Title: APPARATUS FOR PRODUCING MULTI-AXIAL NON-WOVEN FABRIC



(57) Abstract

The invention provides apparatus for producing multi-axial non-woven fabric comprising an endless series of yarn guides (3) having upper and lower reaches which extend widthwise of the apparatus and which are driven in opposite directions, rotatable creel means (2) for supplying yarns (1) to the yarn guides (3), the creel means (2) being driven in the same direction and at substantially the same speed as the endless series of yarn guides (3), and stitching means (5) for stitching the yarns (1) laid by the endless series of yarn guides (3).

APPARATUS FOR PRODUCING MULTI-AXIAL NON-WOVEN FABRIC

This invention relates to apparatus for producing multi-axial non-woven fabric.

The term "multi-axial non-woven fabric" as used herein and the claims hereof means a non-woven textile fabric comprising at least two layers, all of the yarns in each layer being substantially parallel to one another and the yarns in at least said two layers extending in different directions, and stitching extending through said layers, the stitching serving both to connect together said layers and to maintain the parallelity of the yarns in each layer. Such fabrics are well-known in the art and are generally used as reinforcements in articles made from reinforced plastics materials, although they can have uses in other areas such as in the manufacture of window blinds. Examples of such fabrics are those manufactured and sold under the Registered Trademark "COTECH" by Tech Textiles Limited of Andover, Hampshire, England.

The term "yarn" or "yarns" as used herein and in the claims hereof means any yarn(s), thread(s), roving(s), tow(s) or fibre(s) whether these be monofilament or multifilament.

Generally, multi-axial non-woven fabrics of the kind defined are produced on apparatus comprising a pair of driven parallel endless chain conveyors which extend longitudinally of the apparatus on opposite sides thereof and each of which carries a series of pins, at least two guide rail means spaced longitudinally of the apparatus and extending above and across said chain conveyors, at least one of said guide rail means extending at an oblique angle with respect to said chain conveyors, a yarn carriage mounted on each of said guide rail means for movement therealong, each yarn carriage being adapted to

carry a plurality of parallel yarns from one of said chain conveyors to the other during each traverse, shogging means associated with each yarn carriage for engaging the yarns with the pins of the appropriate chain conveyor at the end of each traverse and for ensuring that the yarns laid at each traverse are adjacent to and parallel with the yarns laid on the previous traverse whereby to form a layer of non-woven parallel yarns extending at a predetermined angle with respect to the longitudinal centreline of the fabric being formed, and a stitching head extending across the width of the apparatus to which the laid yarns are transported by said conveyor chains, the stitching head serving to stitch together the layers laid by said yarn carriages so that the layers are held together and the parallelity of the yarns in each layer is maintained. In some cases means is provided for laying parallel warp yarns on or between the layers formed by said yarn carriages, prior to said stitching, to form a layer of yarns extending at 0 degrees with respect to the longitudinal direction of the fabric.

With this known apparatus, except for any optional layer of warp yarns, a separate guide rail means, yarn carriage and shogging means is required for each layer of the finished fabric and the guide rail means, yarn carriages and shogging means of the different layers must be spaced longitudinally of the apparatus. Since it is not uncommon for multi-axial non-woven fabrics of the kind defined to comprise four or more layers, e.g., with the yarns in the different layers extending at 0 degrees, +45 degrees, -45 degrees and 90 degrees with respect to the longitudinal centreline of the fabric, it will be apparent that the known apparatus is usually of considerable length and occupies a considerable amount of valuable floor space.

There is accordingly a need for apparatus for producing multi-axial non-woven fabric as herein defined which is more compact and occupies less floor space than the known apparatus and the present invention has as its object to fulfil this need.

The present invention provides apparatus for producing multi-axial non-woven fabric, the apparatus comprising an endless series of yarn guides having upper and lower reaches extending widthwise of the apparatus, means for driving said series of yarn guides whereby said upper and lower reaches travel in opposite directions, creel means for supplying yarns to said yarn guides, and means for rotating said creel means in substantially the same direction and at substantially the same speed as said series of yarn guides to prevent tangling of the yarns supplied to the yarn guides, wherein the apparatus further comprises collecting means extending across the width of the apparatus for collecting the yarns issuing from the yarn guides and passing the collected yarns to stitching means which extends across the width of the apparatus for stitching together the yarns laid by said yarn guides, and transport means for transporting the laid yarns through said stitching means.

With the apparatus of the present invention, the yarns laid by the upper and lower reaches of the endless series of yarn guides form two superimposed layers of parallel yarns which extend at opposite but equal angles with respect to the longitudinal centreline of the fabric being formed, the layers being stitched together by said stitching means to hold the layers together and to maintain the parallelity of the yarns in each layer. The angle at which said yarns are laid relative to the longitudinal centreline of the fabric being formed is determined by the speed at which said series of yarn guides is driven relative to the speed of said transport means, which latter is dependent on the speed of operation of the stitching means. Changing the speed at which the endless series of yarn guides is driven relative to the speed of the transport means changes the angle of the yarns laid relative to the longitudinal centreline of the fabric being formed.

The apparatus of the present invention may comprise two or more endless series of yarn guides each having upper and lower reaches extending widthwise of the apparatus and said two or more endless series of yarn guides may be substantially parallel and arranged at different levels, e.g., one above the other.

Said two or more endless series of yarn guides may be of substantially the same length and extend across substantially the full width of the apparatus. Alternatively, two or more of said endless series of yarn guides may be of different length, whereby to produce a fabric in which the layers are "stepped" along one or both side margins. This latter is useful where the fabric being produced is a reinforcing fabric for plastics articles since it enables adjacent lengths of fabric to be overlapped without any appreciable increase in the thickness of the reinforcement.

If desired, the length of the or each said endless series of yarn guides may be adjustable while the apparatus is in operation to vary the width of the fabric being produced. This feature is useful since it enables a fabric to be produced which is shaped or tailored, e.g. to suit a mould for a particular reinforced plastics article so that the article can be readily produced without the need to trim or tease the reinforcing fabric to the shape of the mould and with little or no waste.

The or each said endless series of yarn guides may be carried by an endless member such as an endless chain or band. Said endless chain or band may extend around spaced sprockets or pulleys, at least one of

which may be driven, or may be mounted on a guide rail and driven by sprocket or like means.

The speed at which the or each said series of yarn guides is driven relative to the speed at which the laid yarns are transported through said stitching means may be variable to vary the angle at which the yarns are laid relative to the longitudinal centreline of the fabric being formed.

Said creel means may comprise at least one rotatable creel support having means for mounting a plurality of creels of yarn about the periphery thereof. The rotatable creel support may be in the form of a wheel, cylindrical frame or carousel. Said creel mounting means may be such that each creel is rotatable about its own axis and/or such that the axis of each creel remains vertical as the creel support is rotated.

Said stitching means may comprise knitting means.

Said transport means may comprise a driven take-up roller on which the formed fabric is wound and/or may comprise suitable conveyor means.

The apparatus of the present invention may further comprise collecting means for collecting yarns issuing from said yarn guides and passing them to said stitching means.

According to one embodiment of the invention, the collecting means comprises upper and lower driven rollers extending across the width of the apparatus, said rollers each having pins extending outwardly of the periphery thereof, the distance between said rollers being less than the length of said pins whereby the pins of each roller extend between the pins of the other roller at the nip of said rollers.

According to another embodiment, the collecting means comprises upper and lower endless conveyor belts of a width substantially the same as the width of the apparatus and each having pins extending from the outer surface thereof. the conveyor belts having opposed adjacent reaches which travel in the same direction towards said stitching means and which are spaced apart by a distance less than the length of said pins whereby the pins of each conveyor belt extend between the pins of the other conveyor belt in the region of said opposed reaches. Said conveyor belts may further comprise reaches which converge towards said opposed adjacent reaches.

In either of the aforesaid embodiments, said pins may be retractable.

The apparatus of the present invention may further comprise warp insertion means for inserting warp yarns extending longitudinally of the fabric being formed. Such warp insertion means may comprise at least one line of fixed yarn guides extending across the width of the apparatus, e.g. adjacent said stitching means for supplying warp yarns direct to the stitching means.

The apparatus of the present invention may further comprise weft insertion means for inserting weft yarns extending normal to the longitudinal centreline of the fabric being formed. The weft insertion means may comprise a weft insertion carriage, e.g. mounted on said stitching means, reciprocatable across the width of the apparatus.

The invention will be further described with reference to the accompanying diagrammatic drawings, in which:-

Fig. 1 illustrates in perspective view the operation of apparatus according to the present invention,

Fig. 2 is a front elevation of an endless series of yarn guides according to an embodiment of the present invention,

Fig. 3 is a side elevation of an embodiment of collecting means for collecting yarns issuing from an endless series of yarn guides and passing them to stitching means,

Fig. 4 is a side elevation of another embodiment of collecting means for collecting yarns issuing from am endless series of yarn guides and passing them to stitching means,

Figs. 5A and 5B illustrate how apparatus according to the present invention may comprise a plurality of endless series of yarn guides arranged in parallel at different levels and how such endless series of yarn guides may be of different lengths,

Figs. 6A and 6B are a plan view and side view respectively of an embodiment of rotatable creel means according to the invention,

Figs. 7A and 7B are perspective and side views of another embodiment of rotatable creel means, and

Fig. 8 is a perspective view of yet another embodiment of rotatable creel means.

Referring first to Fig. 1 it will be seen that yarns 1 from rotatable creel means 3 each pass through one of an endless series of yarn

guides 2 carried by an endless chain 4 having upper and lower reaches 4a,4b which extend widthwise of the apparatus. Yarns 1 having passed through the endless series of yarn guides 2 then pass to stitching means 5 which stitch bonds the two layers of yarns so formed together to form a fabric 6 in which the yarns 1 in each layer are parallel to one another and are maintained in parallelity by said stitching and wherein the yarns in the two layers extend at predetermined equal but opposite angles with respect to the longitudinal centreline of the fabric 6. The formed fabric 6 is conveyed to a take-up roller or other suitable storage means (not shown).

The angle at which the yarns 1 are laid by the endless series of yarn guides 2 relative to the longitudinal centreline of the fabric 6 is determined by the speed at which the yarn guides 2 are driven relative to the speed at which the laid yarns pass through the stitching means 5, this relative speed being variable to enable the angle at which the yarns 1 are laid to be varied as required.

The apparatus of the invention may optionally include warp insertion means for inserting warp yarns extending longitudinally of the fabric 6. Such warp insertion means may comprise a line of fixed yarn guides ~~(not shown)~~ for supplying a plurality of warp yarns 7 from above direct to the stitching means 5 and/or a line of fixed yarn guides 8 in a fixed guide rail 9 supporting the endless chain 4 for supplying a plurality of warp yarns 10 to the stitching means 5.

In the embodiment shown in Fig. 2, endless chain 4 having upper and lower reaches 4a, 4b, is mounted for rotation on a fixed guide rail 9 supported by frame members 11 and carries a series of brackets 12 which support an endless series of yarn guides 2 in the form of eyes of suitable ceramic or other hard wearing material. The yarn guides

2 may be arranged in a single row 13 or in a plurality of rows 13, 14, 15, etc., according to the number of yarns required in each layer of the finished fabric. Endless chain 4 is driven by sprockets 16.

The collecting means illustrated in Fig. 3 of the drawings comprises upper and lower rollers 17, 18 which extend across the width of the apparatus and are interposed between the endless chain 4 and the stitching means 5. Rollers 17, 18 are driven in opposite directions as indicated by the arrows and each has pins 19 extending outwardly of the periphery thereof. The spacing between the rollers 17, 18 is less than the length of the pins 19 so that the pins of each roller extend between the pins of the other roller.

The collecting means illustrated in Fig. 4 of the drawings comprises upper and lower conveyor belts 20, 21 which extend across the width of the apparatus and are interposed between the endless chain 4 and the stitching means 5. Conveyor belts 20, 21 extend around driven and idler rollers 22, 23 respectively and each has spaced spring-loaded pins 24 which are normally retracted and are caused to extend from the outer surface thereof by contact with cam plates 20c, 21c along reaches 20a, 21a to be described. Conveyor belt 20 has a reach 20a which is adjacent and opposite a reach 21a of conveyor belt 21, the reaches 20a, 21a travelling in the same direction towards the stitching means 5 and the distance therebetween being less than the length of the pins 24 so that the pins of each conveyor belt extend between the pins of the other conveyor belt in the region of the reaches 20a, 21a. Downstream of the reaches 20a, 21a the conveyor belts 20, 21 have reaches 20b, 21b which converge towards the reaches 20a, 21a. In an embodiment (not illustrated) cam plates 20c, 21c are extended to cause pins 24 to extend also along converging reaches 20b, 21b.

Referring now to Figs. 5A and 5B, it will be seen that the apparatus of the present invention may comprise a plurality of endless series of yarn guides 2a, 2b, 2c.....2n which are arranged at different levels,

e.g. one above the other, so as not to interfere with one another and which as illustrated may be of different lengths so as to produce a fabric having one (Fig. 5A) or both (Fig. 5B) side margins "stepped". Separate creel means would, of course, be assocated with each of the endless series of yarn guides 2a, 2b, 2c, etc.

The creel means illustrated in Figs. 6A and 6B comprises a driven rotatable carousel 25 on which is mounted a plurality of creels 26 each rotatable about its own vertical axis. Yarns 1 drawn from the creels 26 pass through first and second endless series of yarn guides 3a, 3b, which are driven in the same direction and at the same speed as the carousel 25, before passing to the stitching means 5, which in this embodiment includes driven rollers 27, 28 for transporting the laid yarns through the stitching means 5.

The creel means illustrated in Figs. 7A and 7B comprises a cylindrical frame 29 rotatable about its longitudinal axis and having a plurality of creels 30 mounted about its periphery over the length thereof. Yarns 1 from the creels 30 pass through an endless series of yarn guides 2, driven in the same direction and at the same speed as the cylindrical frame 29, to the stitching means 5.

The creel means illustrated in Fig. 8 comprises a frame 31 having rotatably mounted thereon four sprocket wheels 32a, 32b, 32c, 32d driven by chains 33, 34 from a motor 35. Mounted on each of the sprocket wheels 32 is a cylindrical frame 36 (only one of which is shown) having longitudinal frame members 37 spaced about the periphery thereof. Each of the frame members 37 has a plurality of creels 38 spaced along the length thereof. Frame members 37 are themselves rotatable about their longitudinal axes by suitable gear means 39 contained within the sprocket wheels 32 to maintain the axes of the

creels 38 vertical as the sprocket wheels 32, and hence the cylindrical frames 36, are rotated. As with the previous embodiments, yarns 1 from the creels 38 pass through endless series of yarn guides (not shown) to stitching means (not shown).

From the foregoing description it will be understood that the apparatus of the present invention is not only more compact and occupies less floor space than the known apparatus for producing multi-axial non-woven fabric but that each endless series of yarn guides enables two layers of the finished fabric to be produced in a single operation.

Where the multi-axial non-woven fabric is intended for use as a reinforcing fabric for reinforced plastics articles, the yarns 1 may be of glass fibre, carbon fibre, Aramid fibre, or any other fibre or material used as reinforcements for plastics. Furthermore, if desired, the yarns of reinforcing material may be interspersed with yarns of thermoplastic material in required proportions to produce a fabric which simply requires heating in a mould to produce a reinforced thermoplastics article.

The claims defining the invention are as follows:

1. Apparatus for producing multi-axial non-woven fabric, the apparatus comprising an endless series of yarn guides having upper and lower reaches extending widthwise of the apparatus, means for driving said series of yarn guides whereby said upper and lower reaches travel in opposite directions, creel means for supplying yarns to said yarn guides, and means for rotating said creel means in substantially the same direction and at substantially the same speed as said series of yarn guides to prevent tangling of the yarns supplied to the yarn guides, wherein the apparatus further comprises collecting means extending across the width of the apparatus for collecting the yarns issuing from the yarn guides and passing the collected yarns to stitching means which extends across the width of the apparatus for stitching together the yarns laid by said yarn guides, and transport means for transporting the laid yarns through said stitching means.

2. Apparatus according to claim 1, comprising two or more endless series of yarn guides each having upper and lower reaches extending widthwise of the apparatus, said two or more series of yarn guides being substantially parallel and arranged one above the other.

3. Apparatus according to claim 2, wherein said two or more endless series of yarn guides are of substantially the same length and extend across substantially the full width of the apparatus.

4. Apparatus according to claim 2, wherein two or more of said endless series of yarn guides are of different length.

5. Apparatus according to claim 1 wherein the length of the or each said series of yarn guides is adjustable while the apparatus is in operation to vary the width of the fabric being produced.

6. Apparatus according to claim 1 wherein the or each said series of yarn guides is carried by an endless flexible member.

7. Apparatus according to claim 6, wherein said endless flexible member is in the form of an endless chain or band extending around spaced sprockets or pulleys and wherein at least one of said spaced sprockets or pulleys is driven.

8. Apparatus according to claim 6, wherein said endless flexible member is in the form of an endless chain or band mounted on a guide rail and driven by sprocket or like means.

9. Apparatus according to claim 1 wherein the speed at which the or each said series of yarn guides is driven relative to the speed at which the laid yarns are transported through said stitching means is variable to vary the angle at which the yarns are laid relative to the longitudinal centreline of the fabric being formed.

10. Apparatus according to claim 1 wherein said creel means comprises at least one rotatable creel support having means for mounting a plurality of creels about the periphery thereof.

11. Apparatus according to claim 10, wherein said rotatable creel support is in the form of a wheel, cylindrical frame or carousel.

12. Apparatus according to claim 10 wherein said creel mounting means is such that each creel is rotatable about its own axis.

13. Apparatus according to claim 10 wherein said creel mounting means is such that the axis of each creel remains vertical as said creel support is rotated.

14. Apparatus according to claim 1 wherein said stitching means comprises

knitting means.

15. Apparatus according to claim 1 wherein said transport means comprises a driven take-up roller on which the formed fabric is wound.

16. Apparatus according to claim 1 wherein said transport means comprises conveyor means.

17. Apparatus according to any one of the preceding claims wherein said collecting means comprises upper and lower driven rollers extending across the width of the apparatus, said rollers each having pins extending outwardly of the periphery thereof, the distance between said rollers being less than the length of said pins whereby the pins of each roller extend between the pins of the other roller at the nip of said rollers.

18. Apparatus according to any one of the preceding claims wherein said collecting means comprises upper and lower endless conveyor belts each having pins extending from the outer surface thereof, the conveyor belts having opposed adjacent reaches which travel in the same direction and which are spaced apart by a distance less than the length of said pins whereby the pins of each conveyor belt extend between the pins of the other conveyor belt in the region of said opposed adjacent reaches.

19. Apparatus according to claim 18, wherein said conveyor belts have reaches which converge towards said opposed adjacent reaches.

20. Apparatus according to any one of claims 17 to 19 wherein said pins are retractable.

21. Apparatus according to any one of the preceding claims comprising warp

insertion means.

22. Apparatus according to claim 21, wherein said warp insertion means comprises at least one line of fixed yarn guides extending across the width of the apparatus.

23. Apparatus according to claim 22, wherein said fixed yarn guides are located adjacent said stitching means and supply warp yarns direct to said stitching means.

24. Apparatus according to claim 1 comprising weft insertion means.

25. Apparatus according to claim 24, wherein said weft insertion means comprises a weft insertion carriage reciprocable across the width of the apparatus.

26. Apparatus according to claim 25, wherein said weft insertion carriage is mounted on said stitching means.

27. A method for producing multi-axial non-woven fabric as herein defined, the method comprising the steps of:

(a) driving an endless series of yarn guides having upper and lower reaches extending widthwise of the fabric being produced whereby said upper and lower reaches travel in opposite directions;

(b) supplying yarns to said yarn guides from creel means; and

(c) rotating said creel means in substantially the same direction and at substantially the same speed as said series of yarn guides;

wherein the method comprises the further steps of:

(d) collecting yarns issuing from the yarn guide on collecting means and passing the collected yarns to stitching means which extends across the width of the fabric to be produced;

(e) transporting the laid yarns through said stitching means; and

(f) stitching together the yarns laid by said yarn guides.

28. A method according to claim 27, which comprises the additional steps of providing at least one further driven endless series of yarn guides having upper and lower reaches extending widthwise of the fabric being produced, arranging said at least one further endless series of yarn guides above and parallel to said first endless series of yarn guides and supplying yarns to said at least one further endless series of yarn guides from said creel means.

29. A method according to claim 28, which comprises providing at least two endless series of yarn guides of substantially the same length whereby to produce a fabric in which all of the layers are of the same width.

30. A method according to claim 28, which comprises providing at least two endless series of yarn guides of different length whereby to produce a fabric in which some of the layers are of different width.

31. A method according to claim 27 which comprises varying the length of the or each said endless series of yarn guides while the fabric is being produced to vary the width of the fabric being produced.

32. A multi-axial non-woven fabric made by a method according to claim 27 having yarns extending across the width of the fabric which have been laid to different lengths whereby to vary the width of the fabric.

33. A multi-axial non-woven fabric made by a method according to claim 27, having yarns extending across the width of the fabric which have been laid at different lengths in different layers of the fabric whereby to produce a fabric having at least one stepped side margin.

34. Apparatus for producing multi-axial non-woven fabric substantially as hereinbefore described with reference to any one of the accompanying drawings.

35. A method for producing multi-axial non-woven fabric substantially as hereinbefore described with reference to the accompanying drawings.

DATED: 1 August 1996

CARTER SMITH & BEADLE

Patent Attorneys for the Applicant:

TECH TEXTILES INTERNATIONAL

37640/93

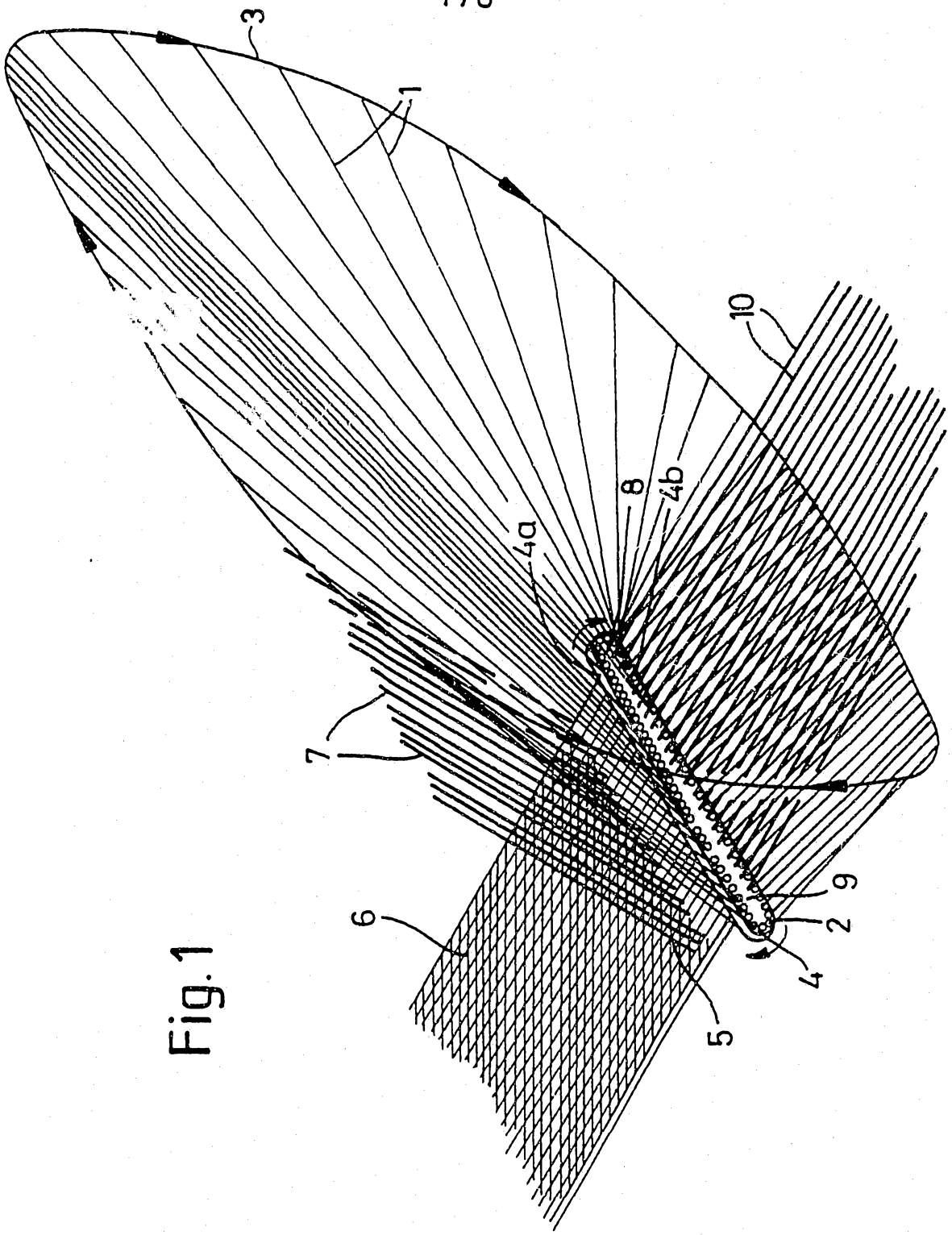


Fig.1

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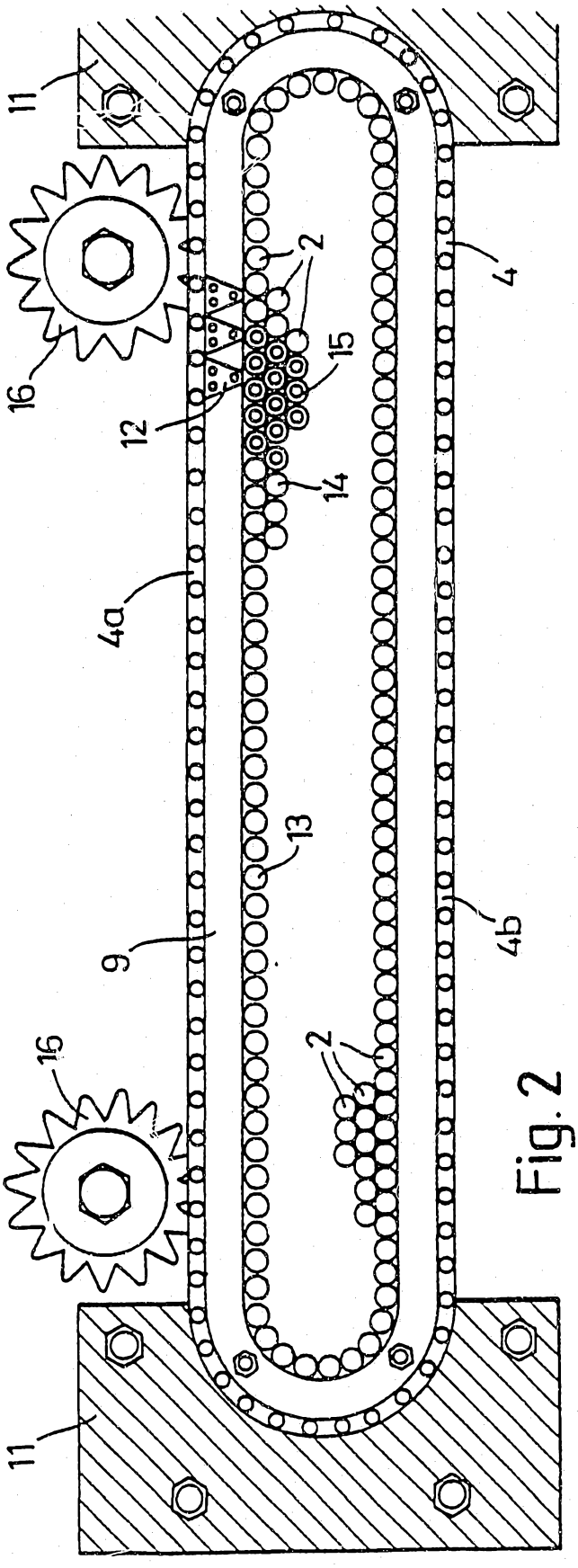


Fig. 2

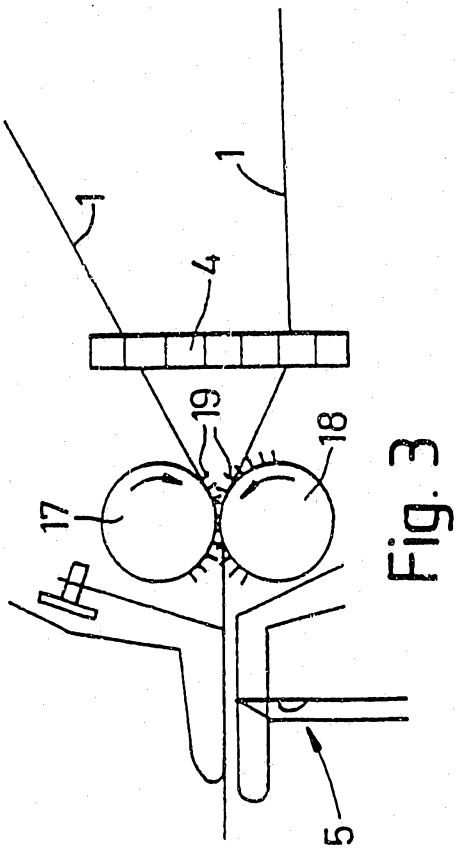


Fig. 3

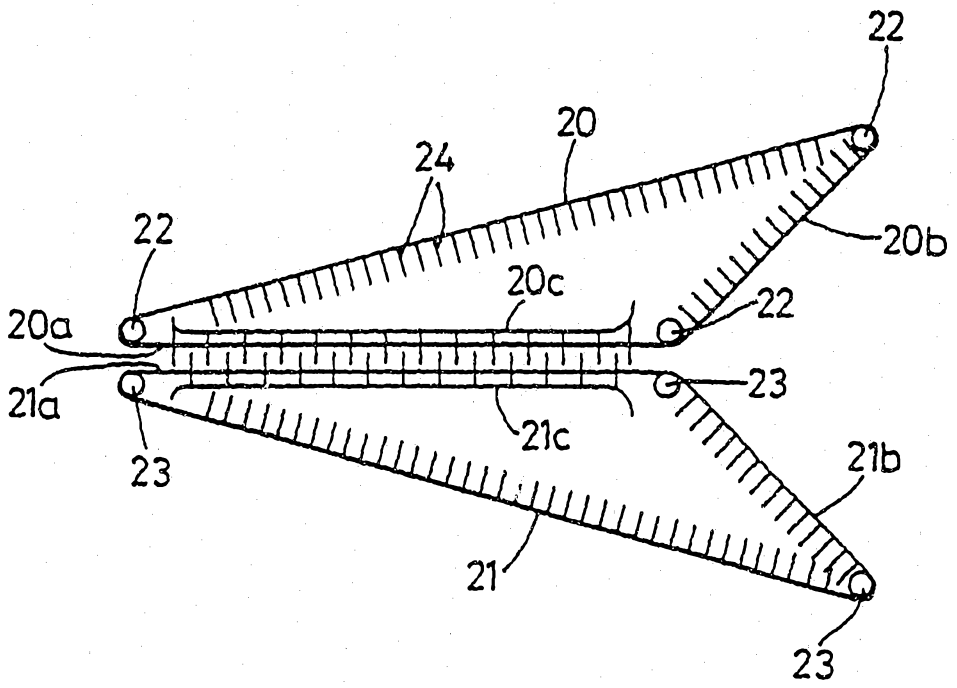


Fig. 4

Fig. 5A

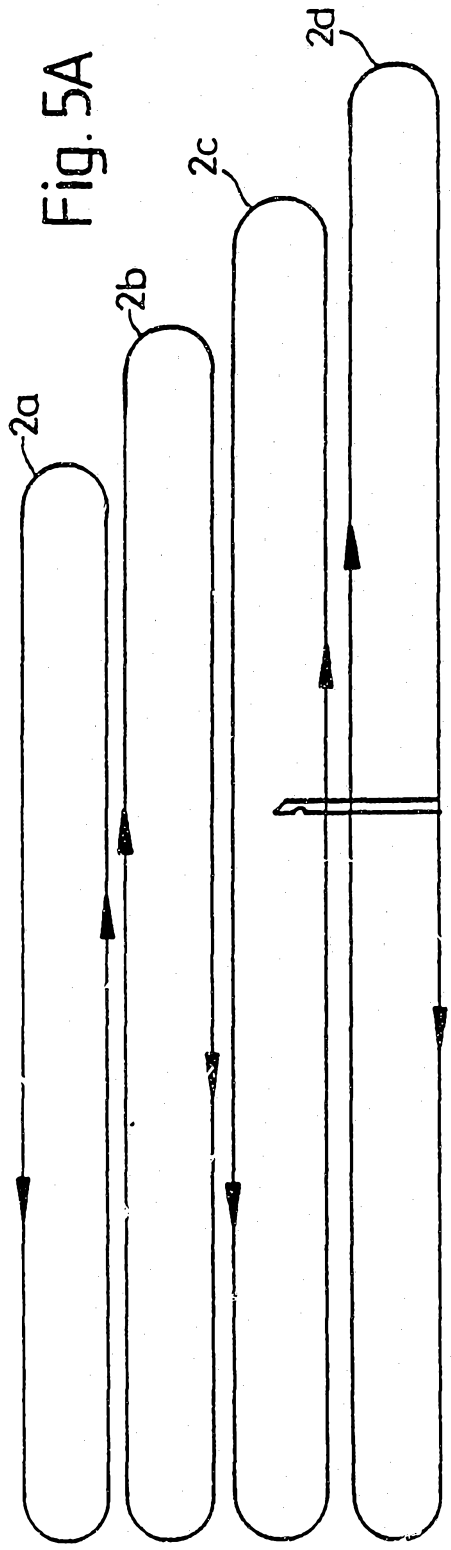
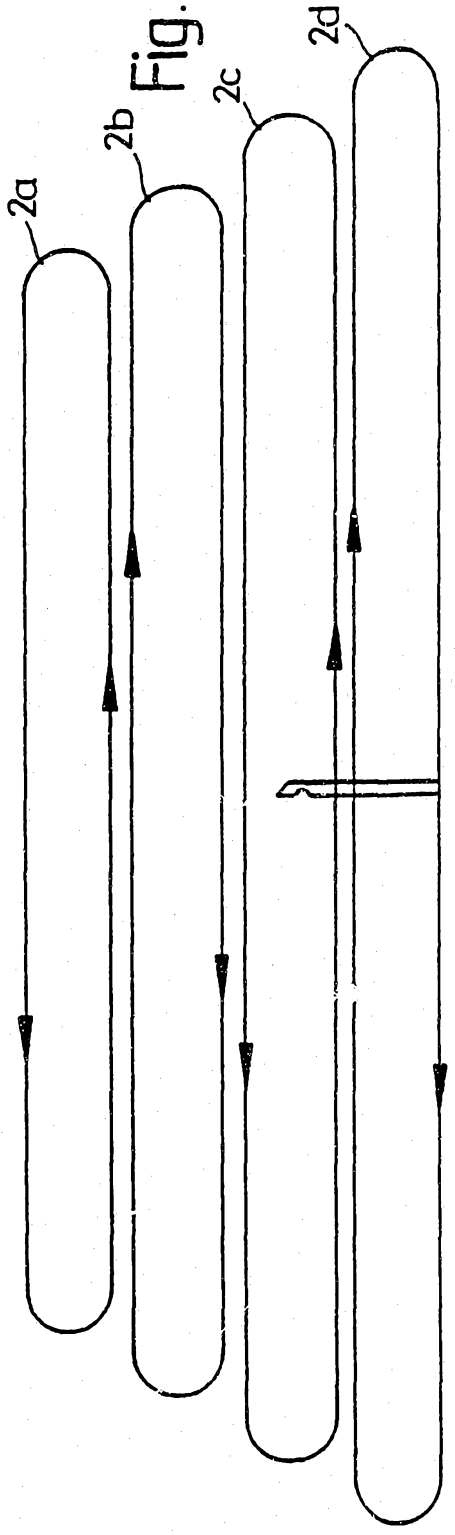


Fig. 5B



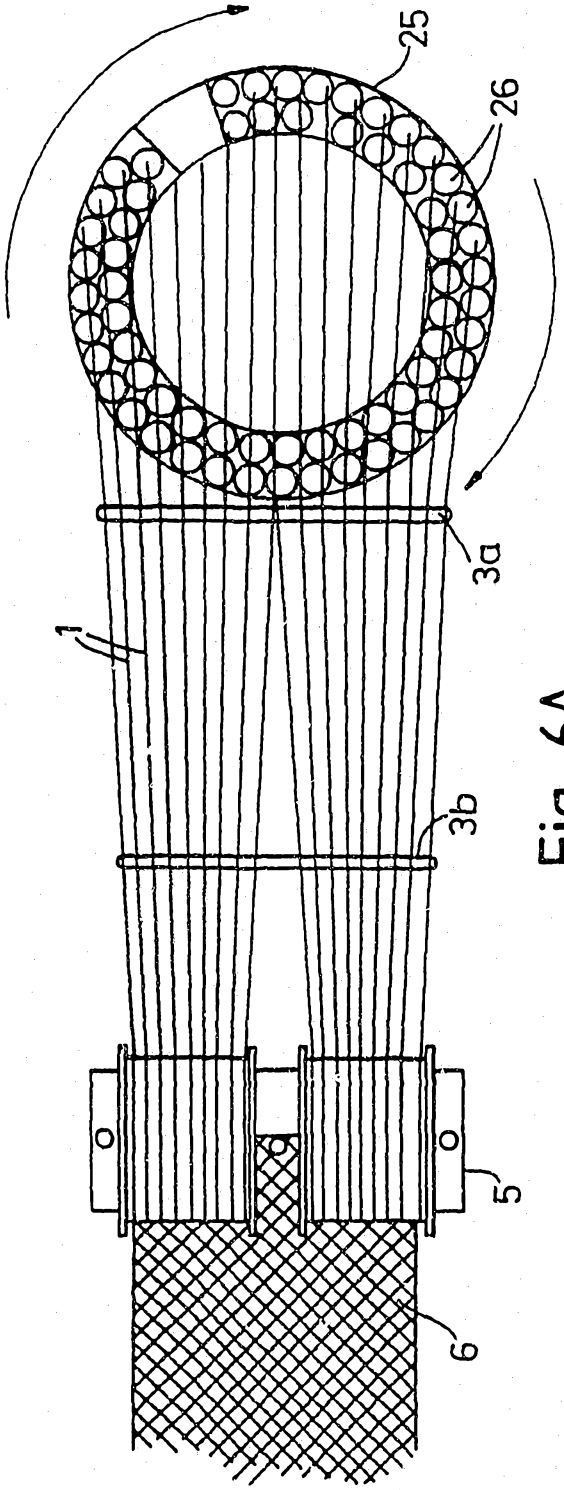


Fig. 6A

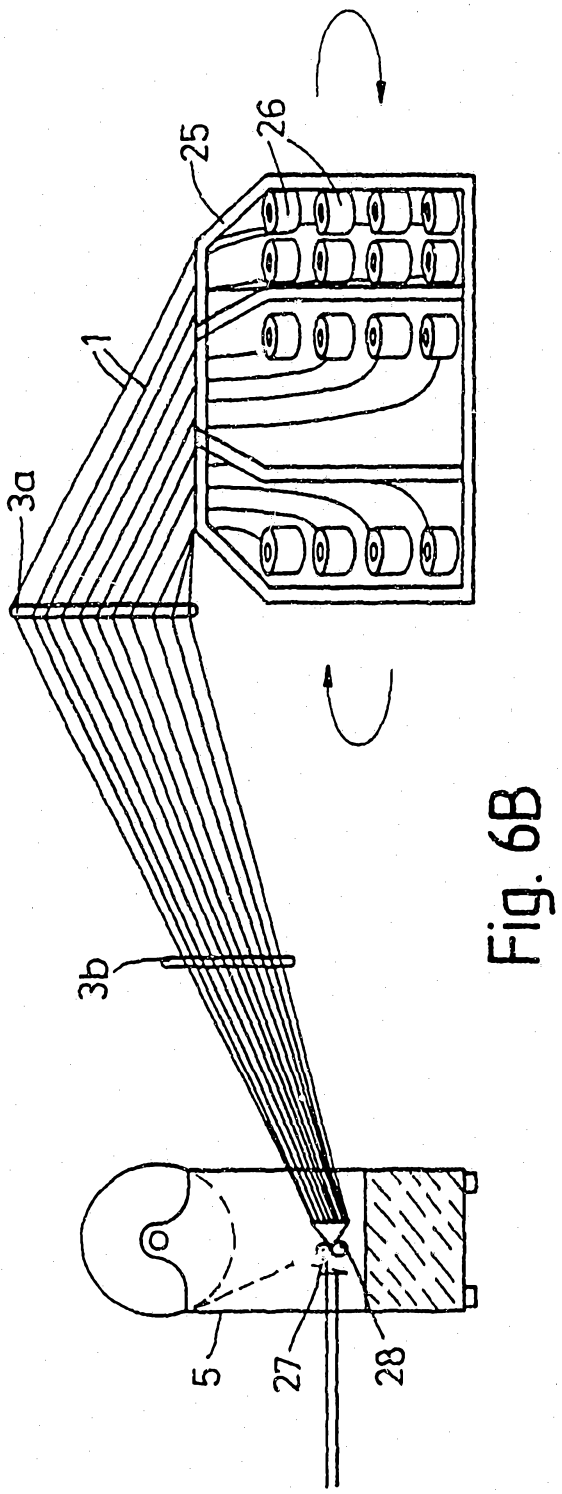


Fig. 6B

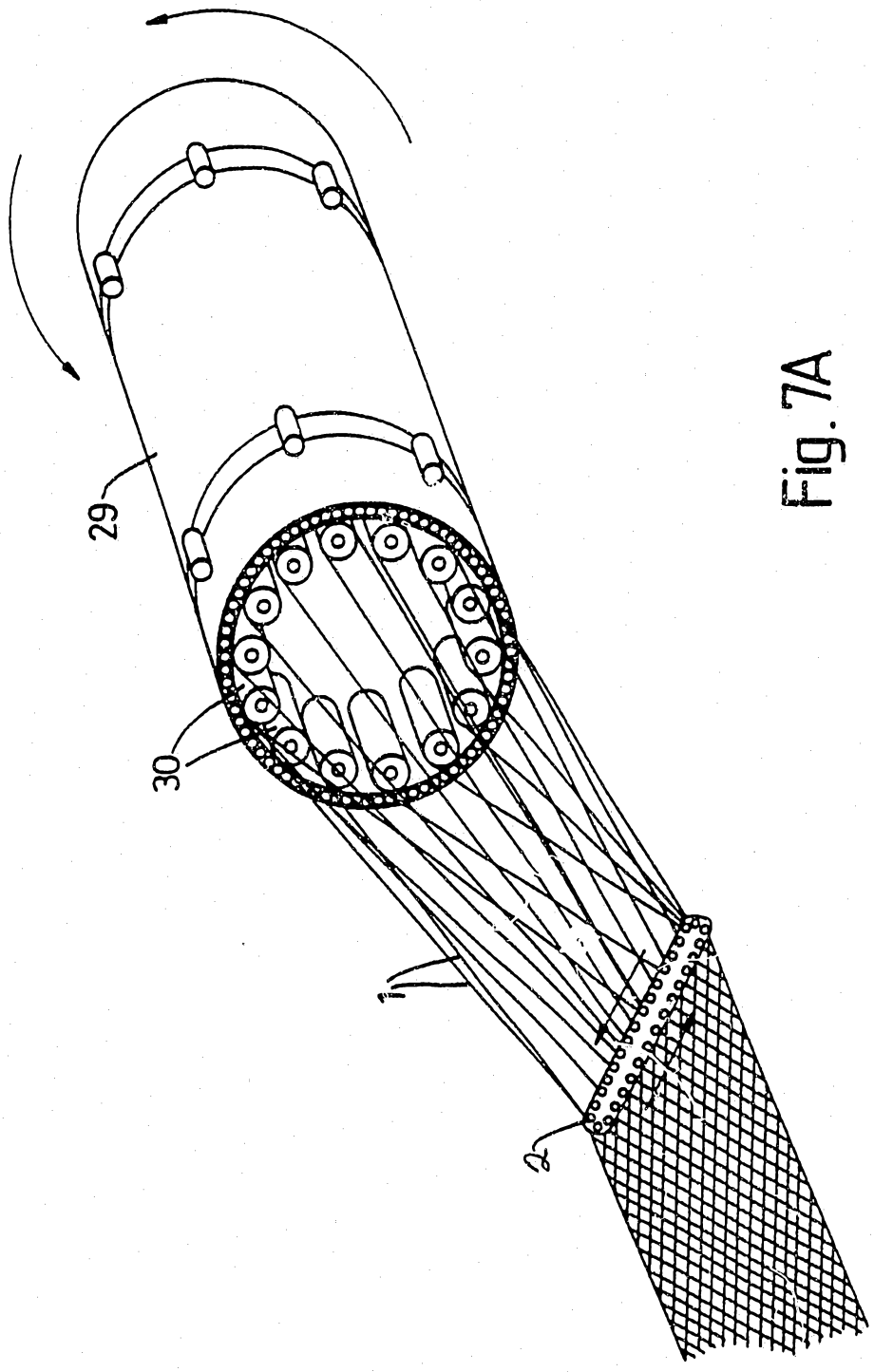


Fig. 7A

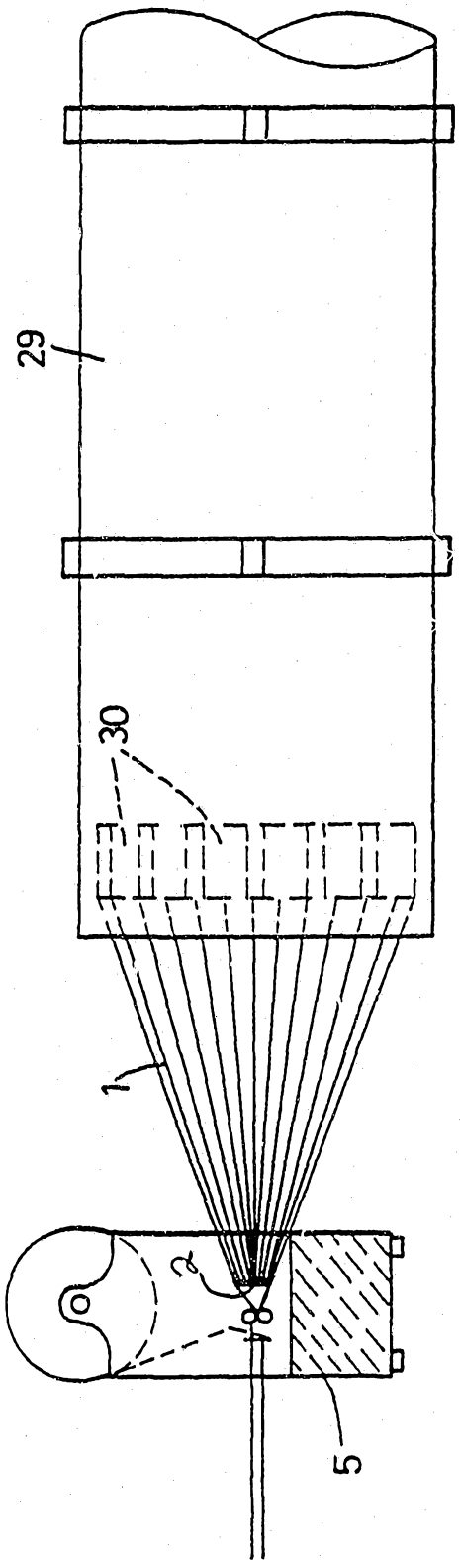


Fig. 7B

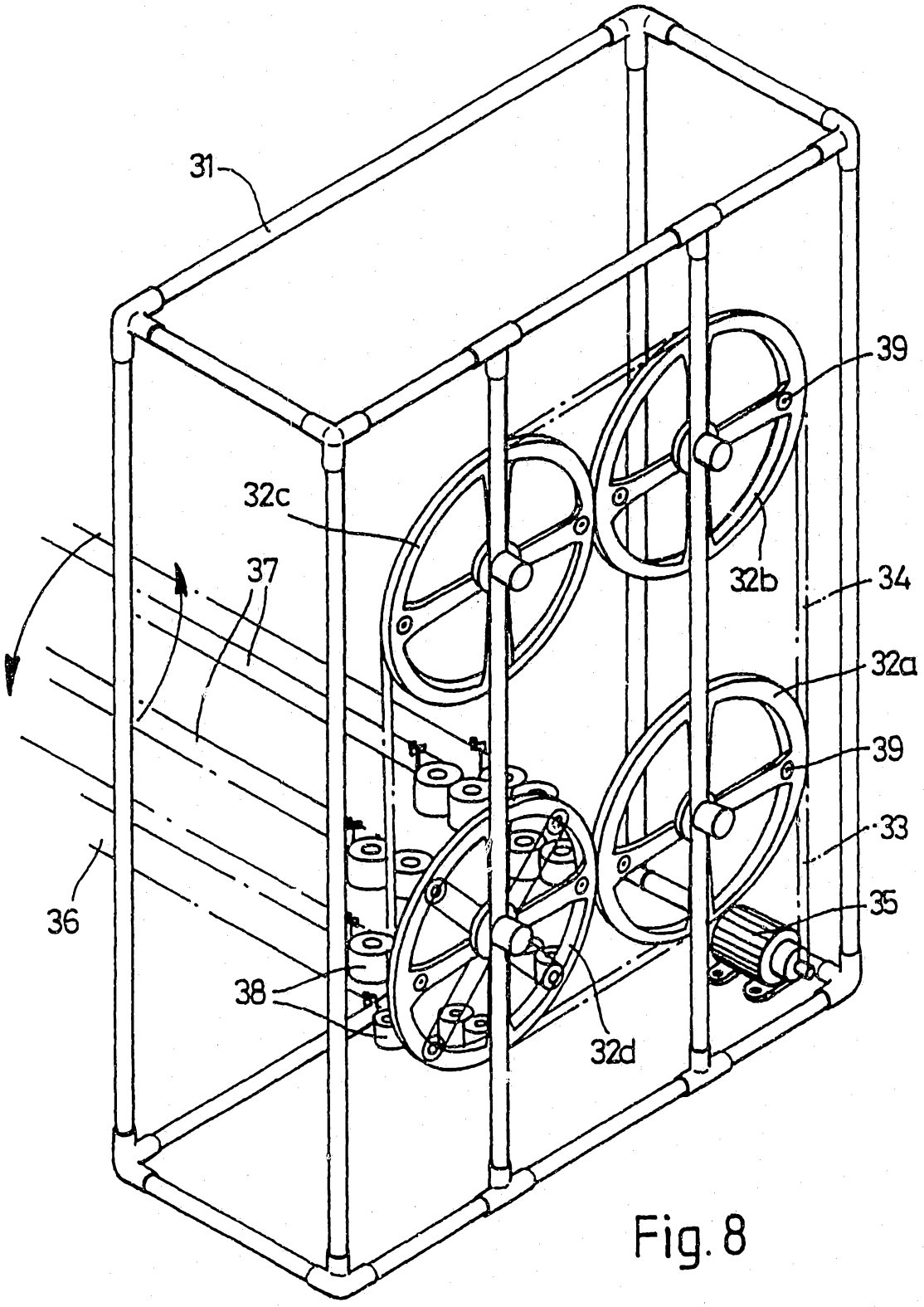


Fig. 8

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 93/00607

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 D04H3/04; B29C67/14

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	D04H ; B29C

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category[10]	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
Y	US,A,2 772 993 (ELTON E. MAGNUSON) 4 December 1956	1,28
A	see column 1-2; claims 1-6; figures 1-4	2-16,29
Y	FR,A,2 036 870 (UNION CARBIDE) 31 December 1970	1,28
A	see claims; figures 1,2	24-27
A	EP,A,0 426 878 (TOYODA) 15 May 1991 see figure 29 see column 13, line 49 - line 48 see column 14, line 1-10; claims	1-20
A	EP,A,0 361 795 (TECH TEXTILES LIMITED) 4 April 1990 see the whole document	1-34

[10] Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
09 JUNE 1993	23. 06. 93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	DURAND F.C.

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

GB 9300607
SA 71576

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
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FR-A-2036870	31-12-70	None		
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