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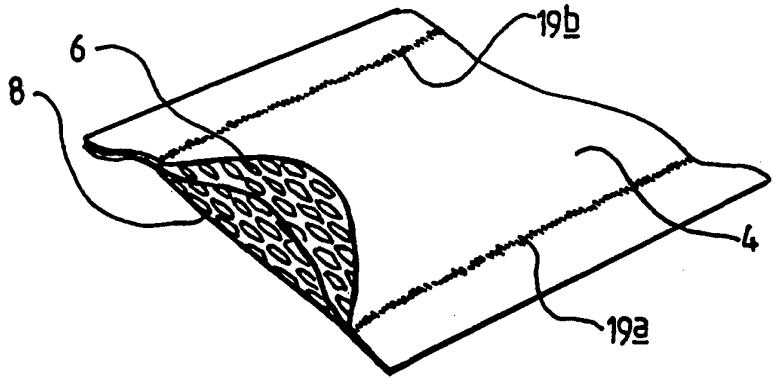
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(54) Title: PACKAGING MATERIAL, PACKAGING PAD AND MACHINE FOR MANUFACTURING PACKAGING MATERIAL

(57) Abstract

A packaging material comprises a base sheet (4; 148a, 148b) of unexpandable material such as paper and a second sheet (6 or 8; 112a, 112b or 112c) of expandable material such as paper, the second sheet having a number of rows of longitudinally spaced slits with the slits of one row offset from the slits of an adjacent row and being secured, in its expanded condition, to the base sheet. A packaging pad may comprise outer layers of unexpandable material with at least one layer of expanded material therebetween. The invention also provides a machine for use in manufacture of the material.



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Title: Packaging material, packaging pad and machine for manufacturing packaging material

Description of Invention

This invention is concerned with improvements relating to packaging material, such as is used to protect fragile articles during transportation.

A packaging material known from US-A-2294478 and US-A-4105724 comprises a sheet of planar material (such as paper) provided with a plurality of transverse rows of longitudinally-spaced slits, with the slits of one row being offset from the slits of the adjacent row whereby when the sheet is subjected to longitudinal tension, the sheet stretches as the slits open, producing "lands" which extend out of the plane of the sheet increasing its thickness and enabling the material to be used for cushioning purposes. Such a material is hereinafter referred to as being expandable material of the kind specified.

A sheet of such material may be used in a number of different ways, but because of the resilience, when tension on the sheet is relaxed the slits tend to close and the sheet adopts more or less its planar form. Thus it is in general necessary for the sheet of material to be wrapped around an article to be protected and retained thereon under tension. Difficulty is also encountered in utilising sheet material of the kind specified as a packaging means which can be used as an infill, or which can be placed under or on or around articles to be protected.

It is also known from US-A-3306513 to spray the expanded sheet with a suitable liquid, which may conveniently be fire retardant, which when dried retains the sheet expanded and allows it to be used as a cushioning material even when laid flat. However such spraying renders the sheet stiff, and reduces the advantages of a "soft" cushioning material, in addition to introducing into the packaging material possibly undesired chemical additives.

According to this invention there is provided a packaging material comprising a base sheet of unexpandable material and a second sheet of expandable material, the second sheet being provided with a plurality of rows of

longitudinally-spaced slits, with the slits of one row being offset from the slits of an adjacent row, the second sheet being secured to the base sheet whilst in expanded condition.

By the term "unexpandable" as used herein we mean unexpandable in the context of use, and not in any absolute sense. In particular we mean significantly less expandable than the expandable material which is used, to achieve the purpose for which it is used.

In its simplest form the invention may be put into practice by procuring a sheet of expandable material of the kind specified, e.g. Kraft paper having any appropriate weight, typically of between 45 and 150gms per square metre, provided with parallel rows of slits extending transversely of the sheet, the slits in one row being offset from the slits in an adjacent row, tensioning the paper in the longitudinal direction to open the slits, and securing the tensioned paper whilst in the said condition to a sheet of unexpandable Kraft paper, typically having a similar density.

The second sheet may be secured to the base sheet by any appropriate means, such as by adhesive, but preferably the sheets are secured together by a physical method which does not utilise additional components, such as by crimping or pressure welding.

A two-ply sheet in accordance with this invention may thus have a thickness of about ten times the thickness of a single sheet, and stay in its expanded state indefinitely. It may thus be used as a packing material without special steps being taken to retain the expandable material in its expanded form, and for example one or more pieces of such material may be laid down and fragile components be laid thereon.

Preferably the sheet material in accordance with the invention comprises a plurality of plies of expandable material, e.g. two, preferably three or more plies also secured to the base sheet whilst in expanded condition. In this manner a significant thickness increase and impact absorption capability may be obtained relatively inexpensively. Preferably one of the sheets of expandable

material is in a reverse orientation. In this way the raised areas in one sheet tend to interlock within the apertures of an adjacent sheet to improve the stability of the packaging material.

If desired a further sheet of unexpandable material may be utilised with the expandable material thus sandwiched between the two sheets of unexpandable material.

Conveniently the outer surface or surfaces of the unexpandable material may be printed so as to carry the name of the contents, manufacturer, distributor, or warnings or the like.

Packaging material in accordance with this invention may be wound on a roll, from which appropriate lengths may be cut as desired, or may be delivered in pre-set lengths.

According to this invention there is also provided a method of manufacturing a packaging material involving

a) procuring a first length of sheet material;

b) procuring a second length of sheet material;

c) applying to said second length generally transversely to the length thereof a plurality of short slits, adjacent slits in the longitudinal direction being offset in the lateral direction, whereby when the sheet is subjected to a longitudinal tension, the slits open as lands between adjacent slits become inclined to the plane of the sheet; and

d) securing the second length whilst under tension to the first length.

According to this invention there is provided a machine for use in the manufacture of packaging material comprising:

a) first supply means to supply a first, unexpandable sheet material;

b) second supply means to supply a second material of the kind comprising a plurality of longitudinally-spaced slits with the slits of one row being off-set from the slits of the adjacent row;

c) means to bring the first and second sheets into contiguous relationship whilst they are being drawn from their respective supply means; and

d) securing means to secure the two sheets together with the first sheet in its expanded condition.

Conveniently the supply means comprises mounting means for respective rolls of expandable and unexpandable materials. However if desired mounting means may be provided for rolls of unexpandable material, the machine comprises slitting means to apply slits to the sheet drawn from one of the rolls to provide for the supply of the expandable sheet material.

Preferably the machine comprises first withdrawing means to draw the first material from its roll, and second withdrawing means to draw the second material from its roll, said first withdrawing means operating at a linear rate which is faster than that of the second withdrawing means.

Preferably the second withdrawing means comprises spaced rollers, advantageously comprising a surface which is, to some extent at least, resiliently deformable.

Preferably the machine comprises an expanding means operative to apply tension to the second material subsequent to leaving the withdrawing means.

Preferably the expanding means comprises spaced rollers operative to grip the second sheet and to expand it whilst drawing it from its withdrawing means. If desired, the rollers may comprise a plurality of radially-extending projections to enter into the slits. Such projections may be in the form of bristles provided on the exterior of the roller. Preferably however the rollers of the expanding means is toothed, the teeth thereof passing through the openings provided in the material by virtue of it having been expanded, and pulling the material away from the withdrawing means at a rate faster than the withdrawing means is operative to pull said second material from the second supply means.

Preferably the teeth are triangular in longitudinal cross-section, preferably being prismatic in form. Preferably each circumferential row of teeth is spaced, and preferably the rollers are so offset that the teeth of one roller are

located in the axial direction directly opposite to a space existing between two adjacent circumferential rows of teeth of the other roller.

Preferably the spacing of the rollers is such that there is little or no diametral gap between the crowns of the teeth of the two rollers.

Preferably one roller is provided with power drive means, the other roller being free, and being rotated by engagement of the teeth thereof in the slits of the expandable sheet material as the sheet material is drawn through the expanding means by the driven roller.

In this manner, problems of synchronisation of the two toothed rollers may be minimised.

Thus, preferably, the expanding means is operative to feed sheet material therethrough at a rate substantially similar to the rate at which the first withdrawing means is operative to feed the unexpandable sheet material from the supply thereof.

The two sheets may be brought into face to face contiguous relationship immediately prior to entry into the nip of the expanding means, or immediately after exit of the expandable material from the expanding means.

Preferably the securing means is located downstream of the nip of the expanding means. Preferably the securing means is operative to secure the sheets together along longitudinal lines at least two of which are located adjacent to the edge margins of the sheets.

Advantageously, the securing means comprises knurling means.

Preferably support means is provided to support the sheets between the expanding means and the securing means, conveniently afforded by supporting bands of rubber or the like elastomeric material.

Advantageously, the machine comprises further supply means for the supply of further expandable sheet material, and preferably further supply means for the supply of further unexpandable sheet material, the construction and arrangement being such that the sheets of expandable material are fed through the expanding means together, conveniently in contiguous relationship with at

least one of the sheets of unexpandable sheet material. Thus, if desired, the sheets of expandable material may be fed through the expanding means together, with the sheets of expandable material being sandwiched between sheets of unexpandable material as they pass through the expanding rollers, but preferably one of the sheets of unexpandable sheet material is brought into contiguous relationship with the plurality of sheets of expandable material subsequent to passage thereof through the expanding means, but prior to passage thereof through the securing means (knurling rollers).

There will now be given a detailed description, to be read with reference to the accompanying drawings, of a packaging material which is a preferred embodiment of this invention, having been selected for the purposes of illustrating the invention by way of example, the method by which the packaging material is made, and the machine upon which it is made, also being illustrative of the invention in certain of its aspects.

In the accompanying drawings:

Figure 1 is a schematic view of the packaging material which is the preferred embodiment of the invention, part thereof having been torn away to expose inner layers, for the purposes of clarity;

Figure 2 is a schematic view showing a machine for use in the manufacture of the said material;

Figure 3 is a view showing the pattern of slits applied to the sheet material as it passes between a pair of slitting rolls;

Figure 4 is a view, taken on the line 4-4 of Figure 2, showing a pair of crimping rollers utilised in the manufacture of the preferred embodiment;

Figure 5 is a schematic side elevation of the machine which is the preferred embodiment of the invention;

Figure 6 is an enlarged view showing expanding means and securing means of the machine;

Figure 7 is an elevation taken in the direction of the arrow A of Figure 5, showing front views of the two rollers of the expanding means; and

Figure 8 is an enlarged view showing the sheets of material passing through the expanding means.

The packaging material which is a preferred embodiment of this invention comprises three plies, 4, 6 and 8 of Kraft paper, being stored on respective supplies thereof in the form of rolls 5, 7 and 9 (Figure 2). The sheets 6 and 8 are each fed through a pair of slitting rolls 10, 12 by which a plurality of slits 13 are applied to each sheet, the slitting rolls also constituting withdrawing means for withdrawing the sheet materials from the supply means 7 and 9.

The slits 13 are applied to the sheets 6 and 8 generally in the pattern illustrated in Figure 3, that is consisting of a plurality of rows of slits, the slits in each row (X) being co-linear and being parallel to the slits of an adjacent row (Y), each slit extending transversely to the length of the sheet and each slit being offset in the lateral direction from an adjacent slit in the longitudinal direction. Such sheet material, as is known in the art, when subjected to a longitudinal tension (in the direction A Figure 3) causes the slits to open, and the material to expand in thickness, "lands" of the material becoming inclined to the plane of the sheet, permitting the material to be used as a cushioning material.

On subjection to the material 6 and 8 to the slitting rolls 10, 12, the two sheets are brought together and passed between a further pair of rollers 14, 16, constituting expanding means of the machine, which are caused to rotate faster than the rolls 10, 12 so as to "stretch" the sheets 4 and 6, opening up the slits as hereinbefore described. Immediately subsequently the sheets 4 and 6 are combined with a sheet of unslitted (i.e. unexpandable) Kraft paper, and passed through a pair of knurling or crimping rollers 18, 20 by which the sheets 4 and 6 are crimped along the edge regions (19a, 19b) to the sheet 8, whereby the sheet 8 retains the sheets 4 and 6 under tension, and hence in their expanded states.

Conveniently the crimping rollers 18 and 20 constitute withdrawing means for withdrawing sheet material from the supply 5 thereof.

As is shown in Figure 2, the paper is drawn from the rolls 7 and 9 in opposite directions - that is, with the "top" face of the paper facing in opposite

directions. In this orientation, it has been found that, on stretching of the paper, the "lands" which are produced are inclined in opposite directions, and whilst they tend to interlock, do not tend to nest to the same extent as when the paper is fed through in the same orientation.

Thus where two or more layers are used as intermediate cushioning sheets, the sheet are oriented with their top face alternately in different directions.

The packaging material thus provided may be wound onto a roll, from which lengths of the material may subsequently be cut as desired for use. Where the packaging material is cut to length, conveniently this is effected by an operation which combines guillotining with a transverse pressure weld, such that the ends of the pad are sealed in the same manner as the side edges. This prevents a reduction in the efficacy of the pad by a relaxation of the stretching of the inner layers, at the end regions.

It would be possible to provide a further longitudinal pressure weld or welds between the edge regions of the sheet, if desired, and for example two relatively closely spaced such welds could be provided midway between the edges with the sheet subsequently being cut, e.g. by a slitting knife, between such two welds to provide two half-width sheets.

Whilst the packaging material which is the preferred embodiment of this invention comprises two sheets of expansible material and one sheet of unexpandable material, if desired three or more sheets of expandable material may be utilised, and if desired the expandable material may be sandwiched between two sheets of unexpandable material. Conveniently in such circumstances the crimping rollers 18 and 20 provide withdrawing means for both sheets of unexpandable sheet material.

The unexpandable material, may be plain, or printed with an appropriate message, warning, logo, trade mark, name or the like.

The machine which is the preferred embodiment of this invention comprises a housing 106 comprising, at a base part thereof, mounting means 108

including mounting members 108a, 108b, 108c and axles 109 on which rolls 110a, 110b, 110c respectively of paper-like material may be mounted.

In the use of the machine which is the preferred embodiment of this invention, in the manufacture of packaging material of the kind specified, the material mounted on the mounting members 108a, 108b and 108c is pre-slitted material of the kind specified. Lengths 112a, 112b, 112c of the sheet material are brought into face to face relationship by withdrawing means 116 in the form of a pair of driven rollers 118a, 118b, the rollers having rubberised surfaces and being operative to feed the 3-ply material indicated by the numeral 120 in Figure 1 towards the expanding means 122.

As will be seen in Figure 5, the sheet materials 112a, 112b and 112c are withdrawn from the rollers 110a and 110c in the same orientation, whilst the sheet is withdrawn from the roller 110b in the opposite orientation.

The machine comprises expanding means 122 provided by upper and lower rollers 124a, 124b, each roller comprising circumferential rows of teeth which are triangular in axial cross-section (as shown in Figure 6) but which are rectangular in longitudinal cross-section, as can be seen in Figure 7.

The circumferential rows 126a - 126z of teeth on the upper roller 124a are spaced apart, and the rows of teeth 127a - 127z of the lower roller 124b are offset laterally, as seen in Figure 7, so that each row 127a is located opposite to a gap between an adjacent pair of rows (e.g.) 126a, 126b, and vice versa.

However, the diametral distance between the crowns of the teeth of the roller 124a and those of the roller 124b is zero, or close to zero.

The rollers of the expanding means 122 operate at a linear rate higher than that of the withdrawing rollers 118a, 118b so that as the three sheets of expandable material pass from the withdrawing rollers 118 into the expanding rollers, the material is stretched longitudinally, and the slits thereof open up to produce inclined "lands" as is known in the art. The teeth 125 of the lower roller enter into the openings produced in the lower sheets, drawing the material through the stretching means. Simultaneously, the teeth 127 of the upper roller

enter into the openings produced in the upper sheets, causing the three sheets to partially nest, as is illustrated in Figure 8. This is an effect of the reversal of the orientation of the intermediate sheet 112b. Engagement of the teeth 126 within the openings of the upper sheets causes the roller 124a to rotate, and in this way problems of synchronisation are avoided. However if desired the upper roller 124a may be driven in synchronism with the lower roller 124b.

Alternative to the rollers being provided with teeth, the rollers may be provided with bristles, disposed around the circumference thereof, the expandable material being fed between the bristles, the bristles readily passing through the slits and through the openings provided as the lands are stretched out of the plane of the surface of the material, the bristles having a flexibility selected such that they will be deformed, rather than to cause the sheet material to tear. In such circumstances preferably the bristles are provided on the circumferential surface of the or each roller at a relatively high density, so as to ensure that a plurality of bristles at each time pass into the openings of the sheet material, to spread the stretching load applied to the sheet material, to reduce tendency of the paper to tear.

Preferably the bristles are arranged on the circumference of the or each roller on a strip of carrier material of relatively narrow width, applied to the circumferential surface of the roller in a helical array. By spacing the two rollers a short distance apart such that the bristles intermesh, adequate penetration of the bristles into the openings of the sheet material is ensured.

By ensuring an appropriate flexibility of the bristles, those bristles which are not required to penetrate into a slit of material will be deflected into a non-operative position on engagement with the sheet material as it passes between the two rollers.

Thus, the bristles may be of natural bristle, such as is used in brushes, but may of course be of a synthetic material, such as plastic or rubber.

Wound around the rollers 124a and 124b, and further rollers 130a, 130b respectively, are supporting means in the form of rubber bands 132a, 132b

which support the expanded sheet material as it passes from the expanding means, exerting some longitudinal constraint to prevent the material from contracting to any significant degree.

The machine which is the preferred embodiment of this invention comprises further mounting means 140, comprising supports 142a, 142b for rollers on which respective rolls 146a, 146b of unexpandable sheet material, such as Kraft or Kraft paper, may be mounted. Closely downstream of the exit of the expandable material from the expanding means 122 is provided securing means 150, in the form of a pair of intermeshing knurling rollers 152a, 152b adapted to crimp together side edge margins of the composite sheet material.

Lengths 148a, 148b of the unexpandable sheet material are fed respectively into contiguous relationship above and below the composite expanded material as it leaves the supporting rollers 130, and together the five sheets are fed through the securing means 150, which operates at least at one, preferably both edge margins of the composite sheet. Such securement of the expanded material to the sandwiching sheets of unexpandable sheet material prevents any longitudinal movement of the expandable material as would take place if the expandable material were to contract towards its unexpanded form. The existence of the two sheets of unexpandable sheet material thus retains the core of expandable material stretched, and allow it to retain its capability of effecting a cushioning function, in its use as a cushioning material.

If desired however some retention against contraction may be effected by the use of a single sheet of unexpandable material alone, i.e. one of the two rollers 142 or 144 may be omitted.

Particularly in such circumstances, the securing means 150 may be operative simultaneously to secure the composite sheets together at an intermediately-spaced but longitudinally-extending line.

As with the embodiment shown in Figure 2, in the preferred embodiment the securing means constitutes means for withdrawing sheet material

from the rolls 146a, 136b. However if desired separate withdrawing means may be provided for one or both sheets.

Whilst in the preferred embodiment the supply means is provided by mounting means for respective sheets of expandable (slitted) material and for expandable (unslitted) material, if desired the machine may be provided with mounting rolls for the supply of expandable (unslitted) material, such as in the form of five rolls of Kraft paper, the second supply means comprising in addition to the mounting means for three of the rolls, slitting means for three of the sheets, whereby the sheets are subjected to the appropriate slitting operation subsequent to be drawn from the rolls thereof, and prior to being fed through the expanding means 122.

Whilst in the preferred embodiment both sheets 148a and 148b of unexpandable material are brought into contiguous relationship with the expandable sheet or sheets subsequent to said sheets passing through the expanding means, if desired one of said sheets may be brought into such contiguous relationship before the expandable material passes through the expanding means. In such circumstances the teeth of the adjacent roller will tend to cause the unexpanded material to become corrugated, as the material is deformed by engagement with the teeth, as the teeth pass into the openings provided in the expanded material. Preferably however no more than one such sheet is so brought into contiguous relationship upstream of the expanding means.

It is to be appreciated that whilst the invention has been described above in the context of utilising sheet material provided with slits in the form of a regular pattern of parallel slits, uniformly offset laterally in the longitudinal direction, if desired other slit arrangements may be utilised, including a more randomly arranged set of slits, or slits which enable the material to be expanded other than by the application of tension solely in the longitudinal direction. For example an array of slits may be provided which extend at an angle to the longitudinal axis, allowing the slit material to be expanded by tension laterally thereof.

Additionally whilst the invention has been described in relation to the use of a Kraft material for both expandable and unexpandable sheet materials, if desired other materials may be utilised, including combinations of different types of material.

The features disclosed in the foregoing description, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, or a class or group of substances or compositions, as appropriate, may, separately or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS

1. A packaging material comprising a base sheet (4; 148a, 148b) of unexpandable material and a second sheet (6 or 8; 112a, 112b or 112c) of expandable material, the second sheet being provided with a plurality of rows of longitudinally-spaced slits (13) with the slits of one row being offset from the slits of an adjacent row and being secured to the base sheet in its expanded condition.

2. A packaging material according to Claim 1 wherein the base sheet (4; 148) is of paper, and the second sheet (6 or 8; 112) is of paper provided with a plurality of parallel rows of slits (13), the slits in one row (X) being offset from the slits in an adjacent row (Y).

3. A packaging material according to one of Claims 1 and 2 wherein the second sheet (6 or 8) is secured to the base sheet (4) along side edge margins (19a, 19b) by a physical method which does not utilise additional components, such as by crimping or pressure welding.

4. A packaging material according to any one of the preceding claims comprising a plurality of sheets (6, 8; 112a, 112b, 112c) of expandable material secured to the base sheet (4; 148) whilst in expanded condition.

5. A packaging material according to Claim 4 wherein adjacent sheets (4, 6; 112a, 112b, 112c) of expandable material are in mutually reverse orientation.

6. A packaging material according to any one of the preceding claims comprising a further sheet of unexpandable material (148) with the expandable material (112) sandwiched between the two sheets of unexpandable material.

7. A method of manufacturing a packaging material involving

a) procuring a first length (4; 148) of sheet material;

b) procuring a second length (6 or 8; 112a, 112b, 112c) of sheet material;

c) applying to said second length generally transversely to the length thereof a plurality of short slits (13), adjacent slits in the longitudinal direction being offset in the lateral direction; and

d) securing the second length (6 or 8; 112) whilst under tension to the first length (4; 148).

8. A method according to Claim 7 wherein the first and second lengths of sheet material are of paper.

9. A packaging pad comprising outer layers 148a, 148b) of unexpandable sheet material and at least one layer (112) of expandable sheet material secured between the outer layers along longitudinal edge margins whilst in expanded condition, whereby the or each sheet of expandable material is retained in expanded condition against longitudinal contraction.

10. A machine for use in the manufacture of packaging material comprising

a) first supply means (5; 142, 146) to supply a first, unexpandable sheet material (4; 148);

b) second supply means (7, 9, 10, 12; 108, 109, 110) to supply a second material (6, 8, 112) of the kind comprising a plurality of longitudinally-spaced slits (13) with the slits of one row (X) being offset from the slits of the adjacent row (Y);

c) means (18, 20; 150) to bring the first and second sheets into contiguous relationship whilst they are being drawn from their respective supply means; and

d) securing means (18, 20; 150) to secure the two sheets (4, 6, 8; 148, 112) together with the first sheet in its expanded condition.

11. A machine according to Claim 10 comprising first withdrawing means (18, 20; 152) to draw first material from the first supply means and second withdrawing means (10, 12; 116) to draw second material from the second supply means, said first withdrawing means (152) operating at a linear rate which is faster than that of the second withdrawing means (116).

12. A machine according to one of Claims 10 and 11 wherein the second withdrawing means (116) comprises spaced rollers (118a, 118b).

13. A machine according to one of Claim 11 and 12 comprising an expanding means (14, 16; 122) operative to apply tension to the second material subsequent to leaving the withdrawing means (10, 12; 116).

14. A machine according to Claim 13 wherein the expanding means comprises rollers (124a, 124b) operative to grip the second sheet and to expand it whilst drawing it from its withdrawing means (116).

15. A machine according to Claim 14 wherein the rollers of the expanding means are toothed, the teeth (126) thereof passing through the openings provided in the material by virtue of it having been expanded, and pulling the material away from the withdrawing means at a rate faster than the withdrawing means is operative to pull said second material from the roller thereof on the second mounting means.

16. A machine according to Claim 15 wherein the teeth (126) are triangular in cross section.

17. A machine according to one of Claim 15 and 16 wherein each circumferential row of teeth is spaced, and preferably the rollers are so offset that the teeth (126) on one roller (124a) are located in the axial direction directly opposite to a space existing between two adjacent circumferential rows of teeth (127) of the other roller (124b).

18. A machine according to any one of Claim 15, 16 and 17 wherein the spacing of the rollers is such that there is little or no diametral gap between the crowns of the teeth (126a, 126b) of the two rollers.

19. A machine according to any one of Claims 15 to 18 wherein one roller (124a) is provided with drive means, the other roller (124b) being free.

20. A machine according to Claim 13 wherein at least one of the rollers is provided with a plurality of bristles extending radially outwardly from the circumference thereof, the bristles passing through the openings provided in the material by virtue of it having been expanded, and pulling the material away from the withdrawing means at a rate faster than the withdrawing means is operative to pull said second material from the roller thereof on the second mounting means.

21. A machine according to any one of Claims 14 to 20 wherein the expanding means (122) is operative to feed sheet material therethrough at a rate substantially similar to the rate at which the first withdrawing means (150) is operative to feed the unexpanded sheet material from the roller thereof.

22. A machine according to any one of Claims 10 to 21 wherein the securing means (150) is located downstream of the nip of the expanding means.

23. A machine according to any one of Claims 10 to 22 wherein the securing means is operative to secure the sheets together along longitudinal lines at least two of which are located adjacent to the edge margins of the sheets.

24. A machine according to any one of Claims 10 to 23 wherein the securing means comprises knurling means.

25. A machine according to any one of Claims 10 to 24 wherein supporting means (132a, 132b) is provided to support the sheets between the expanding means (122) and the securing means (150).

26. A machine according to any one of Claims 10 to 25 comprising further mounting means (108a, 108b) for mounting one or more further rolls (110a, 110b) of expandable sheet material, and preferably further mounting means (144) for mounting a further roll (146) of unexpandable sheet material.

27. A machine according to Claim 25 wherein the sheets of expandable material are fed through the expanding means (122) together, with the sheets of expandable material being sandwiched between the sheets of unexpandable material as they pass through the securing means (150).

28. A machine according to Claim 26 wherein the sheets of unexpandable material are fed through the expanding means together, with one sheet of unexpandable material as they pass through the expanding rollers, the other of the sheet of unexpandable material being brought into contiguous relationship with the plurality of sheets of expandable material subsequent to passage thereof through the expanding means, but prior to passage thereof through the securing means.

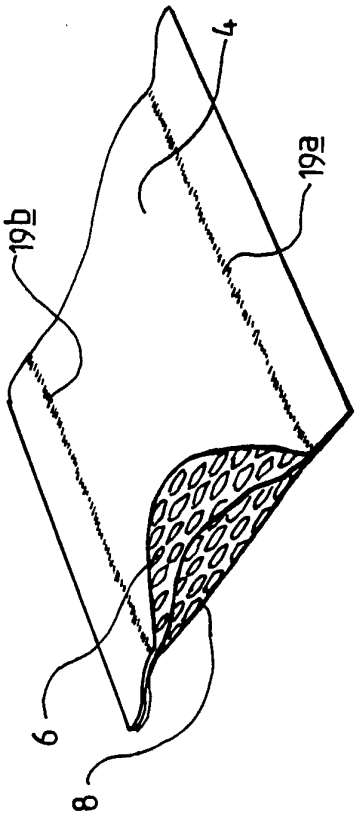


FIG 1

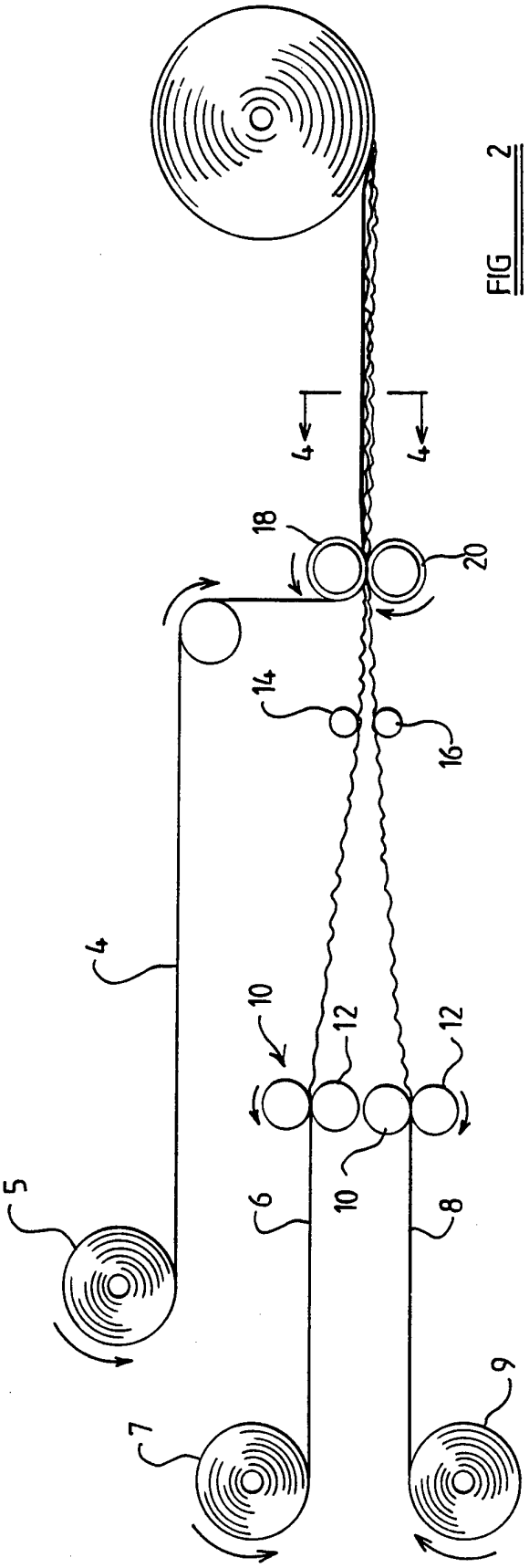


FIG 2

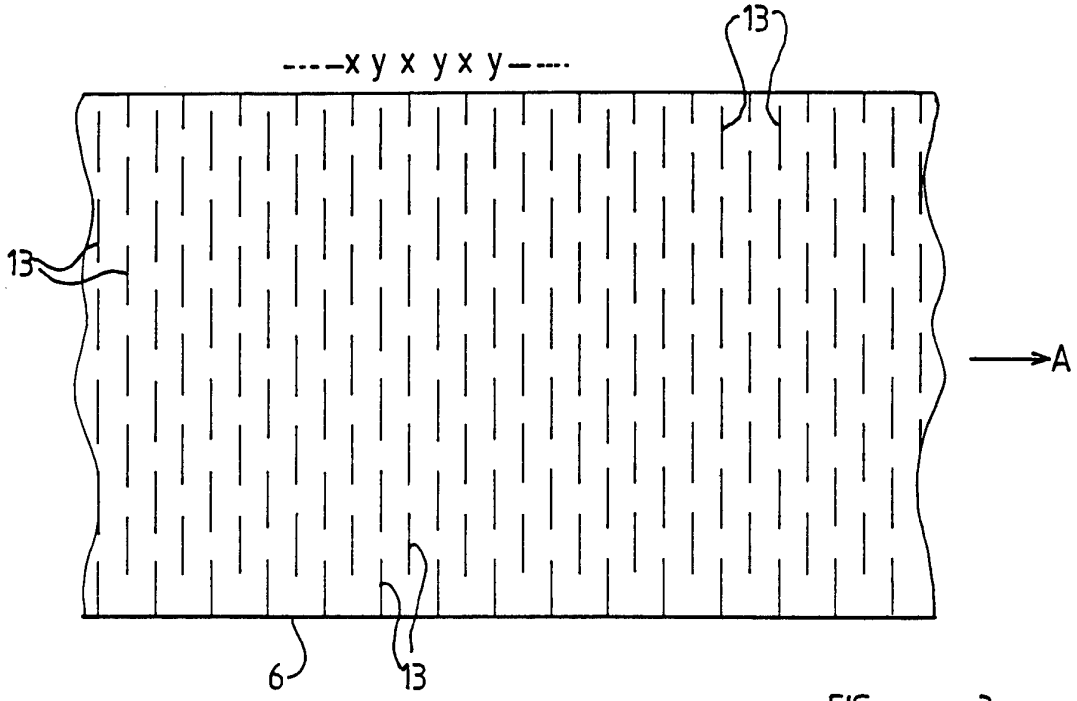


FIG 3

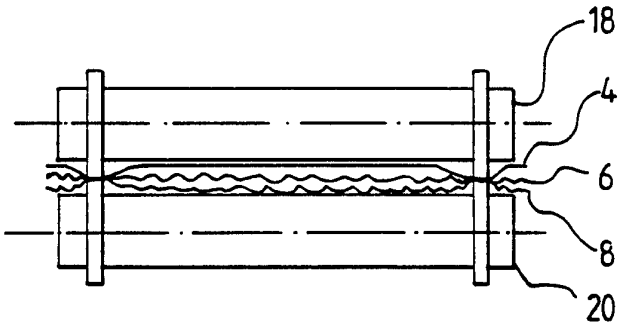


FIG 4

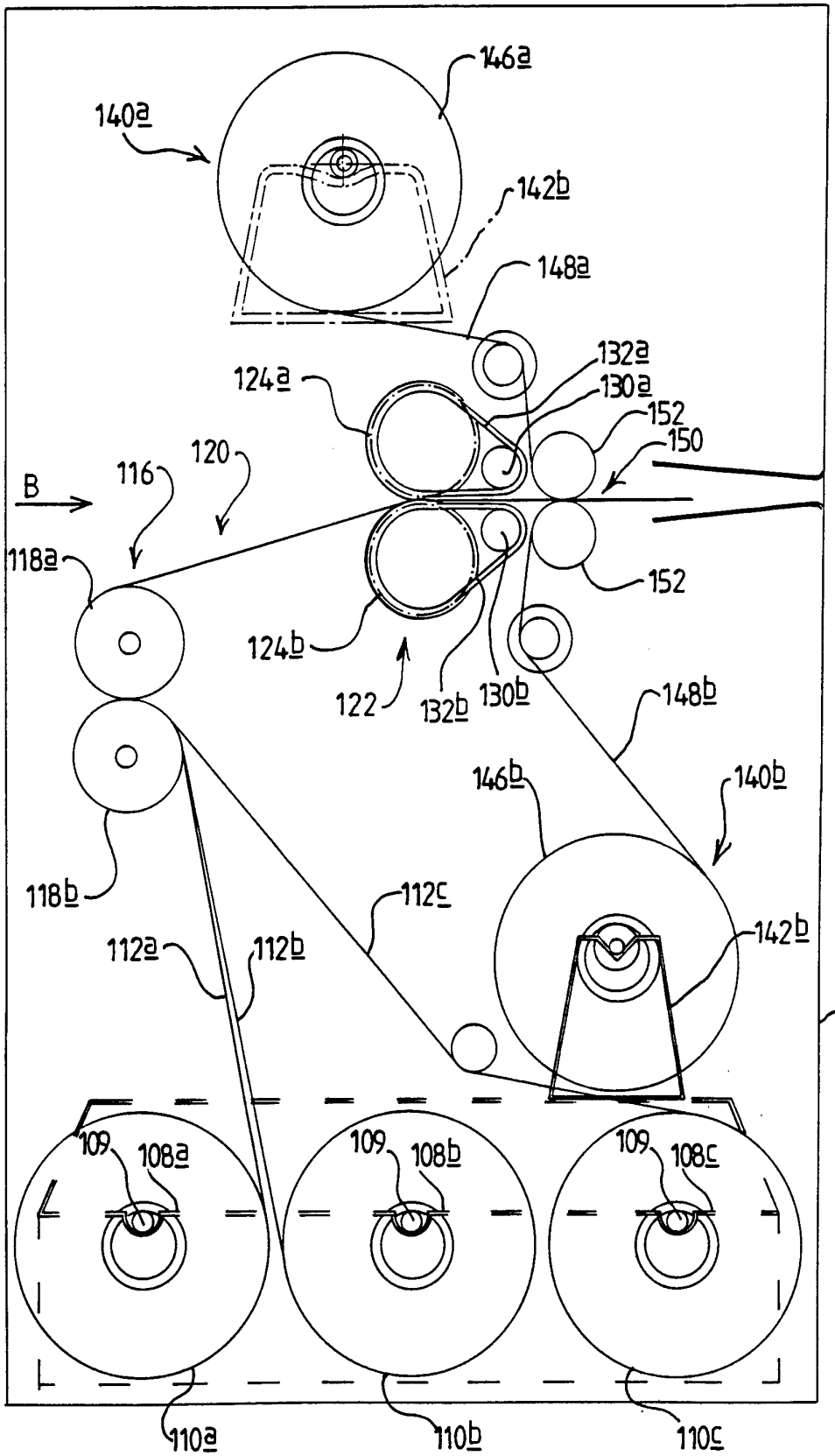

146a
140a
142b
148a
132a
124a
130a
152
150
120
116
B
118a
152
124b
122
132b
130b
148b
146b
140b
118b
112c
112a
112b
142b
106
109
108a
109
108b
109
108c
110a
110b
110c

FIG 5

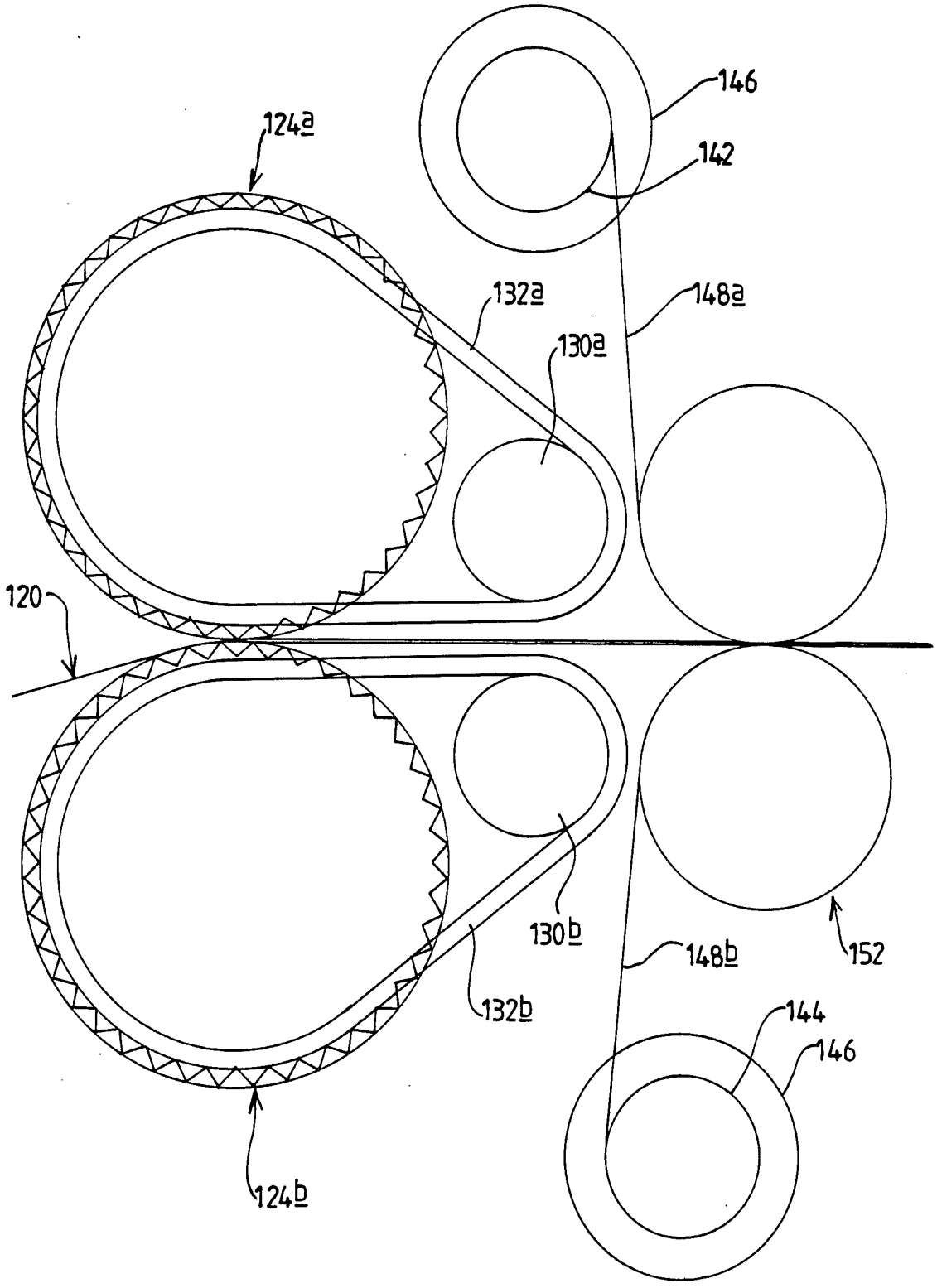

146
142
124a
132a
148a
130a
120
130b
148b
152
132b
144
146
124b

FIG 6

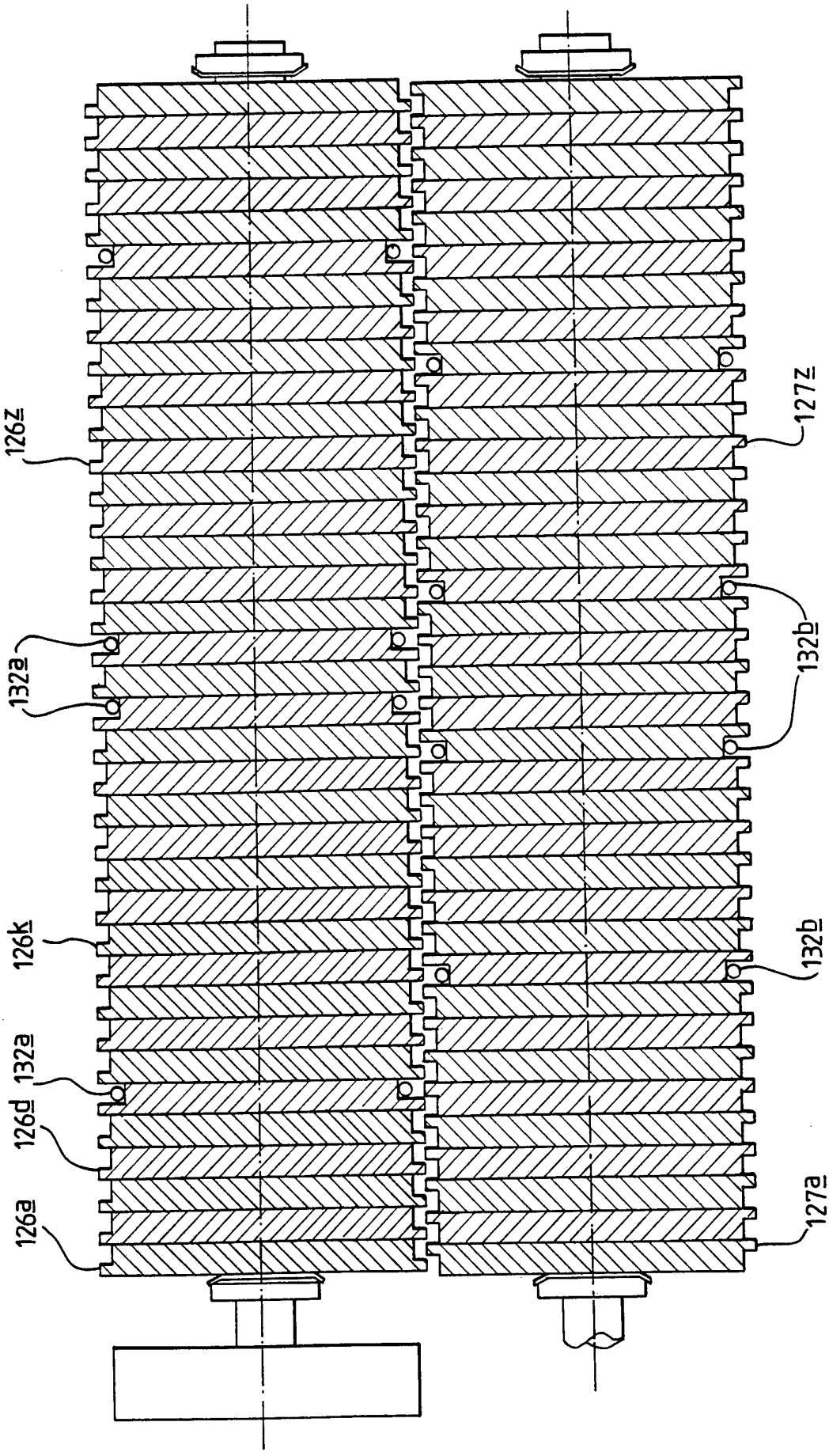


FIG 7

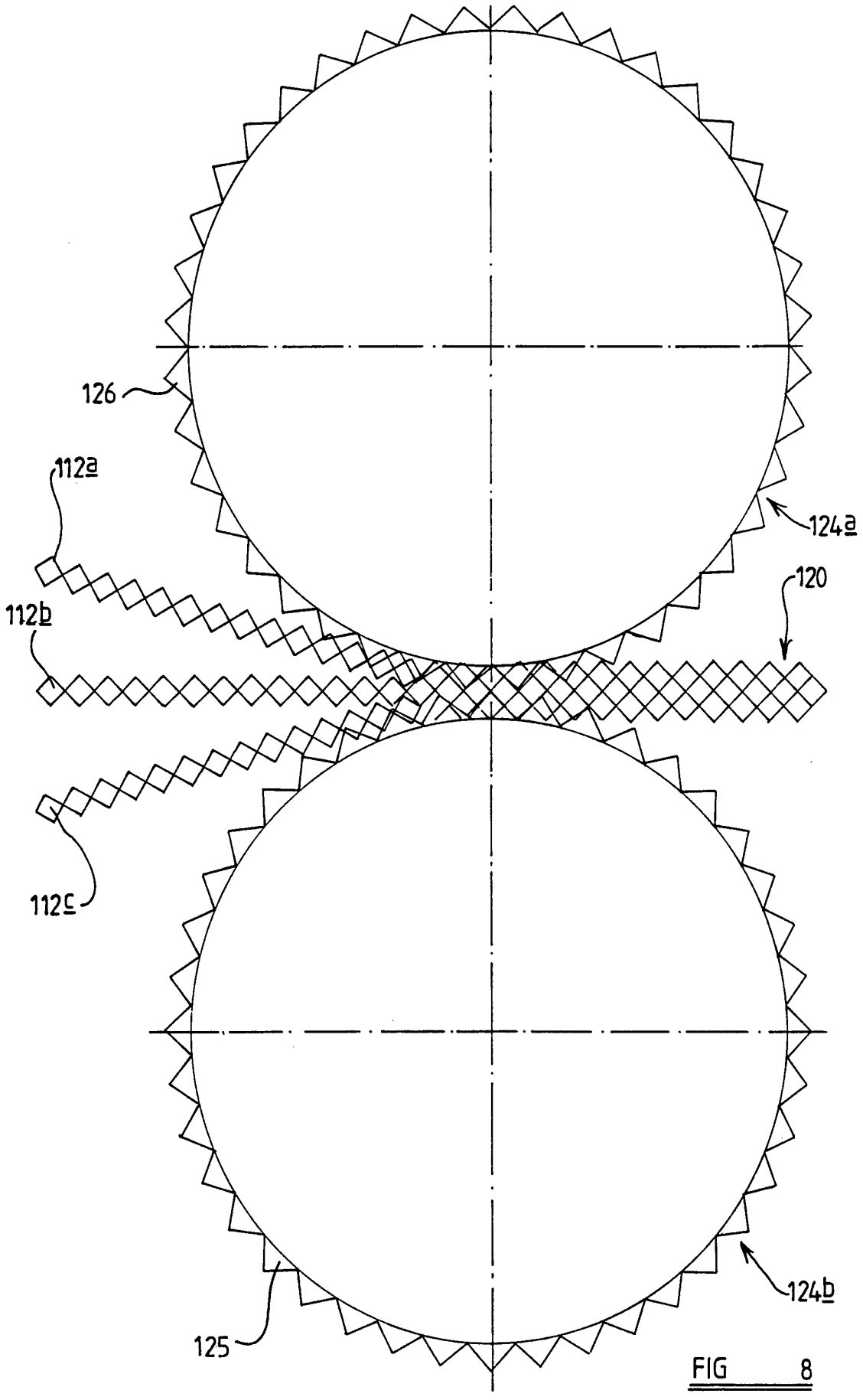


FIG 8

INTERNATIONAL SEARCH REPORT

Interr al Application No
PCT/GB 95/01578

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B31D1/00 B65D81/03 B65D65/40 B31D3/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B31D B65D B21D

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,4 105 724 (TALBOT EDWARD BUTTERFIELD) 8 August 1978 cited in the application ---	1,7,9
A	US,A,2 294 478 (NORRIS,NELSON) 1 September 1942 cited in the application ---	1,7,9,10
A	US,A,3 810 800 (DOLL M) 14 May 1974 ---	1,7,9,10
A	EP,A,0 573 353 (EUROP PROPULSION) 8 December 1993 cited in the application ---	1,7,9,10
A	US,A,1 344 826 (SEXTON) 29 June 1920 ---	1,7,9,10
A	CH,A,619 416 (EXPLOSAFE SA) 30 September 1980 -----	1,7,9,10

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 October 1995	25. 10. 95

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Roberts, P

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INTERNATIONAL SEARCH REPORT

information on patent family members

Intern al Application No
PCT/GB 95/01578

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