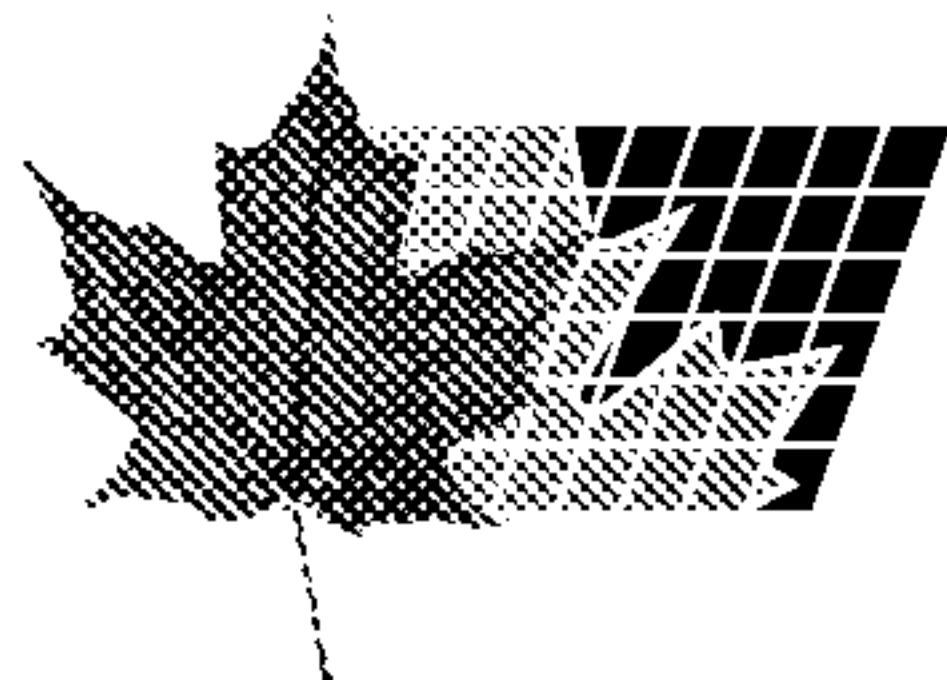




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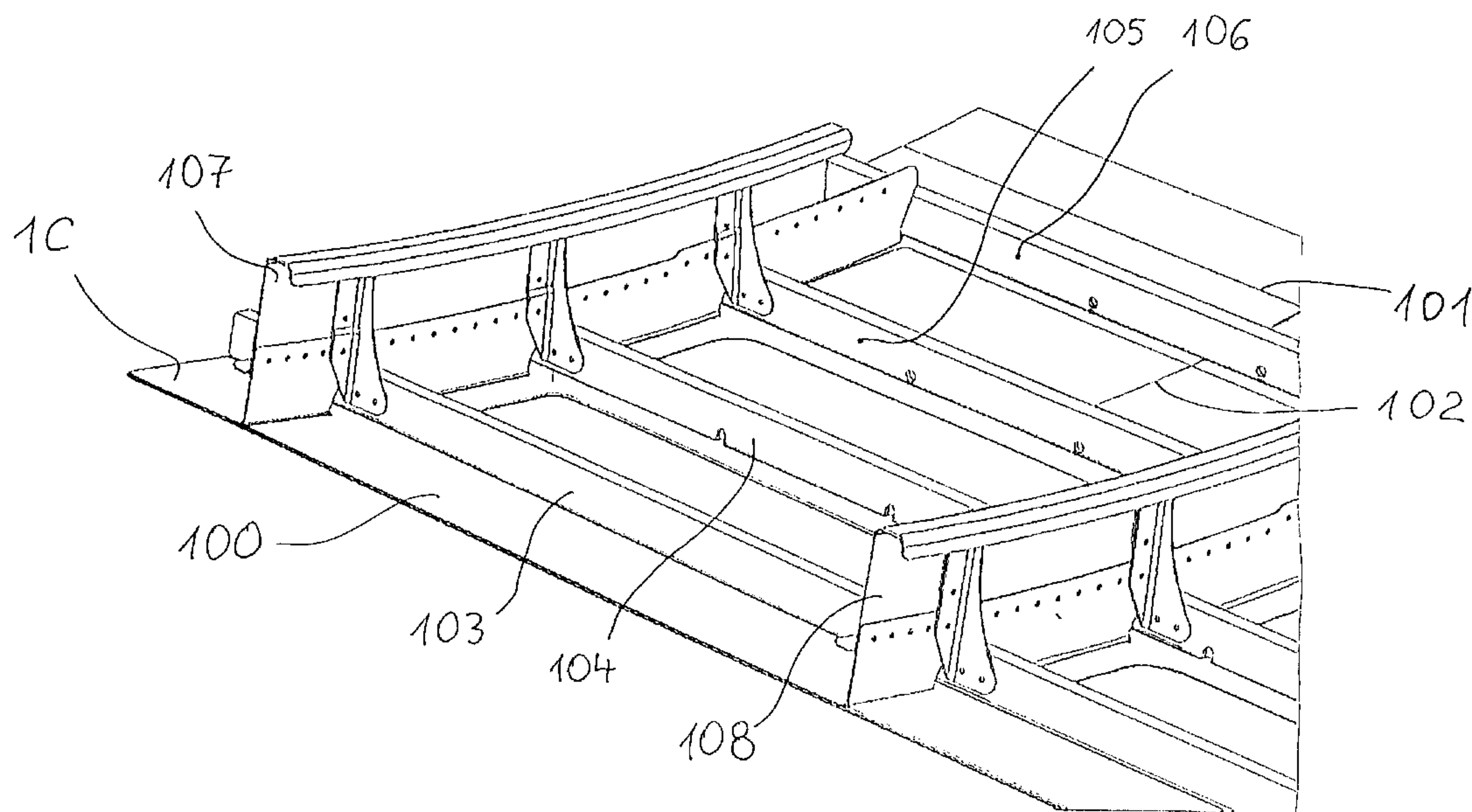
(51) Int.Cl.⁷ B64C 1/12

(30) 1999/09/03 (199 41 924.8) DE

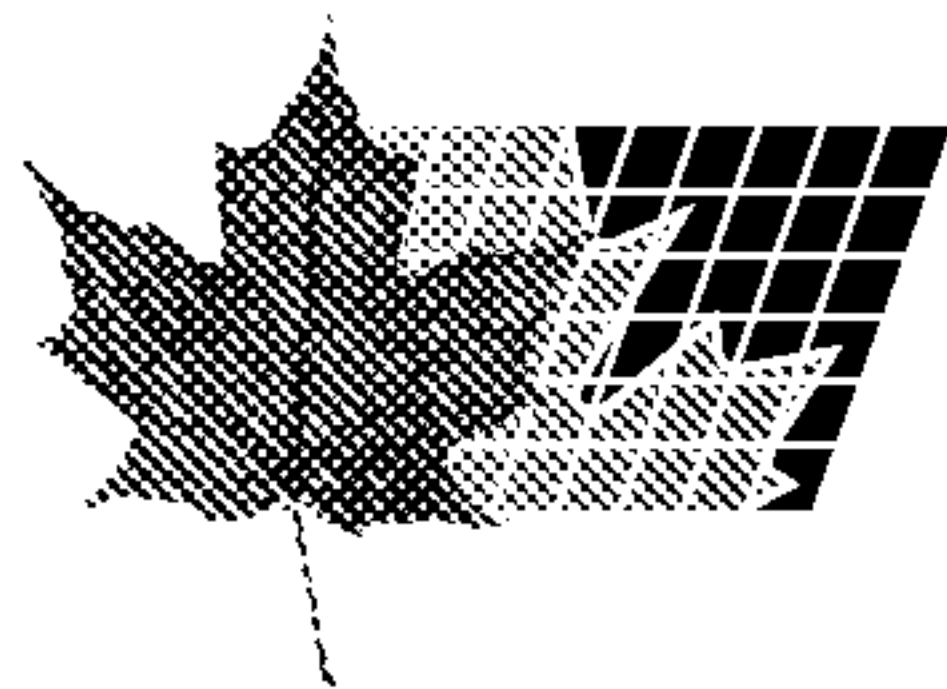
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(54) **ELEMENT DE STRUCTURE A GRANDE SURFACE POUR
AERONEF ET METHODE DE FABRICATION**

(54) **LARGE AREA STRUCTURAL COMPONENT FOR AN
AIRCRAFT AND A METHOD OF MANUFACTURING THE
SAME**



(57) A large format or large surface area structural component of an aircraft, such as an aircraft fuselage shell, includes a skin panel and a plurality of stiffening elements such as stringers and frames. The skin panel is fabricated from a



(21) (A1) **2,317,366**

(22) 2000/09/05

(43) 2001/03/03

plurality of individual skin sheets that respectively have different material compositions and different thicknesses, and that are welded together along respective butt weld joints to form the skin panel having different characteristics of strength and the like at different locations. The stiffening structural elements such as stringers and frames may similarly be fabricated by welding together individual material strips respectively having different material compositions and/or thicknesses. Alternatively, an integral shell component can be formed by integrally extruding a skin panel with stringer members integrally formed thereon. With such a fabrication process and resulting structure, there is no need to carry out chemical or mechanical material removal steps, or material addition steps, for providing areas having different skin thicknesses in the resulting structural component. There is also no need to use skin sheets having the largest possible dimensions, but instead a great plurality of small individual skin sheets is joined together in the manner of a patchwork quilt, so as to provide the particular individual characteristics at each location as required in the finished structural component.

TITLE OF THE INVENTION

LARGE AREA STRUCTURAL COMPONENT FOR AN AIRCRAFT AND METHOD OF MANUFACTURING THE SAME

ABSTRACT OF THE DISCLOSURE

A large format or large surface area structural component of an aircraft, such as an aircraft fuselage shell, includes a skin panel and a plurality of stiffening elements such as stringers and frames. The skin panel is fabricated from a plurality of individual skin sheets that respectively have different material compositions and different thicknesses, and that are welded together along respective butt weld joints to form the skin panel having different characteristics of strength and the like at different locations. The stiffening structural elements such as stringers and frames may similarly be fabricated by welding together individual material strips respectively having different material compositions and/or thicknesses. Alternatively, an integral shell component can be formed by integrally extruding a skin panel with stringer members integrally formed thereon. With such a fabrication process and resulting structure, there is no need to carry out chemical or mechanical material removal steps, or material addition steps, for providing areas having different skin thicknesses in the resulting structural component. There is also no need to use skin sheets having the largest possible dimensions, but instead a great plurality of small individual skin sheets is joined together in the manner of a patchwork quilt, so as to provide the particular individual characteristics at each location as required in the finished structural component.

FIELD OF THE INVENTION

The invention relates to a large format or large surface area structural component for an aircraft, which includes at least one skin field or skin panel, and further relates to a method of manufacturing such a large surface area structural component.

BACKGROUND INFORMATION

In the present day manufacturing of large format or large surface area structural components, and especially fuselage shell components for an aircraft, the skin panels, also called skin fields, used for manufacturing such components typically have dimensions of about 2.5m x 10m. Particularly, the largest possible size is used for each individual skin sheet that makes up the skin panel for manufacturing the fuselage shell, in order to minimize the number of lengthwise and crosswise seams between adjacent skin sheets or panels, and thereby to minimize the overall weight of the aircraft fuselage as well as the required amount of assembly work. Minimizing the structural weight is an especially important consideration in the construction of aircraft, in view of the energy consumption and therewith the economical operation of the resulting aircraft.

A minimization of the total weight of the fuselage requires a mechanical structural optimization of the fuselage shell at each location to meet the locally effective requirements, e.g. different strength requirements at different locations. Thus, the skin

panels are individually embodied to have different or varying thicknesses, depending on the particular local loading that will be applied to the skin panel at different locations. For example, it may be necessary to provide thickenings on the skin panels in the area of the stringer connections in order to provide more support for the connected stringer.

Such areas of differing thickness of a particular skin panel are typically produced by present day techniques using sheetmetal-to-sheetmetal riveting, or sheet to sheet adhesive bonding or gluing, or mechanical milling, or chemical etching or other material removal techniques. The chemical etching or material removal of a skin panel is carried out by masking the panel, cutting and partially removing areas of the mask to form a prescribed pattern, and then removing material by chemical etching or mechanical material removal from the surface area or areas that have been exposed by the patterning and partial removal of the mask.

Next, the skin panels are joined together to form so-called half shells whereby riveting as well as adhesive bonding are used as joining techniques. Before carrying out the riveting process, the sheets and stringers are anodized to provide surface protection, primed, cleaned with an activator along the joint surfaces, and then provided with a surface seal. Then the stringers are fitted in position and fixed by means of tacking rivets. The riveting is carried out automatically, whereby sealant is squeezed or exuded out of the joint locations. This squeezed-out sealant forms a so-called sealant rope or bead that must be

smoothed out by hand and then protected by a protective coating against aggressive media.

5 In the context of adhesive bonding or gluing, the skin sheets and doubling members or reinforcing members are produced by contour milling of semi-finished plates. The stringers are sheet metal profiles or extruded profiles, which are cut to proper length and then subsequently deformed into the required shape. Before the adhesive bonding process, the individual parts are subjected to a specialized adhesive pretreatment. The parts are degreased, 10 cleaned, pickled, anodized in chromic acid, and finally primed. In order to carry out the adhesive bonding, the adhesive joint surfaces are provided with an adhesive film, the individual parts are positioned and pressed together and then held together using fixing screws. Then, the adhesive is cured and hardened under 15 the effect of increased temperature, pressure and time in an autoclave. Thereafter, the component must be cleaned, and then provided with a sealant rope or bead and once again with a protective layer to provide protection against corrosion.

20 The above described rather complicated manufacturing processes for fabricating a fuselage shell structure are described in more detail in the VDI progress reports ("Fortschrittsberichten") Series 2: Fabrication Technology (Fertigungstechnik), No. 326, Dissertation 07/94 by Dipl.-Ing. Peter Heider "Lasergerechte Konstruktion und lasergerechte Fertigungsmittel zum Schweissen 25 grossformatiger Aluminium-Strukturbauteile" ("Laser Compatible Construction and Laser Compatible Production Means for Welding

Large Format Aluminum Structural Components"), pages 3 to 5. This publication similarly describes the laser beam welding process for the production of large format structural components, whereby possible manners of construction of a structural component are exemplified at pages 42 to 47 of this report. In all of these manners of construction however, the starting point is always an available skin panel, which must be thickened and/or have material removed at corresponding appropriate locations, as has been discussed above, and which shall always have the largest possible dimensions in order to minimize the necessary lengthwise and crosswise seams or joints and thereby minimize the total resulting weight of the fuselage.

U. S. Patent 3,023,860 (Ellzey) discloses a body construction and a corresponding method in which sheet metal parts are joined together to form a body construction or structural component. However, this body construction involves a corrugated sheet with stiffening elements and a flat sheet that are arranged adjacent one another and joined together, in order to form the structural component. A selection of different semi-finished parts is not provided for, in order to achieve an adaptation to different requirements and an optimization of the total resulting weight of the structural component.

SUMMARY OF THE INVENTION

In view of the above, it is an object of the present invention to provide a large format or large surface area structural compo-

5 nent that may be produced by a simplified and less costly fabri-
cation process and that minimizes or avoids the necessity of
introducing additional reinforcements onto the skin sheet by
applying additional sheet metal layers by means of riveting or
adhesive bonding, or by the mechanical or chemical material
removal of a partial thickness of the metal sheet at other areas.
It is a further object of the invention to provide such a struc-
tural component that has an optimized weight in consideration of
meeting the structural requirements at any location. The inven-
10 tion also aims to allow such a structural component to be fabri-
cated with a customized or specialized structure that is particu-
larly adapted to the structural requirements in each particular
application. The invention further aims to avoid or overcome the
disadvantages of the prior art, and to achieve additional advan-
15 tages, as are apparent from the present specification.

The above objects have been achieved according to the invention
in a large surface area or large format structural component for
an aircraft that comprises at least one skin panel, wherein the
skin panel is formed of a plurality of individual structural
20 elements, which have each respectively been selected in terms of
the material and the thickness in view of the locally effective
requirements and loads that will be applied to a particular
portion or area of the structural component in its finished end
use. After being so selected and arranged, the structural ele-
25 ments are joined to each other by a welding process.

Particularly, the skin panel is formed of a plurality of structural elements, and especially separate skin sheets, that respectively have different thicknesses and that are respectively made of different materials. Thus, the resulting skin panel has
5 different thicknesses and different material compositions at different areas, thereby providing different strengths and other structural characteristics at different locations so as to meet the different requirements at these different locations. Also, this structural component has been fabricated without requiring
10 strengthening members to be added onto the skin panel, and without requiring material removal from the skin panel.

Also, it is particularly advantageous that the individual skin sheets making up the overall structural component are no longer required to have the largest possible dimensions as is the case
15 in the prior art. Instead, smaller individual skin sheets are joined together, with stringers and frame or rib segments to form a large structural component and particularly a fuselage shell structure. The maximum resulting size of the fuselage shell is not limited by, but rather is independent of, the size of the
20 individual skin sheets from which the shell is fabricated. Thus, it is possible to manufacture fuselage shells having a size that cannot be achieved with presently existing fabrication processes and equipment. This is especially true since the smaller individual skin sheets that are used according to the invention are
25 easier to handle and manipulate during the fabrication. This is true for the fabrication equipment and processes, as well as for the fabrication workers. The concept of using individually

specialized skin sheets having smaller dimensions to build larger resulting structural components is directly contrary to the prior art teachings that call for using the largest possible dimensions of a skin sheet to minimize the number of seams and thereby minimize the joining effort and the resulting weight. The present invention overcomes these problems and achieves additional advantages as described herein.

The above objects have further been achieved according to the invention in a method of producing a large surface or large format structural component, involving the following steps. First, individual skin sheets are cut to length or otherwise cut to the proper dimensions, from various different available semi-finished materials that respectively are made of different material compositions and have different material thicknesses. The material and the thickness for a respective skin sheet to be used at a particular location of the structural component is selected dependent on the respective requirements that will apply to that location of the structural component in its end use application. Alternatively or additionally, extruded panels are produced by an extrusion process to meet the prescribed requirements at any particular location. Then, the metal skin sheets and/or the extruded panels are joined together to form a skin panel. The thus-formed skin panel is then further processed, and particularly is deformed into a cylindrically or spherically curved structural component by means of a deforming process, such as rolling or stretch forming, i.e. drawing.

In a further embodiment of the invention, the above objects have been achieved in a method for producing profile sectional parts involving the following steps. First, blank parts are cut to the proper length and/or other dimensions and possibly heat-treated or deformed as needed, whereby each respective blank part is made from a respective material having a respective thickness dependent on and responsive to the prescribed profile geometry and requirements of the profile sectional part to be manufactured. The several blank parts are joined together by means of a welding process to form respective profile sectional parts or structural elements. Then the profile sectional parts or structural elements are after-machined, and particularly contour machined or processed.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be clearly understood, it will now be described in connection with example embodiments, with reference to the accompanying drawings, wherein:

Fig. 1 is a schematic perspective diagram of the fabrication sequence for manufacturing a skin panel from semi-finished parts according to a first embodiment;

Fig. 1A is a schematic sectional diagram illustrating the cause of a bending moment that arises in joined skin panels using a conventional overlapping joint;

Fig. 2 is a schematic perspective view of the fabrication sequence for manufacturing profile sectional parts such as stringers, clips and frames;

Fig. 3 is a schematic perspective view of a fuselage shell structure according to the invention;

Fig. 4 is a schematic perspective view of an extruded panel as a semi-finished part for the further manufacturing of a skin panel;

Fig. 5 is a schematic perspective view of several extruded panels joined to each other along respective joints; and

Fig. 6 is a schematic perspective view of respective sheet metal parts joined onto an extruded panel along respective joints.

15 DETAILED DESCRIPTION OF PREFERRED EXAMPLE EMBODIMENTS AND OF THE BEST MODE OF THE INVENTION

Fig. 1 schematically shows the fabrication sequence for manufacturing a large surface area or large format structural component 1 according to the invention. The structural component 1 is especially an aircraft fuselage shell component, which is formed from a plurality of semi-finished materials or parts 2, 3, 4 and 5 that are respectively made from different materials and respec-

tively have different thicknesses, and that are joined to each other to form the fuselage shell component 1. The different semi-finished parts 2, 3, 4 and 5 are schematically indicated in the drawing figures through the use of different lining or hatching, which is intended to indicate the different thicknesses or material compositions thereof. The individual semi-finished parts 2, 3, 4 and 5, which are generally regarded as metal sheets 2, 3, 4 and 5, can be provided, for example, in the form of substantially continuous long rolls of the semi-finished material, from which the individual parts are cut out as needed. In the selection of the material for each respective semi-finished part, it must be take into account that a good weldability of the material relative to the materials of the adjacent parts must be achieved, which, for example, may be achieved using aluminum alloys such as a AlMgSiCu, AlMgLi, or AlMgSc as the materials of the respective semi-finished parts 2, 3, 4 and 5.

According to the invention, the individual semi-finished parts 2, 3, 4 and 5 are each respectively cut only to that particular size, i.e. the particular dimensions, as required for that particular material thickness and material composition at the given location of the finished structural component 1. As an example, when a skin area having a particular thickness and a particular set of material characteristics is needed at an area having certain dimensions in the finished structural component 1, a correspondingly sized skin sheet 21 is cut to have the proper length from a roll of sheet metal material 2 having the proper width, thickness and material to meet the requirements at the

given location. A somewhat narrower skin sheet 22 is cut from the same semi-finished part 2, but is cut to the required smaller dimensions as needed for a different area of the finished structural component 1. In a similar manner, various sheet metal blanks are cut from the other semi-finished parts or material rolls 3, 4 and 5, so as to provide the skin sheets 31, 32, 33, 34, 35, 36 and 37 from the semi-finished part 3, the skin sheets 41, 42, 43, 44 and 45 from the semi-finished part 4, and the skin sheets 51, 52 and 53 from the semi-finished part 5.

If it is necessary for the requirements of the particular application, the thus-cut sheet metal blanks may now be chemically or mechanically pretreated or machined, or provided with a surface protective coating or the like, as individually needed. Thus, it becomes possible to carry out a chemical material removal or etching from particular or limited ones of the pre-cut sheet metal blanks, without requiring a masking process or any other special measures for limiting the chemical treatment to a particular area. Such a chemical treatment may be necessary, for example, if a special or particular surface contour is to be achieved on a given skin sheet, or if a very localized reinforcement is necessary for load introduction points or the like.

It is advantageous in this fabrication process, that not the entire structural component, but rather only individual ones of the precut blank skin sheets are treated or machined in the above described manner, as needed. Thereby, the various apparatus necessary for transporting the skin sheets as well as the chemi-

cal bath for carrying out a chemical treatment do not need to be sized for the maximum dimension of the fuselage shell, but rather only must have the dimensions of the largest individual skin sheet, which is significantly smaller than the overall maximum size of the fuselage shell. This especially makes it possible to achieve a very economical chemical bath apparatus and treatment, and also achieves an improved utilization factor for such a smaller chemical bath apparatus.

As a further process step, after the skin sheets 21, 22, 31, 32, 33, 34, 35, 36, 37, 41, 42, 43, 44, 45, 51, 52 and 53 have been precut to size, and possibly subjected to a chemical or mechanical pretreatment as mentioned above, the plurality of individual sheet metal parts are then welded together to form a large skin panel 1A. The respective joining of the individual skin sheets to each other is preferably achieved by means of laser beam welding to form butt welds of the individual parts. This process achieves a high welding process speed (for example in the range of approximately 10 to 15 m/min using presently available equipment and techniques), and is also rather low in the rate of defects and deformation of the workpiece, while also being economically practical. Another possible joining method for fabricating the butt joints is, for example, a frictional contact welding or so-called friction stir welding process, such as described in the published international patent application WO 93/10935 and which is known to persons of skill in this art. Note that the drawing of panel 1A still shows all individual skin sheets with seams therebetween (e.g. before completed welding), while the drawing of the finished component 1 omits seams between same-material skin sheets and shows the finished result in the major plane of the component 1.

The butt weld joints are preferably provided at those locations where step-wise variations in the thickness are necessary due to the layout of the fuselage shell. In other words, at locations at which such step-wise variations in thickness are necessary
5 anyway, it is sensible to provide a seam or joint at such a location between two respective suitable skin sheets having the two different thicknesses. Thus, the skin panel 1A can be optimally adapted to the requirements and particularly the loading conditions of the finished fuselage shell or the finished fuselage,
10 by proper selection or adaptation of the thickness of the individual skin sheets 21, 22, 31, 32, 33, 34, 35, 36, 37, 41, 42, 43, 44, 45, 51, 52 and 53. In this case, the additional need for reinforcements or thickening members, as well as chemical or mechanical removal of material from the skin panel 1A, are minimized or completely eliminated.
15

The weld seam geometry and particularly the path of the respective weld seams can be laid out on the skin panel 1A or on the structural component 1 in such a manner. so that the weld seams or joints provide further functions, for example, the effect of
20 acting as a rip-stop seam, also known as a dummy weld seam. By appropriately designing the weld seams in such a manner as rip-stoppers, the tension level is thereby reduced and the continuous progression of a rip or crack in the material is hindered or prevented. Namely, when a rip or crack is initiated, and extends
25 to one of the rip-stop weld seams, the rip or crack is intended to be terminated at the seam so that it does not progress any further.

Another advantageous effect achieved by the use of butt welds according to the present invention, is that the tension level of the skin panel joints can be positively influenced due to the avoidance of a bending moment that typically arises when the lengthwise seams or joints are formed as overlapped joints. To provide a further understanding in this context, Fig. 1A shows how an additional bending moment is generated in the overlap areas of conventional overlapped joints. Due to the prevailing internal pressure P within the fuselage, this pressure P acts on the skin sheets 200 and 300 of the fuselage shell, which in turn gives rise to a circumferential force F that acts on the skin sheets 200 and 300. Due to the overlap of respective portions of the two skin sheets 200 and 300, there exists a skin sheet offset S in the radial direction between these two skin sheets 200 and 300. The above mentioned circumferential force F thus acts on the respective skin sheets 200 and 300 respectively offset by the skin sheet offset distance S , which acts as a lever arm and induces a corresponding bending moment, generally represented by $F \times S$. This bending moment has a negative influence on the tension level. By entirely avoiding overlapping joints, according to the invention, the additional bending moment and its negative effects will also be avoided.

After the skin panel 1A has been fabricated, especially in a substantially flat planar configuration, by respective butt weld joining of the individual skin sheets 21, 22, 31, 32, 33, 34, 35, 36, 37, 41, 42, 43, 44, 45, 51, 52 and 53, the resulting skin panel 1A is subjected to a further manufacturing step involving

the bending or deforming of the skin panel 1A into a cylindri-
cally or spherically curved structural component 1. This bending
or deforming process is carried out with any known forming meth-
ods and forming equipment, for example by means of drawing and/or
5 rolling, dependent on and adapted to the curvature of the struc-
tural component 1 that is to be achieved.

Fig. 2 schematically shows an example of a fabrication sequence
for manufacturing profile sectional parts according to the inven-
tion. Similarly, as the skin panel 1A discussed above, the
10 present example profile sectional parts 10, 11, 12, 13, 14 and
15 are each individually formed by joining proper components from
different semi-finished materials or products 6, 7, 8 and 9.
These semi-finished products 6, 7, 8 and 9 preferably are made
of different materials and/or have different thicknesses, and may
15 be cut to different sizes as required, and then joined together
to form the resulting profile sectional parts having different
strength characteristics and the like in different areas or
portions thereof. For example, a profile sectional part 10 is
formed by precut blank parts 61 and 91 that have been cut from
20 the semi-finished products 6 and 9 respectively, and then welded
to each other. A further profile sectional part 11 is formed by
joining together precut blanks 62 and 81 that have been cut from
the semi-finished products 6 and 8 respectively.

Before the welding process, it is possible to carry out any
25 necessary steps such as deformation steps or mechanical machining
steps on respective individual ones of the precut parts 61, 91,

62 and 81. Thus, it is possible to manufacture very individual-
ized profile sectional parts according to the demands or require-
ments at hand, without giving rise to high storage or warehousing
costs for keeping a corresponding assorted selection of the
5 finished parts at hand. In other words, the individual profile
sectional parts can be fabricated to meet individual requirements
at the time they are needed, thus avoiding the need for keeping
different specialized profile sectional parts on hand. Prefera-
bly, the fabrication is carried out in a computer controlled or
10 computer aided manner, so that the respective required profile
geometry can simply be called up as needed, and then automati-
cally manufactured under the control of corresponding data sets
that define the profile geometries and required characteristics
for the respective required profile sectional parts such as
15 frames, clips, stringers, and fixtures as required for an indi-
vidual aircraft or an entire aircraft type or family. The fin-
ished profile sectional parts 12, 13, 14 and 15 demonstrate that
different profile shapes can be provided in the finished parts,
simply by appropriately pre-cutting the semi-finished product
20 materials from which the profile sectional parts are fabricated.

After the various profile sectional parts, which are particularly
embodied as frames, clips, stringers, etc., have been fabricated,
these are installed in or joined onto the structural component
1 for manufacturing a fuselage shell of an aircraft, whereby the
25 profile sectional parts act as reinforcements or the like for the
structural component 1. A portion of a finished fuselage shell
100 is shown in Fig. 3. In this example, the fuselage shell 100

comprises a skin panel 1C, which has been manufactured or assembled, for example, from a plurality of individual skin sheets according to the fabrication process described above in connection with Fig. 1. Exemplary butt weld joints 101 and 102 are shown in Fig. 3. Further lengthwise butt weld seams have been hidden or covered by the arrangement of stringers on the skin panel 1C.

The stringers 103, 104, 105 and 106 are arranged on the skin panel 1A or rather on the structural component 1 to extend therealong in the lengthwise direction of the aircraft so as to stiffen and strengthen the fuselage shell. In this context, the stringers 103, 104, 105 and 106 have preferably been fabricated according to the fabrication process described above in connection with Fig. 2, or in any conventionally known manner, and are then joined onto the structural component 1 by a welding process. Frames 107 and 108 are arranged on the fuselage shell 100 extending in a direction perpendicular to the lengthwise direction of the aircraft. These frames 107 and 108, among other things, serve to carry the load introduction of loads from the tail unit or empennage and the like, which is connected to the frames by appropriate fixtures. The frames 107 and 108 are secured to the stringers 103, 104, 105 and 106 by respective frame-clip-rivet connections that are generally known in the art of aircraft manufacturing, or any other known manner. For example, it is similarly possible to connect the frames and/or clips to the corresponding joined components and/or to the overall fuselage structure 100 by means of welding.

Fig. 4 shows a further embodiment of a semi-finished part 16, which can be further used to manufacture a structural component 1 according to the invention. Particularly, the semi-finished part 16 is manufactured as an extruded panel 16, which includes
5 integrally formed stiffening or strengthening elements 18, e.g. ribs or stringers 18, that are integrally formed on a base element or base sheet 17, to provide a single integral large format profile sectional member in the form of the extruded panel 16. Thus, the single integrally extruded panel 16 can replace the
10 separate or individual and differently embodied structural elements, namely the skin and the stringers, that are typically used in aircraft construction. The base element 17 forming the skin 17 is embodied in a thin-walled manner to meet the requirements of the loads arising in the aircraft fuselage structure, while
15 the lengthwise extending stiffening elements 18A to 18H act as stringers and integrally stiffen and strengthen the resulting structural component 1. The extruded panel 16 preferably consists of a defect or damage tolerant alloy, for example AlMgSiCu or AlMgLi, and is configured with a typical form that pertains
20 to aircraft fuselage shells, with regard to the thickness of the base element 17, i.e. the skin 17, as well as the dimensions and form of the stringers 18A to 18H.

Through the use of such an integral extruded panel 16 for an aircraft fuselage shell, the number of individual parts is reduced, since the skin and stringers together are integrally
25 formed in a single fabrication process, namely an extrusion process, to provide the above described integral semi-finished

part 16. Thus, the present invention can totally avoid the need for joining operations between conventional separate skin panels and stringers, and also can avoid the formation of corrosion attack locations such as rivet holes and joint gaps, which must otherwise be treated and sealed in a rather complex and costly manner.

A further substantial advantage of this inventive embodiment is that thickened portions of the fuselage skin can be provided extending in the lengthwise direction, i.e. parallel to the stringers 18, in any thickness as required up to the maximum thickness limit of the extrusion technology being utilized. Namely, such thicker areas of the fuselage skin are directly and integrally extruded with the extruded panel 16, by simply providing the appropriately configured and dimensioned extrusion die. Moreover, stepped differing thicknesses of the skin 17 as well as a load dependent cross-section adaptation of the stringers 18A to 18H can be achieved within limited regions of an extruded panel 16 by means of chemical or mechanical milling.

Fig. 5 shows the joining of a plurality of extruded panels 16, 16' and 16", which have each individually been fabricated by extrusion as discussed above in connection with Fig. 4. Preferably, laser beam welding or friction contact welding, i.e. so-called friction stir welding, processes are used for joining these extruded panels 16, 16' and 16" to form a skin panel 1 of a fuselage shell or at least a part of a skin panel 1'. Particu-

larly, the joints are realized in the manner of butt weld joints or seams 19 and 19'.

Fig. 6 illustrates a further variant of a process for fabricating a skin panel 1" or at least a part of the same. At least one
5 extruded panel 16 can be used as a supplement to or in combination with one or more sheet metal parts, for example an illustrated skin sheet 23 which has been fabricated from the sheet metal semi-finished part 2. These components are joined together along a butt weld joint 19" to form the skin panel 1". In this
10 context, any of the above described processes can be utilized. According to the known differential construction technique, individual stringers 20A, 20B, 20C and 20D are mounted on the skin sheet 23, preferably by welding. In this context, the stringers may be joined onto the skin sheet even before the
15 components 16 and 23 are joined to each other.

By using at least one extruded panel 16 as a supplement to or in combination with any one or more of the sheet metal semi-finished parts described above in connection with Figs. 1 to 3, the possibilities for variations of the semi-finished parts being utilized, and thereby the possibility of further improving the
20 adaptation of the finished structural component to the requirements at hand, are further increased. This is achieved in accordance with the present inventive method of welding together a plurality of smaller sheets having various thicknesses, along
25 butt weld joints, so as to form the resulting structural component.

Although the invention has been described with reference to specific example embodiments, it will be appreciated that it is intended to cover all modifications and equivalents within the scope of the appended claims. It should also be understood that
5 the present disclosure includes all possible combinations of any individual features recited in any of the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows.

1 1. A large surface area structural component for an
2 aircraft fuselage, comprising a skin panel that comprises first
3 and second skin components, wherein said first and second skin
4 components are welded together along a weld joint, and wherein
5 said first and second skin components respectively have at least
6 one of respectively different material compositions and
7 respectively different thicknesses.

1 2. The structural component according to claim 1, wherein
2 said first and second skin components respectively have said
3 respectively different material compositions.

1 3. The structural component according to claim 2, wherein
2 said first and second skin components respectively have said
3 respectively different thicknesses.

1 4. The structural component according to claim 1, wherein
2 said first and second skin components respectively have said
3 respectively different thicknesses.

1 5. The structural component according to claim 4, wherein
2 said weld joint is a butt weld joint, and wherein said skin panel
3 has a stepwise thickness variation from said first skin component
4 to said second skin component across said butt weld joint.

1 6. The structural component according to claim 1, wherein
2 said weld joint is a butt weld joint.

1 7. The structural component according to claim 1, wherein
2 said weld joint has such a configuration, structure and placement
3 in said skin panel so as to be a rip-stopper joint.

1 8. The structural component according to claim 1, wherein
2 said skin panel has a spherically curved contour.

1 9. The structural component according to claim 1, wherein
2 said skin panel has a cylindrically curved contour.

1 10. The structural component according to claim 1, wherein
2 at least one of said skin components is a respective skin sheet
3 that is cut from a semi-finished sheet metal material.

1 11. The structural component according to claim 10, wherein
2 said first skin component is said skin sheet, and wherein said
3 second skin component is an extruded panel that integrally
4 includes a base sheet and a plurality of lengthwise extending
5 stiffening elements integrally formed on said base sheet.

1 12. The structural component according to claim 1, wherein
2 at least one of said skin components is a respective extruded
3 panel that integrally includes a base sheet and a plurality of

lengthwise extending stiffening elements integrally formed on said base sheet.

13. The structural component according to claim 12, wherein said base sheet is configured as a thin-walled skin and each one of said stiffening elements is configured as a strengthening stringer.

14. The structural component according to claim 1, wherein said structural component is at least a portion of an aircraft fuselage shell.

15. The structural component according to claim 1, further comprising a plurality of profile sectional members selected from the group consisting of stringers, frames and clips, wherein each one of said profile sectional members respectively comprises a plurality of pre-cut blank parts that are joined together and that respectively have at least one of respectively different material compositions and respectively different thicknesses.

16. The structural component according to claim 15, wherein said profile sectional members are welded onto said skin panel along respective laser weld joints by means of laser beam welding.

17. A method of manufacturing a large surface area structural component, comprising the following steps:

- 3 a) fabricating a first skin component and a second skin
4 component;
5 b) welding together said first and second skin components
6 along a weld joint to form a skin panel; and
7 c) deforming said skin panel by at least one of drawing and
8 rolling so as to give said skin panel a cylindrically or
9 spherically curved contour and to form thereof said
10 structural component.

1 18. The method according to claim 17, wherein said step of
2 fabricating said first skin component comprises providing a
3 plurality of semi-finished sheet metal materials respectively
4 having different thicknesses and/or different material
5 compositions, selecting a respective selected one of said semi-
6 finished sheet metal materials based on a selected thickness and
7 a selected material composition thereof, and cutting out a
8 respective skin sheet as said first skin component from said
9 selected semi-finished sheet metal material.

1 19. The method according to claim 17, wherein said step of
2 fabricating said second skin component comprises integrally
3 extruding said second skin component as an extruded panel
4 integrally including a base sheet and stiffening elements
5 extending lengthwise therealong.

1 20. The method according to claim 17, wherein said welding
2 in said step b) comprises at least one of laser beam welding and
3 frictional welding.

1 21. The method according to claim 17, further comprising
2 an additional step of chemically or mechanically treating at
3 least one of said skin components, after said step a) and before
4 said step b).

1 22. The method according to claim 21, wherein at least one
2 of said skin components is expressly not subjected to said
3 chemical or mechanical treating.

1 23. The method according to claim 21, wherein an entirety
2 of said one of said skin components is subjected to said chemical
3 or mechanical treating, without providing any masking of said one
4 of said skin components.

1 24. The method according to claim 17, further comprising
2 a step of welding profile sectional members selected from
3 stringers, frames and clips onto said skin panel so as to
4 strengthen said structural component.

1 25. A method of manufacturing a profile sectional member,
2 comprising the following steps:

- 3 a) providing a plurality of different semi-finished sheet
4 metal materials respectively having different thicknesses
5 and/or different material compositions;
6 b) selecting at least two different ones of said sheet metal
7 materials and respectively cutting therefrom at least two
8 pre-cut blanks;

- 9 c) welding together said at least two pre-cut blanks to form
10 a profile sectional member; and
11 d) contour machining said profile sectional member.

1 26. The method according to claim 25, further comprising
2 heat treating or deforming at least one of said pre-cut blanks
3 before said step c).

1 27. The method according to claim 25, wherein said welding
2 in said step c) comprises laser beam welding.

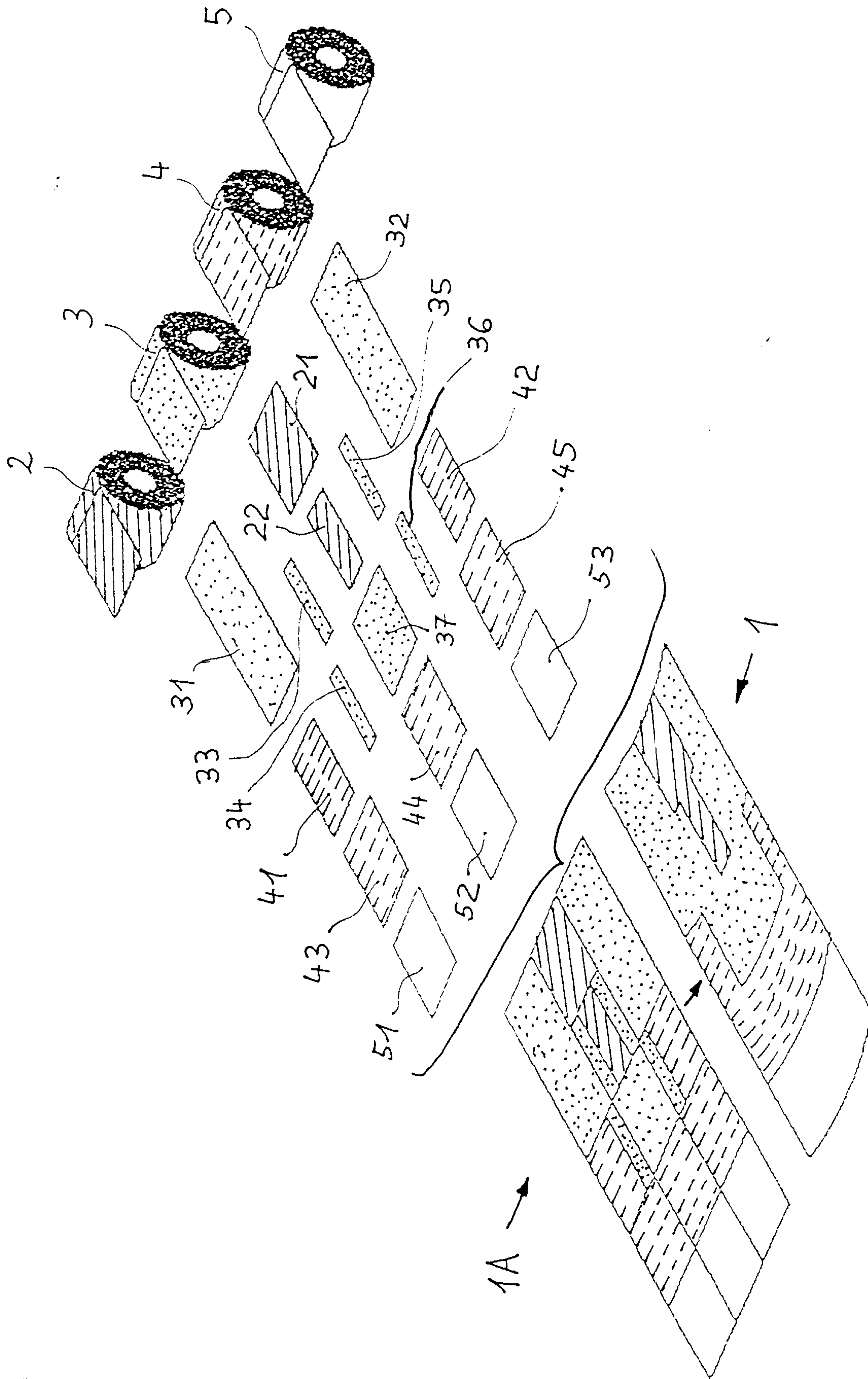


Fig. 1

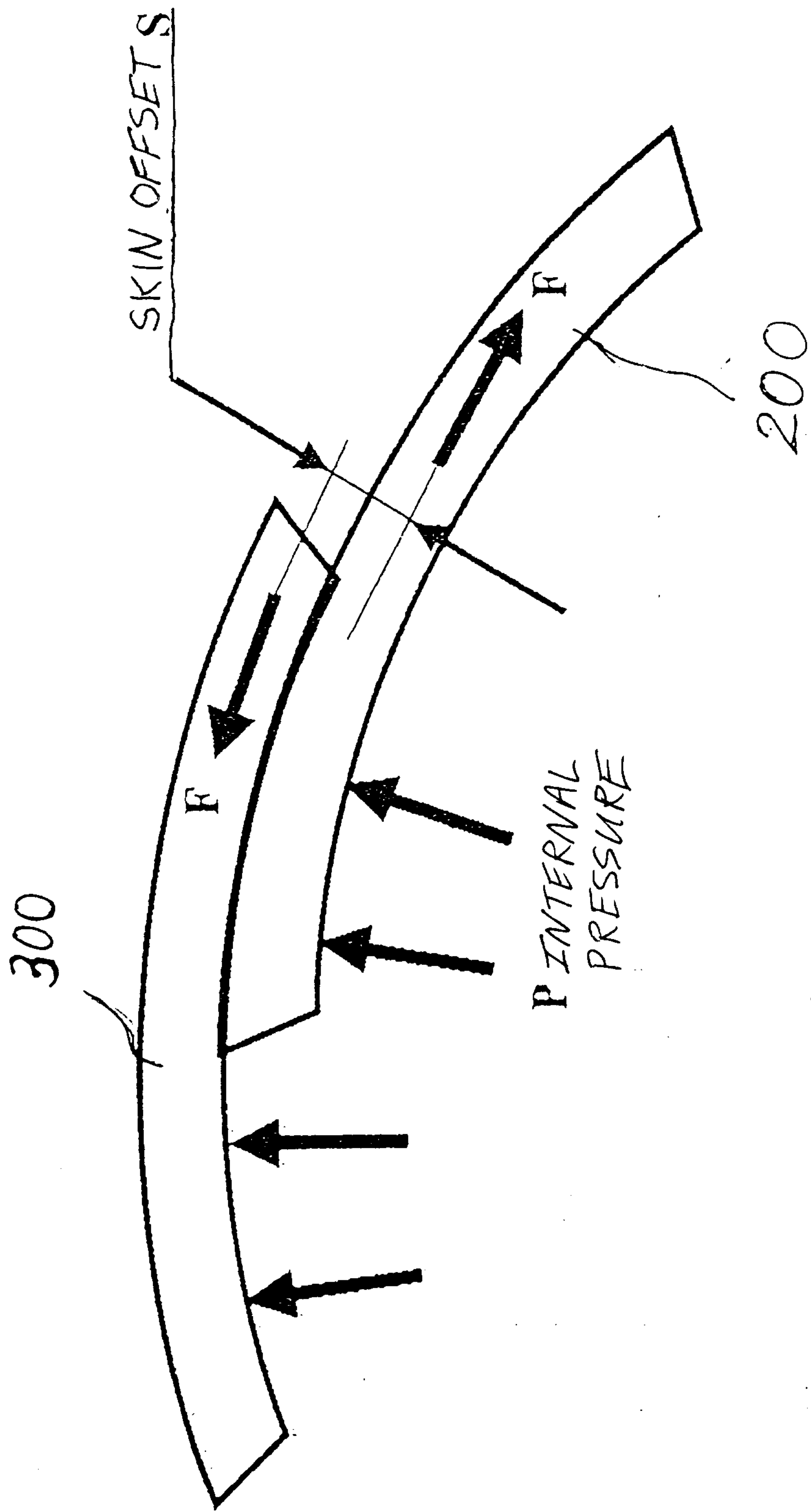


Fig. 1A PRIOR ART

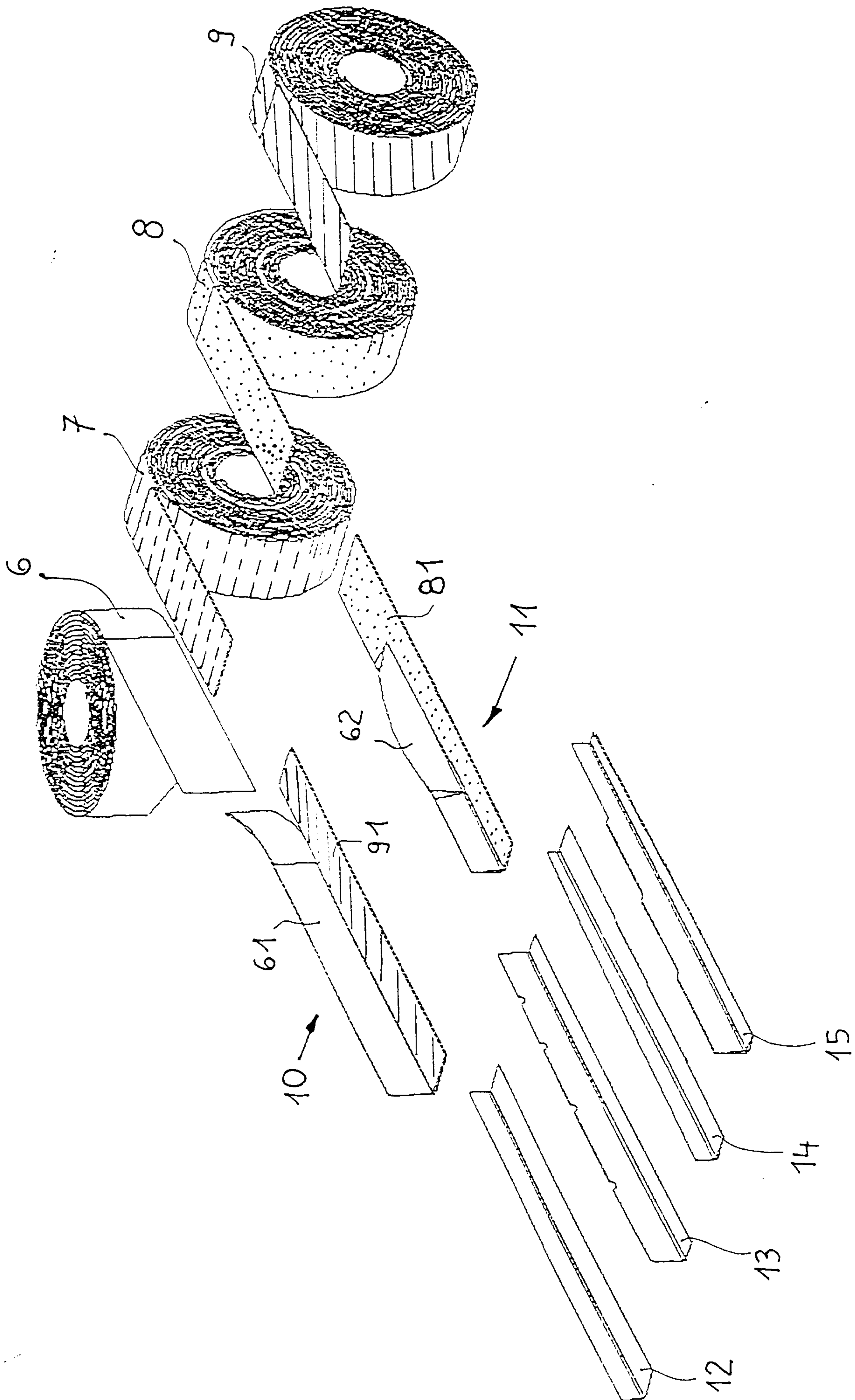


Fig. 2

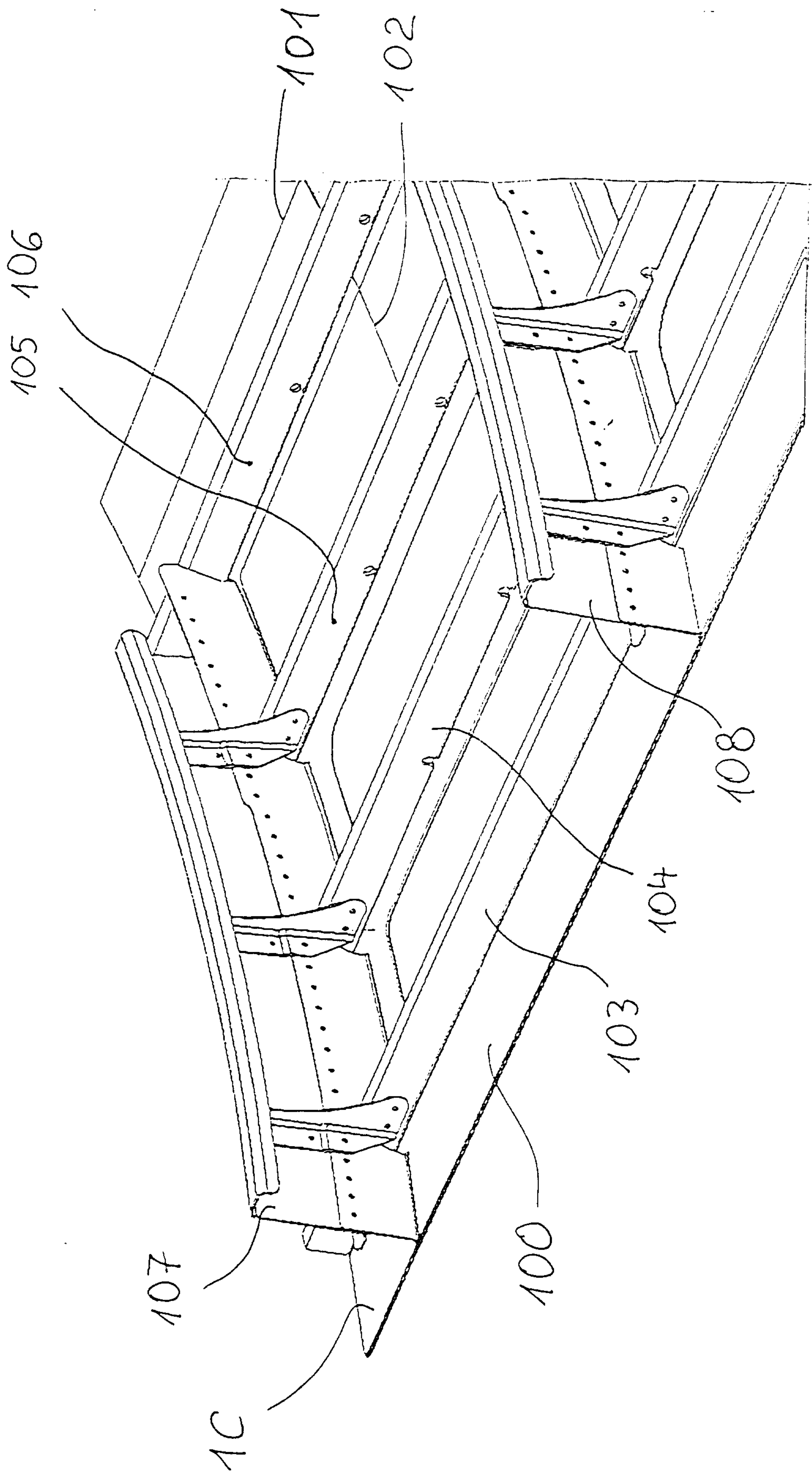


Fig. 3

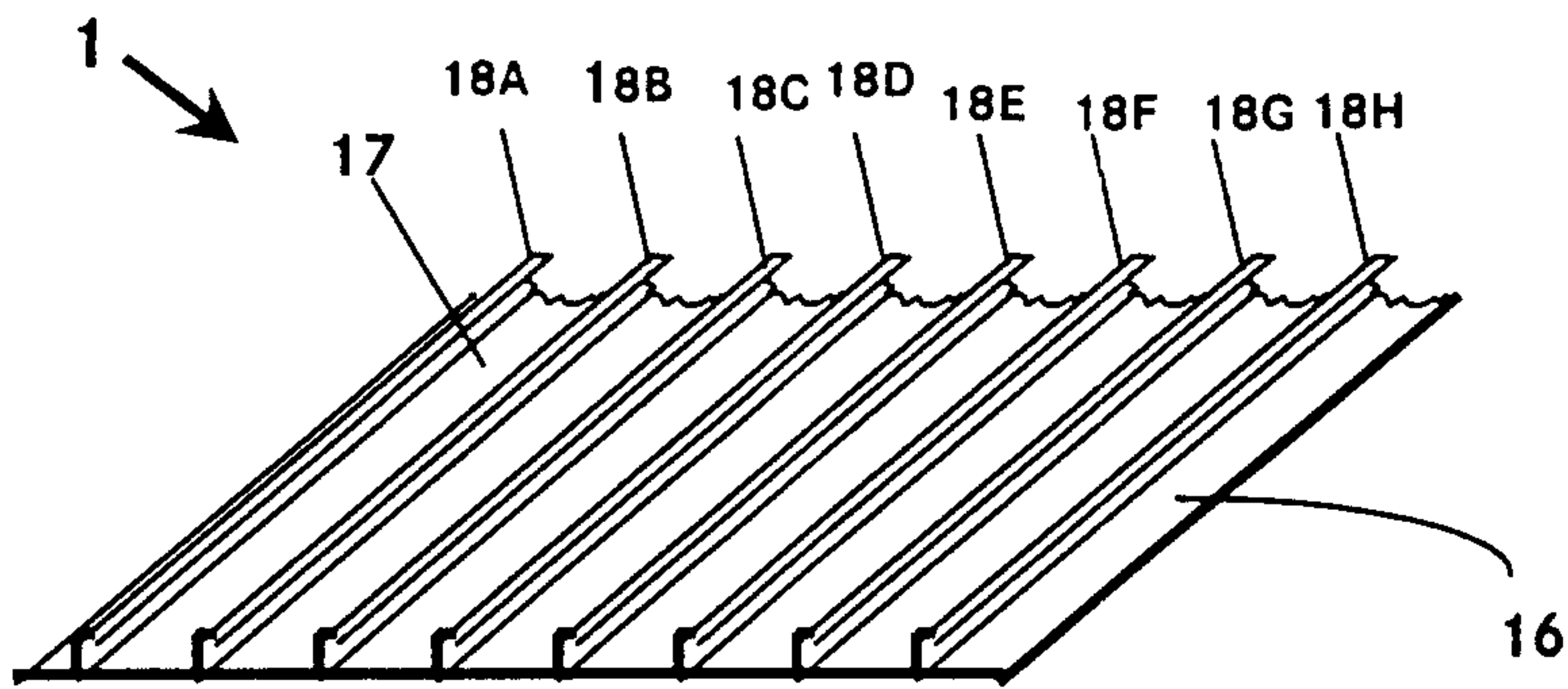


Fig.4

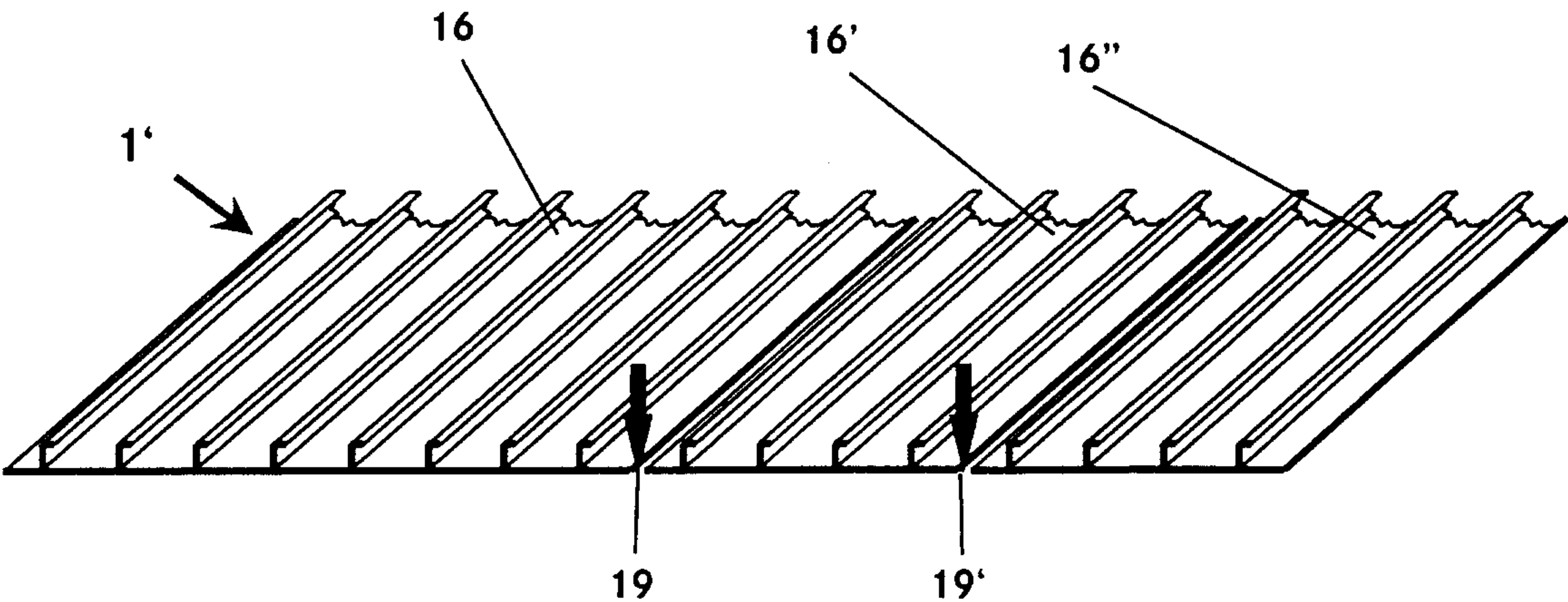


Fig.5

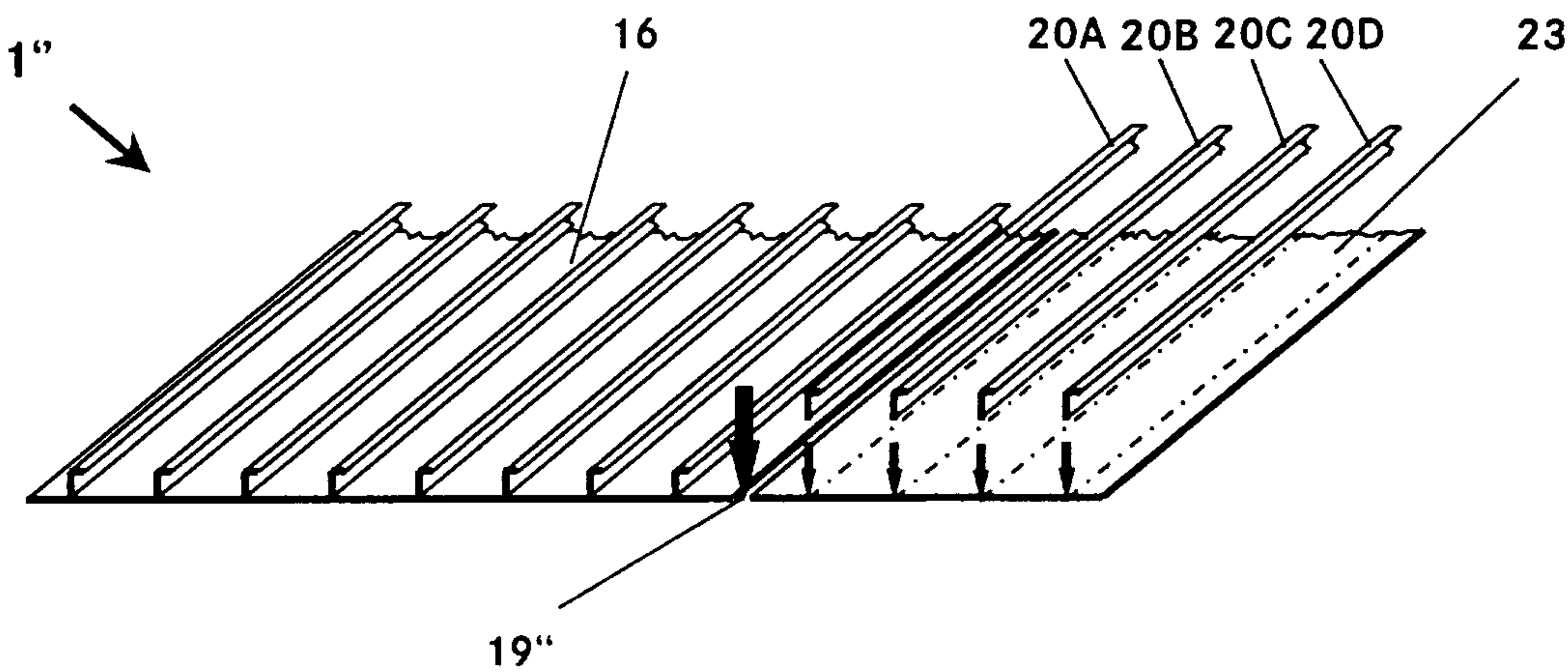


Fig.6

