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(72) Inventors:

- **Cicalini, Giancarlo**
55062 Castelveccchio di Compito
Lucca (IT)
- **Gelli, Mauro**
Capannori
Lucca (IT)

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(71) Applicant: **Fabio Perini S.p.A.**

55100 Lucca (IT)

(74) Representative: **Mannucci, Michele et al**

Ufficio Tecnico Ing.A. Mannucci S.r.l.

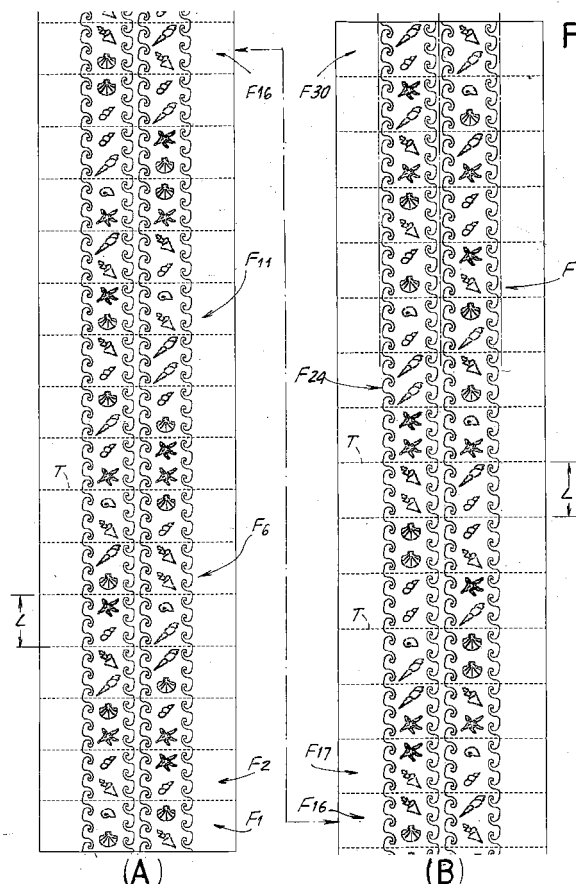
Via della Scala 4

50123 Firenze (IT)

(54) **Embossed sheet material, embossing unit and method for the production**

(57) The invention relates to a web product (N) comprising at least one ply decorated by embossing- Along

the extension of the web product (N) variable combinations of at least two sequences of embossing motifs come after each other.



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Description

Technical Field

[0001] The present invention relates to an embossed product, in particular, although not exclusively, to a multi-ply embossed product, i.e. a product composed of more plies joined to one another. In particular, although not exclusively, the invention relates to a paper web product, such as specifically a tissue paper product, for example for the production of rolls of toilet paper, kitchen towels and similar products.

[0002] The invention also relates to an embossing unit for a web material, wherein two or more plies are embossed separately and joined to one another, for example by means of glue.

[0003] According to another aspect, the invention relates to a method for embossing a web material, preferably, although not exclusively, a multi-ply material.

State of the Art

[0004] Embossing is one of the operations that are typically performed on the tissue paper plies or sheets, for the production of paper items for cleaning and personal hygiene, or also for commercial or industrial use, such as for example toilet paper, kitchen towel, napkins, handkerchiefs and similar products.

[0005] The embossing operation is performed with the dual aim of improving the aesthetic characteristics and of increasing the functional characteristics, such as in particular softness, smoothness, absorption capacity or thickness of the finished product.

[0006] Generally, a tissue paper material, such as kitchen towel and toilet paper, is composed of two or more plies of paper, which are embossed separately and subsequently joined to each other by applying glue and laminating the plies between counter-rotating rollers defining a lamination nip.

[0007] The embossing is typically performed by feeding each ply between an embossing roller, provided with protuberances, and a pressure roller with an external surface coated in an elastically yielding material, typically rubber. In this case one talks about steel-rubber embossing, the embossing roller being typically produced in steel. In some cases, the embossing is performed between two rollers made of steel or other hard material, the first provided with protuberances and the second with corresponding hollows. The protuberances of the embossing roller produce corresponding protuberances or projections in the paper ply. The protuberances formed in the two outermost plies are facing the inside of the finished product.

[0008] According to a possible technique (called tip-to-tip), the two plies of the paper web material are joined together taking the protuberances of one ply to correspond with the protuberances of the other ply, having applied previously a glue on the protuberances of one of

the two plies, or at least on a part thereof. In practice, two embossing rollers, which separately emboss two paper plies by means of corresponding pressure rollers, form between themselves a lamination nip, through which the two embossed plies pass, before being detached from the rollers. In the lamination nip, the protuberances of a roller coincide with the protuberances of the other roller, and the reciprocal distance between the rollers can be such as to cause a localized compression of the plies in correspondence of these protuberances.

[0009] US-A-3,414,459 describes a tip-to-tip embossing device for obtaining a product of this type. The tip-to-tip embossing technique has been perfected and improved, in order to solve particular problems, which arise with this method. US-A-5,096,527, for example, describes a technique for reducing vibrations and wears in the tip-to-tip embossing units. US-A-6,113,723 describes a distribution of protuberances whose object is to increase the strength of gluing by means of a particular arrangement of the protuberances. US-A-5,736,223 describes a method for producing a paper sheet article comprising three layers or plies of tissue paper.

[0010] US-A-5,173,351, US-A-6,032,712, US-A-6,245,414, and US-A-6,053,232 describe embossing-laminating units, which, with particular expedients, avoid a concentrated wear of the protuberances even when the protuberances do not coincide completely, but rather they produce a zone-to-zone correspondence, between some of the protuberances of a roller with some of the protuberances of the other roller. US-A-3,961,119 describes a tip-to-tip embossing unit, wherein two embossing rollers cooperating with each other are provided with helical bosses. The bosses of an embossing roller present projections, which mesh with cavities obtained in the helical bosses of the opposite embossing roller.

[0011] According to a different technique, the two plies are embossed separately, each between an embossing roller and a counter-roller or pressure roller. The two plies are subsequently glued in such a way that the protuberances of a ply are nested between the protuberances of the other ply. In this case, one talks about "nested" embossing. Lamination of the two plies is performed between one of the embossing rollers and a laminating roller, while the two embossing rollers do not touch each other. Examples of embossing-laminating devices of this type are described in US-A-3,556,907, US-A-3,867,225, and US-A-5,339,730.

[0012] US-A-5,686,168 describes a nested embossing method, wherein the plies are joined by means of lamination between two opposite embossing rollers.

[0013] US-A-6,578,617 and US-A-6,470,945 describe embossing units which can perform embossing according to both the technologies described above. To switch from a tip-to-tip embossing to a nested embossing, it is possible to modify the angular phase and/or the axial position of the two embossing rollers.

[0014] US-A-6,261,666 describes a similar device for performing alternatively a tip-to-tip or a nested emboss-

ing. Another similar device is described in US-A-6,109,326.

[0015] Initially, embossing was performed according to very simple geometrical patterns, with uniform distributions of protuberances with a frusto-conical or frusto-pyramidal shape. This embossing substantially had a technical function, being suitable to provide a product with adequate thickness and with sufficient softness as well as absorption capacity.

[0016] Currently the embossing has to serve a double purpose, both techno-functional and aesthetic. Therefore, embossing patterns and embossing units were developed, which allow to obtain a product aesthetically pleasing and, at the same time, suitable to meet the more and more demanding aesthetic requirements and commercial needs required from these product. The embossing no longer is obtained only through elementary geometrical patterns, but it requires the combination of more or less close embossing (sometimes of micro-embossing) and decorative patterns embossed and possibly printed. Examples of complex embossing are described in US-A-6,136,413, US-A-5,846,636, and US-A-6,106,928.

[0017] US-A-6,755,928 and US-A-6,681,826 describe a new embossing technique which allows to obtain patterns with increased aesthetic prestige and easily interchangeable.

[0018] In the traditional embossing units, one or more embossing rollers are provided, on the surface of which embossing motifs are obtained, defined by protuberances of different shape, in order to satisfy the aesthetic and techno-functional requirements described above. In many known embossing devices or units, the surface of the embossing roller or of each embossing roller is provided with a repetitive embossing pattern. The product thus obtained is therefore composed of a continuous web, on which a single pattern is repeated indefinitely, or at the most a very limited number of patterns different from each other, which cover globally a length of the web material equal to the circumferential extension of the embossing roller.

[0019] In some modern embossing units (see WO-A-2006092817), along the circumferential extension of the embossing roller or of each embossing roller a sequence of patterns different from each other is provided. Each pattern decorates a single sheet into which the web material is subdivided. If the web material is manufactured in logs constituted by a continuous strip subdivided through tear-off and perforation lines (which divide the web material into single sheets that can be torn off separately) each sheet is decorated with one of the patterns of the series of patterns provided along the circumferential extension of the roller. Therefore, in the finished product one can find for example 2-6 patterns different from each other, which form a cyclically repeating sequence. In practice, on the finished roll there is reproduced in succession the sequence of embossing patterns different from each other, which is along the circumferential ex-

tension of the embossing roller. The latter presents a limited circumference, therefore limited will be also the number of patterns of the sequence, which can be reproduced on the finished material. If the material is embossed with a sequence of N patterns different from each other, repeated in succession, after N tear-off or sheets (where N = 2-6, approximately) there is a sheet which presents the same embossing of the first sheet.

10 Objects and summary of the invention

[0020] One object of the present invention is to provide an embossed web material, which presents greater variability of embossing patterns, so that in a single pack one can find a plurality of sheets with patterns different from each other in a larger quantity than what can be obtained with the traditional techniques, i.e. in particular a number of patterns different from each other greater than the number of patterns obtained on one circumferential extension of the embossing roller or embossing rollers with which the product was obtained.

[0021] A further object of the present invention is to provide an embossing unit, which allows to obtain a multiply embossed web product characterized by a great variability of the embossing patterns realized on the single sheets forming it.

[0022] According to a first aspect, a first embodiment of the invention provides a web product comprising at least a ply, decorated by embossing, in which along the extension of said web product variable combinations of at least two sequences of embossing motifs come after each other. As the embossed motifs are obtained by combining two series or successions of patterns, if said two sequences present different number of pattern and more in particular the two sequences are defined by two numbers of patterns different from each other and prime to each other, the total number of decorative combinations is equal to the product of the number of patterns in each sequence. For example, if the two sequences contain respectively N and M patterns, where N and M are numbers prime to each other, the combined use of these sequences will result in a succession of NxM different combinations and therefore a great variation of the patterns in the finished product.

[0023] In a known manner, the product can be subdivided into sheets, each sheet presenting a combination of patterns of said two sequences. In practice, the product can be a pack of napkins, handkerchiefs or other single products, preferably folded and stacked. However, in an advantageous embodiment the product is formed by sheets forming a continuous web and they are subdivided from each other by perforation lines, along which said sheets can be detached one from the other. The continuous web material thus obtained can be for example wound in rolls, such as rolls of kitchen towel, toilet paper or similar.

[0024] In one embodiment, the product has a single ply, or a plurality of plies embossed simultaneously in a

single passage, for example by means of a pair of embossing rollers and corresponding pressure rollers positioned in sequence along the feed path of the web material. However, in a preferred embodiment, the product comprises at least two plies bonded to each other, separately embossed and subsequently joined, for example by gluing. In this case, one embodiment of the invention provides for a first ply be embossed with the patterns of a first sequence, and for the second ply with the patterns of a second sequence. After having been embossed separately, the two bonded plies produce a multi-ply web product, wherein each area of the product is characterized by the combination of two embossing motifs or patterns, obtained on the first and on the second ply respectively. It should be understood that each ply can in turn be formed by more layers bonded to each other and that, in addition to these two plies, further plies can be provided, separately embossed or even smooth, interposed between embossed plies, or other alternative combinations of embossed and/or smooth plies. The plies can be coupled by gluing. In this case, according to a preferred embodiment of the invention, gluing is performed by means of two different glues, for example of different color, applied one on the one and one on the other of the two embossing patterns obtained on the two plies of the web material. Alternatively, it is possible to apply on one embossing pattern an ink and on the other embossing pattern a neutral or colored glue, preferably with a color different from those of the ink or with different nuances. It is also possible to have three different embossing patterns, colored and/or glued differently from each other.

[0025] In one embodiment, each of the two sequences of embossing patterns or motifs has a length equal to a multiple of a dimension of the sheets into which the web material is subdivided. The two lengths differ from each other by a multiple of said dimension, preferably by a multiple equal to 1 of this length.

[0026] In one embodiment, the product is configured so that:

- along a first ply of said web a first sequence of embossing motifs is obtained, with a first number of patterns at least partially different from each other, each of which is applied on at least one of said sheets;
- along a second ply of said web a second sequence of embossing motifs is obtained, with a second number of patterns at least partially different from each other, each of which is applied on at least one of said sheets, said second number being different from said first number;
- each sheet is decorated with a combination of a first pattern of the first embossed sequence on the first ply and of a second pattern of the second sequence embossed on the second ply.

[0027] As the web material can have a great length with respect to the length of the embossing motif, in one embodiment the first sequence and the second sequence

of patterns are applied on the web material in a repetitive manner.

[0028] The patterns of the two or more sequences of patterns can be completely different from each other. However, this is not necessary, as the desired effect of a great variability of the overall motifs formed on the web material is obtained even if a part of the pattern of the two sequences are equal, even arranged according the same order, or according a different order in the two sequences. Preferably, the pattern are arranged so as not to overlap each other, but rather to occupy adjacent areas of the same sheet of the same portion of web material. It is also possible that the two patterns - one for each sequence - involving or occupying the same portion of material, for example the same sheet of a roll, are at least partially interspersed with each other.

[0029] According to a different aspect, the invention relates to an embossing unit comprising a first embossing roller and a second embossing roller, provided with protuberances defining embossing patterns. According to an advantageous embodiment of the invention, the embossing unit provides that:

- on said first embossing roller at least a first sequence of embossing patterns is provided along the circumferential extension of the roller;
- on said second embossing roller at least a second sequence of embossing patterns is provided along the circumferential extension of the roller;
- said first sequence and said second sequence have a length equal respectively to a first multiple and to a second multiple of a base length, said first and second multiples being different from each other.

[0030] Advantageously, the two embossing rollers have diameters different from each other, which differ by such a value that the length of the circumference of the two rolls differs by a multiple (possibly equal to 1) of a base length which constitutes the pitch of the patterns on the finished product. In practice, if this is subdivided into sheets, for example single tear-off of paper in a perforated roll, the base length will be substantially equal to the length of the single sheet measured along the longitudinal direction of the web material.

[0031] In one embodiment the first embossing roller and the second embossing roller each cooperate with a respective first pressure roller. Pressure roller is intended as a roller for example coated with a yielding material and provided with a smooth external surface, inside which penetrate the protuberances of the corresponding embossing roller. However, pressure roller is also intended generally as a roller, whose cylindrical surface is in hard material, for example steel, and on this surface an engraving is provided, in negative corresponding to the embossing protuberances of the embossing roller. In this case the web material can be embossed by means of the male-female co-action of the cavities and protuberances of the two rollers cooperating with each other.

[0032] In one embodiment, the embossing unit has a single path for a ply or set of plies forming the web material. Along this path the two embossing rollers can be arranged in sequence. Preferably, the embossing unit is provided with two paths for at least two plies, a first path developing about the first embossing roller and a second path developing about the second embossing roller. In both cases, more embossing rollers in succession can be provided, in order to obtain a combination of patterns by means of three or more sequences of embossing patterns, at least two of which present a different number of patterns in order to obtain the combinatory effect of multiplication of the final patterns.

[0033] When the embossing unit has two or more paths for two or more plies of web material, which must be joined, one or more glue dispensers can be provided, in order to apply one or more glues on the plies. In one embodiment of the invention the glues are different from each other in color.

[0034] In general, the invention also relates to a web material converting line comprising an embossing unit as defined above, combined with one or more further converting machines, for example: a perforator unit; a rewinding machine; a gluer for gluing the ends formed by winding the web material; a severing machine.

[0035] According to a further aspect, the invention also relates to an embossing method for embossing a web material. In one embodiment, the method provides for the web material to be embossed by means of at least a first sequence of embossing patterns and a second sequence of embossing patterns, said two sequences differing in length, so that on said web material a succession of variable combinations of the patterns of said first and second sequence is obtained.

[0036] Further advantageous features and embodiments of the web product, the method, and the embossing unit according to the invention are indicated in the attached claims and will be further described hereunder with reference to some non-limiting embodiments provided by way of examples.

Brief description of the drawings

[0037] The invention shall be better understood by following the description and the accompanying drawing, which shows non-limiting practical embodiments of the invention. More in particular, in the drawing:

figure 1 shows a diagram of an embossing unit according to the invention;
 figures 1A and 1B show schematic enlarged details of figure 1;
 figure 2 shows a schematic section of a portion or sheet of a multi-ply web material according to the invention;
 figure 3 shows a planar development of the cylindrical surface of a first embossing roller of the embossing unit of figure 1;

figure 4 shows a planar development of the cylindrical surface of a second embossing roller of the embossing unit of figure 1;

figure 5 shows a development of the multi-ply web material obtained by means of the embossing unit of figure 1;

figure 6 shows a roll of web material;

figure 7 shows a diagram of a conversion line for paper for producing rolls of multi-ply embossed tissue paper;

figure 8 shows a diagram of a modified embodiment of the invention;

figures 8A, 8B show enlargements of details of figure 8;

figure 9 shows a schematic enlarged section of a web material obtained by means of the embossing unit of figure 8;

figure 10 shows a diagram of an embossing unit according to a different embodiment of the invention;

figure 11 shows a greatly enlarged section of the product obtained with the embossing unit of figure 10;

figure 12 shows a diagram of an embossing unit in a further embodiment;

figure 13 shows a greatly enlarged schematic section of a product obtained with the embossing unit of figure 12;

figure 14 shows a diagram of an embossing unit in a further embodiment;

figure 15 shows a schematic planar development of the cylindrical surfaces of the two embossing rollers of the unit of figure 14;

figure 16 shows a planar view of a portion of web material obtained by means of the embossing unit of figure 15;

figure 17 shows a greatly enlarged schematic section of the product of figure 16; and

figure 18 shows a diagram of a further modified embodiment.

Detailed description of embodiments of the invention

[0038] Figures 1, 1A and 1B schematically show an embossing or embossing-laminating unit to perform embossing and lamination of two plies of web material, for example tissue paper. In one embodiment, the embossing unit, indicated in its entirety with number 1, comprises a first path for a first ply V1 and a second path for a second ply V2. Each ply V1, V2, in turn, can be composed of a single layer or of more layers. Further paths for a third or more ply would also be possible, for example to be inserted between the ply V1 and the ply V2.

[0039] In one embodiment, along the path of the ply V1 a first pressure roller 3 is arranged, cooperating with a first embossing roller 5. In one embodiment, the pressure roller 3 is coated in an elastically yielding material, for example rubber or similar. The embossing roller 5 is provided, on its cylindrical surface, with protuberances

5P defining an embossing pattern, whose characteristics will be better described hereunder. In the nip formed by the pressure roller 3 and the embossing roller 5, the ply V1 is embossed, i.e. it is subjected to a deformation through the action of the reciprocal pressure between the two rollers, which causes penetration of the embossing protuberances 5P into the yielding coating layer 3A of the pressure roller 3. Along the extension of the embossing roller 5, downstream of the embossing nip between the rollers 3 and 5 with respect to the direction f1 of feed of the ply V1, a glue dispenser 7 is arranged; this dispenser applies by means of a roller 7A a glue on the embossed protuberances of the ply V1, in correspondence of all or some of the embossing protuberances 5P of the embossing roller 5. In one embodiment, the glue applied by the dispenser 7 is colored. In a different embodiment, the glue applied by the dispenser 7 can be neutral, i.e. colorless.

[0040] In one embodiment, along the path of the ply V2 the embossing unit 1 comprises a second pressure roller 9, coated in rubber or other elastically yielding material, indicated with 9A. The pressure roller 9 cooperates with a second embossing roller 11 the surface of which is provided with embossing protuberances 11P, which define an embossing pattern described in more detail hereunder.

[0041] Along the circumferential extension of the second embossing roller 11, a color dispenser 13 is arranged, with a color applicator roller 13A similar to the dispenser 7 with the dispensing roller 7A. The ply V2 is embossed in the embossing nip between the rollers 9 and 11 and on it an embossing pattern is impressed, corresponding to the pattern defined by the protuberances 11P. On at least some of the protuberances obtained on the ply V2, the dispenser 13 applies a color in a manner similar to what occurs with the glue applied by the dispenser 7 with respect to the ply V1 embossed between the rollers 3 and 5.

[0042] In one embodiment of the invention, the two embossing rollers 5 and 11 are arranged in such a way as not to touch each other in the nip 17 defined between them. Therefore, in this case the embossed ply V2 is detached from the second embossing roller 11 and placed on the embossed ply V1. Both the plies V1, V2 are thus driven about the first embossing roller 5 and fed through a lamination nip 19 between the first embossing roller 5 and a laminating roller 15. The laminating roller 15 can be coated in an elastically yielding material. In the embossing nip 19 the two plies V1 and V2 are joined through the effect of the pressure between the rollers 5 and 15.

[0043] Figure 2 schematically shows a greatly enlarged transverse section of a portion of the web material N formed by the plies V1 and V2 embossed and joined by gluing. P1 schematically indicates by way of example protuberances of the embossing pattern on the ply V1, and P2 schematically indicates protuberances of the embossing pattern on the ply V2. C1 indicates the glue ap-

plied by the glue dispenser 7 on the ply V1, and C2 indicates the color applied by the dispenser 13 on the ply V2. In correspondence of the glue C1 the two plies are pressed by the laminating roller 15 against corresponding protuberances 5P of the embossing roller 5, whilst in correspondence of the color C2 there can be an effect of light compression on the ply V2 exerted by the laminating roller 15. Preferably, the web material N formed by the combination of the plies V1+V2 will be wound in a roll with the ply V1 outside, so as to present a better look both thanks to the integrity of the protuberances P1 and to the fact that the colored glue is perfectly visible, whilst the color applied on the ply V2 will be less bright, as it will have to show through the ply V1 lying over it. In a modified embodiment of the invention, lamination may take place between the embossing rollers 5, 11, in the nip 17, with an adequate arrangement of the embossing patterns defined by the protuberances 5P and 11P. In this case, two glues C1, C2 can be used instead of a glue C1 and a color C2. The two glues C1, C2 may be both colored, preferably with different colors, or one colored and the other neutral. The roller 15 can be omitted.

[0044] In one embodiment, the embossing rollers 5 and 11 have diameters and thus circumferential extensions different from each other. In the illustrated example, the second embossing roller 11 has a diameter greater than the diameter of the first embossing roller 5. In particular, each of the two embossing rollers 5 and 11 have a circumferential extension, i.e. a length of the circumference, equal to a multiple of a base length L. This length L substantially corresponds to the length of each sheet into which the web material N is subdivided. The web material N can be wound in a log after having been subdivided into said sheets with length L through transverse perforation lines. Figure 6 shows by way of examples a roll R of wound web material N, subdivided into sheets F through transverse perforation lines T. In a known manner, each roll R can be obtained by cutting transversely a log with greater axial length, obtained by winding a web material N of great width.

[0045] In order to obtain a finished product wound in logs R, in a possible embodiment (see diagram in figure 7) the embossing unit 1 is placed inside a converting line, wherein downstream of the embossing unit 1 a perforator 21 is arranged, which subdivides the web material N formed by the plies V1, V2 (joined together) into single sheets F through the perforation lines T. The perforated web material is then fed to a rewinding machine schematically indicated with 23, of a known type and thus not described in detail, which produces single logs Ls of wound web material N, with or without winding tubular cores. The logs Ls have an axial length equal to a multiple of the axial length of the finished roll R, and usually present head and tail trimmings. The trimming are eliminated and the logs Ls are subdivided in single rolls R in a log saw 25 downstream of a gluing unit 24, which glues the free end of each log Ls, so that it will not be unwound during the subsequent transformation operations, includ-

ing the phases of packaging the rolls R. The machines 24, 25 are known per se, and they will not be described in greater detail.

[0046] It should be understood that the concepts on which the invention is based could be used also in converting lines wherein the finished product is a pack of folded sheets, for example paper handkerchiefs or napkins, instead of a roll.

[0047] Figures 3 and 4 show an embodiment of the embossing pattern on the two embossing rollers 5 and 11. Figures 3 and 4 show respectively the cylindrical surfaces of the roller 5 and of the roller 11 developed on a plane.

[0048] With initial reference to figure 3, A5 indicates the width of the surface of the roller 5 on which the embossing pattern formed by the protuberances 5P is obtained. This width A5 substantially corresponds to the axial width of the cylindrical surface. In this embodiment, the surface is subdivided in two lateral bands BL and two central bands BC. The central bands BC have a width (indicated with BC) greater than the lateral bands BL and substantially equal to the width of the web material wound on the roll R obtained by the subsequent processing of the web material. The length of the planar open surface of the embossing roller 5 is equal to $5 \times L$, i.e. the circumferential extension of the roller 5 is equal to five times the base length L. In this way the cylindrical surface of the roller 5 is subdivided into ten central panels R5, each of which has dimensions substantially corresponding to the dimension of a single sheet F (figure 6).

[0049] In each of the ten panels R5 an embossing pattern is provided, formed by protuberances 5P. The decorative motifs are indicated with G1-G5. In the embodiment shown in figure 3, the embossing patterns are represented by sea motifs (sea shells and starfishes), but it should be understood that this is only a possible example of embodiment, as the embossing patterns or motifs can be of any type. Furthermore, it is observed that in this embodiment in the two central bands BC the same patterns are provided, but arranged according to different sequences (G1, G2, G3, G4, G5 in the left band and G2, G5, G3, G1, G4 in the right band in the drawing). In a different embodiment, the sequence of the pattern in the left band BC (in the drawing) may be the same as the sequence in the right band. In a further variant of embodiment in the two bands BC sequences of patterns may be obtained, which are completely different from each other.

[0050] According to one embodiment, the embossing motif obtained on the roller 5 also presents a continuous decoration DC along each of the two central bands BC. In the illustrated example, the continuous decoration DC is formed by stylized waves, merely by way of example. Wave motifs can be found also in the lateral bands BL. The arrangement of the continuous decorations DC and of the sequences of decorations G1-G5 different in the two bands BC reduces vibrations which are produced in the embossing unit 1 through the action of the contact

between roller 5 and roller 3, thus making more uniform the reciprocal contact between the above mentioned rollers, and reduces differences in wear on the various areas of the pressure roller 5.

[0051] In the drawing of figure 3, straight lines T1, T2, and T3 are indicated, which represent the lines along which the web material, embossed with the embossing roller 5, is cut by the log saw with which the logs of material N are divided into rolls R. The strips of embossed web material in correspondence of the lateral bands BL are eliminated as head and tail trimmings, whilst the strips of web material embossed by the bands BC will constitute two finished rolls R. T indicates the positions in which on the web material N the tear-off and perforation lines T (figure 6) will be obtained, through which the material N is subdivided into single sheets F.

[0052] It should be understood that in practice the embossing roller 5 may have a much greater axial length A5 and thus a much greater series of central bands BC, for embossing plies of web material which, once wound, will form logs of axial length equal to many multiples of the axial length of the finished roll R. Each log will be then subdivided into two head and tail trimmings, respectively, and into a high number of usable rolls R. Typically, the logs currently produced by the modern rewinding machines can reach an axial length of 5 meters, while the rolls R present axial lengths in the order of 10-30 cm.

[0053] Figure 4 shows the planar development of the cylindrical surface of the second embossing roller 11. The width, corresponding to the axial length of the roller 11, is indicated with A11 and corresponds to the dimension A5 of the embossing roller 5. The length of the planar development of the embossing roller 11, i.e. its circumferential extension, is equal to $6 \times L$, i.e. to six times the base length. T1, T2, T3 indicate again the positions of the cutting lines with which the web material will be subdivided into two rolls, constituted by the winding of the central bands BC of the two plies V1, V2. T indicates the positions of the perforation lines. G6-G11 indicate decorative patterns obtained in the central bands BC of the roller 5, arranged, also in this case, according different sequences in the two bands BC. DC indicates the continuous decoration. The surface of the embossing roller 11 is thus subdivided into a plurality of panels R11 with dimensions which are equal to the dimensions of the panels R5 and therefore with a dimension L equal to the length of the single sheet F of the finished roll R and with a dimension BC equal to the width of the web material N which constitutes the finished roll R.

[0054] However, unlike the roller 5, which presents ten panels R5, the roller 11 presents twelve panels.

[0055] When the rollers 5 and 11 with the embossing decorative motifs described above are mounted on the embossing device or unit 1, they produce on the two plies V1 and V2 embossing motifs according to the decorations G1-G5 on the ply V1 and according to the decorations G6-G11 on the ply V2. Figures 3 and 4 thus also show portions of the plies V1 and V2 respectively, after

they have been embossed in the nips between the pressure and embossing rollers. When the two plies are joined by the laminating roller 15, a decoration is obtained, which is formed by the combination of the decorations G1-G5 and G6-G11.

[0056] As the two rollers 5 and 11 have a different circumferential extension, and more exactly equal to 5 and 6 times the length of the sheet F, on the finished material N sequences of sheets F will be obtained, characterized by thirty different repeating combinations. In general, if an embossing roller has a circumferential extension equal to M1 times the base dimension L and the other embossing roller has a circumferential extension equal to M2 times the base dimension, with M1 and M2 prime with each other, the finished product obtained by bonding together the plies V1 and V2 embossed separately by the rollers 5 and 11 will have a sequence comprising M1xM2 different combinations of decorations.

[0057] Figures 5A, 5B show the web material N obtained by joining the plies V1 and V2 embossed with rollers 5 and 11 on whose surfaces there are the motifs of figures 3 and 4. On each sheet F there is a pair of sea patterns, obtained one on each of the plies V1, V2. If the two plies are glued with glues C1, C2 of different colors (or with a colored glue and an ink or other dye of color different from that of the glue), the two embossed patterns of each sheet F (F1-F30) will be characterized by different colors with a particular aesthetic result.

[0058] Figures 5A and 5B show the different sheets obtained in the central part of the rollers 5 and 11 omitting the decorations related to the lateral bands BL. With initial reference to the lower part of figure 5, the first two adjacent sheets F1 are illustrated, the left one of which is obtained by the decoration G1 and the right stylized wave of the roller 5, plus the decoration G6 and the left wave of the roller 11. immediately above, the second two adjacent sheets F2 are shown, the left one of which is obtained by the decoration G2 of the roller 5 and by the decoration G7 of the roller 11 combined with the respective stylized waves on both sides. Above the two sheets F2 the sheets F3 are shown, and so on until the pair of sheets F16 at the top in figure 5A. In figure 5B, at the bottom is illustrated again the pair of sheets F16, and above it the subsequent pair of sheets F17. The sequence will continue until the upper end, in which F30 shows the last combination of patterns, and then the sequence repeat indefinitely.

[0059] In the illustrated example the embossing patterns obtained on the two rollers 5 and 11 are partially equal (the patterns G1-G5 correspond to the patterns G8-G11, G7), apart from the fact that the same patterns have in the panels of the roller 5 a different position with respect to the corresponding patterns of the roller 11, so that in the finished product N no overlapping of patterns occurs. Moreover, it should be understood that the patterns G1-G5 could be all different with respect to the patterns G6-G11.

[0060] Furthermore, in the illustrated example, in the

roller 5 the patterns G1-G5 of the left band BC are equal (even if arranged in a different manner) with respect to the patterns of the right band BC. The same is true for the patterns G6-G11 of the roller 11. However, also in this case it is understood that the various central bands BC, into which each embossing roller 5, 11 is subdivided, could be characterized by pattern different from band to band, in which case a greater variability of the final patterns of the rolls is obtained. In this way one could for example obtain packs of rolls R in which each roll presents a great number (M1xM2) of different combinations of motifs, with all the rolls different from each other, as obtained from plies V1, V2 embossed in correspondence of bands BC in which different embossing patterns are obtained.

[0061] At least some of the advantages which can be obtained with the embossing unit and the embossing method described above can be also used on products not subdivided into sheets, i.e. continuous products or without transverse perforation lines T. In fact, also in this case a high variation of the surface motifs of the product can be obtained. In this case, it will be however possible to define a base length L (not necessary linked to a dimension of sheet), which defines the panels R and on the base of which to determine the circumferential extension of the embossing rollers (as multiple of this base length).

[0062] Alternatively, also in the case of products subdivided into sheets through perforation lines, it is possible to vary the look of the various sheets without having a phasing between decorated object and perforation line, through the use of a roller with continuous or discontinuous patterns, which can be interspersed between continuous or discontinuous patterns on the other roller.

[0063] In the above description reference was made to an embossing and laminating unit, which produces a web material N with two plies joined to each other by gluing. However, the teachings provided by the present invention can be applied also to more complex embossing units, with more than two paths for more than two plies, or also in simpler embossing units, although in this case less advantageously.

[0064] Figures 8 and 9 show an embodiment, wherein the embossing unit is designed for producing a web material in a single ply, or even constituted by more plies but embossed all together. In one embodiment, the embossing unit, indicated in its entirety with 100, comprises a first pressure roller 103, which can present a cylindrical surface coated in an elastically yielding layer 103A, such as rubber or similar. The pressure roller 103 forms, with a first embossing roller 10S, an embossing nip 104, through which the web material N to be embossed travels. The first embossing roller has a plurality of protuberances 105P (see enlargement in figure 8A), which define a first embossing pattern. Along the path of the web material N a second pressure roller 107 is arranged, which cooperates with a second embossing roller 109, provided with embossing protuberances 109P (figure 8B). In one

embodiment, the cylindrical surfaces of the embossing rollers 105 and 109 can be configured as shown in figures 3 and 4, thus presenting two diameters different from each other. In one embodiment, the roller 109 has a diameter greater than the diameter of the roller 105 and its circumference is equal to a multiple $M1$ (for example $M1=5$) of a base length L represented by the length of the sheets into which the web material N is subdivided through perforation lines in a subsequent processing phase, for example by a perforating unit 21 (Fig. 7). The embossing roller 109 presents a circumferential length equal to $L \times M2$, wherein $M2$ is different from $M1$, for example $M2=6$.

[0065] As the web material N is embossed twice on the two rollers 105 and 109, in order to avoid that during the second embossing the pattern embossed by the roller 105 is pressed, the embossing patterns obtained by the two rollers 105 and 109 are advantageously offset, as shown for the embossing motifs G1-G11 of figures 3 and 4. In this way, each panel R , into which the second embossing roller 109 is subdivided, will decorate a portion of the web material in which it is not yet embossed by the corresponding panel R of the roller 105. The rollers 105 and 109 can be sufficiently close as to avoid the web material from excessively sliding, in order to assure a correct positioning of the embossing patterns produced by the two rollers on the same area of the material N , i.e. on the portion of material N destined to form a same sheet F . The pressure roller 107 cooperating with the second embossing roller 109 and defining with this latter a second embossing nip 108 can present a hollow area 107A, corresponding to the position in which on the material N is located the pattern embossed by the embossing roller 105. This avoids compression of the embossing pattern formed by the first pair of rollers 103, 105. Advantageously, in order to avoid difficulties in centering the embossing pattern through the two rollers 105 and 109 on the same web material or ply N , the continuous patterns or decorations DC can be omitted.

[0066] Figure 9 shows a schematic greatly enlarged section of a web material N embossed with the embossing unit 100 of figures 8, 8A, and 8B. P105 and P109 indicate the embossing protuberances obtained with the rollers 105 and 109 respectively.

[0067] Figure 10 shows a modified embodiment of the embossing unit of figure 8. The same numbers indicate the same or equivalent parts to those of the embossing unit of figure 8. In this embodiment, a glue dispenser 110 is located around the embossing roller 109 downstream of the pressure roller 107. The glue dispenser 110 applies a glue on the protuberances produced by the embossing roller 109 in cooperation with the pressure roller 107. Downstream of the glue dispenser 110 a laminating or roller 111 is provided. In the nip formed between the embossing roller 109 and the laminating roller 111 a second smooth ply $V2$ is inserted. In a modified embodiment, the ply $V2$ can be previously embossed, for example with a background micro-embossing. The product obtained is

schematically shown in figure 11, where C indicates the glue applied on the protuberances P109 of the ply $V1$.

[0068] Figure 12 shows a modified embodiment of the embossing unit of figure 11. The same numbers indicate parts identical or equivalent to those of the embossing unit of figure 11. In this embodiment the embossing rollers 105, 109 are arranged so that all the protuberances P105 and P109 produced thereby on the ply $V1$ are oriented in the same direction, i.e. inside the finished product (Fig. 13) formed by joining the plies $V1$ and $V2$ with the glue C .

[0069] Figure 14 shows a modified embodiment of the embossing unit of figure 1. The same numbers indicate parts identical or equivalent to those of the embodiment in figure 1. In this case, a glue is applied only on the ply $V1$ through the glue dispenser 7, whilst the second embossing roller 11 has no dispenser and on the ply $V2$ neither a glue nor an ink or color is applied. In order to guarantee an adequate joining of the two plies $V1$ and $V2$ notwithstanding the application of only one glue, an adequate distribution of the embossing patterns may be adopted.

[0070] Figures 15 and 16 schematically show a criterion for producing embossing protuberances on the cylindrical surfaces of the two rollers 5 and 11 (Fig. 15) and the result of the combination of these patterns on the web material N (Fig. 16). For simplicity of representation, the decorative motifs are indicated with the letters A, B, C, D, E, and F. On the surface of the roller 5 (figure 15, on the left) as a way of example four areas are produced with dimensions approximately equal to the dimension of a sheet F of the finished product. On each of these areas or panels the embossing patterns are arranged at the centre and near the vertices. The four areas are characterized by patterns different from each other, with the same criteria described above. Figure 15, on the left, shows the planar development of the roller 11, which has a greater circumferential length, equal to five times the length of the single sheet F of the finished web material N . In each panel embossing patterns, different from each other, are obtained, which are symbolically represented by the groups of letters D, E, F, G, and H. Figure 16 shows a portion of the web product N obtained by embossing the ply $V1$ with the embossing patterns A, B, C, and D on the roller 5 and the ply $V2$ with the embossing patterns D, E, F, G, and H. The patterns arranged on roller 5 are interspersed with respect to the patterns of the roller 11, so as to have a distribution of glue (only on the patterns of the roller 5 in this example) sufficient to make the plies $V1$ and $V2$ to adhere. It could be also hypothesized to distribute the glue for example only on frame patterns, which surround each panel in which the roller 5 is subdivided, whilst the central area is embossed (on the ply $V2$) but devoid of glue, with advantages in terms of softness of the finished product.

[0071] Figure 17 shows a schematic greatly enlarged section of the web product N obtained with this system, herein C indicates the glue, applied on the protuberances P5 produced by the roller 5, whilst the protuberances P11

produced by the roller 11 are devoid of glue. To avoid compression of these latter by the laminating roller 15, the protuberances P11 may have smaller height with respect to the protuberances 5P obtained on the embossing roller 5. This can be obtained with an adequate geometry of the protuberances 5P and 11P of the embossing units 5 and 11 and/or with an adequate pressure and/or an adequate hardness of the coating of the pressure rollers 3, 9.

[0072] In the example illustrated in figures 15, 16, the two rollers 5, 11 have an area with equal pattern (pattern D). However, it should be understood that one of the areas with the decoration D can be modified with a decoration I different from all the others, in order to obtain a greater variety of motifs.

[0073] Figure 18 shows a further embodiment of the invention. The embossing - laminating unit is indicated as a whole with 201. It comprises a first path for a ply V1 and a second path for a ply V2 which, once they have been processed, are joined to form a web material N. Arranged along the path of the ply V1 is a first embossing roller 203 cooperating with a first pressure roller 205 to form a first embossing pattern with a first sequence of decorations, for example N decorations in succession. In one embodiment, associated with the embossing roller 203 is a color dispenser, for example a printing unit 206 similar to the dispenser 13 of figure 1.

[0074] Arranged downstream of the first embossing roller 203, again along the path of the ply V1, is a second embossing roller 207 cooperating with a pressure roller 209, for example coated in an elastically yielding material, such as the pressure roller 205. The embossing roller 207 presents on its own surface embossing protuberances defining a second sequence of embossing patterns, for example in a number of M, where N and M are numbers prime to each other. The two embossing rollers 203, 207 present different diameters. In one embodiment, with the embossing roller 207 a second color dispenser unit 211 cooperates, for example a printing unit, which applies an ink on the ply V1.

[0075] Arranged downstream of the embossing roller 207 is a third embossing roller 213 cooperating with a third pressure roller 215. 217 indicates a glue dispenser which applies a glue on the embossing protuberances produced by the embossing roller 213. Arranged along the extension of the roller 213 is a laminating unit 219. In the nip defined between the rollers 213 and 219, also the ply V2 is fed in addition to the ply V1, to obtain lamination of the plies themselves.

[0076] In one embodiment, two glue dispensers can be provided, to apply glues different from each other, for examples glues of different color. Preferably, the two glue dispensers are associated with two different embossing rollers. For example, in the diagram of figure 18 the unit 211 can be a glue dispenser, analogously to the dispenser 217. Alternatively, the unit 216 can dispense glue in combination with the unit 217 or with the unit 211. Or also all the units 206, 211, 217 can apply a glue, or the unit

206 applies a glue and the units 211, 217 a color or an ink.

[0077] It is understood that the drawing merely shows illustrating and non-limiting examples of the invention, which may vary in forms and arrangements without however departing from the scope of the concept on which the invention is based. Any reference numbers in the appended claims are provided purely to facilitate reading in the light of the description hereinbefore and of the accompanying drawings, and do not limit the scope of protection of the claims whatsoever.

Claims

1. A web product comprising at least a ply decorated by embossing, **characterized in that** along the extension of said web product variable combinations of at least two sequences of embossing patterns come after each other.
2. Web product as claimed in claim 1, **characterized in that** a first of said sequences is formed by a first number of embossing patterns different from each other and a second of said sequences is formed by a second number of embossing patterns different from each other, said first and said second number being numbers prime to each other.
3. Web product as claimed in claim 2, **characterized in that** said two sequences do not present equal sub-sequences of embossing patterns.
4. Product as claimed in claim 1, 2, or 3, **characterized in that** it is subdivided into sheets, each sheet presenting a combination of patterns of said two sequences.
5. Product as claimed in claim 4, **characterized in that** said sheets form a continuous web and are subdivided one from the other by perforation lines, along which said sheets can be separated one from the other.
6. Product as claimed in claim 5, **characterized in that** it is wound in a roll.
7. Product as claimed in one or more of the previous claims, **characterized in that** it comprises at least two plies joined to each other.
8. Product as claimed in claim 7, **characterized in that** on a first of said plies a sequence of patterns is provided and that on a second of said plies a second sequence of patterns is provided, said two sequences presenting lengths different from each other.
9. Product as claimed in claim 8, **characterized in that** said at least two sequences each present a length

equal to a multiple of a dimension of said sheets and differ by a length equal to at least a multiple of said dimension.

10. Product as claimed in claim 7, 8 or 9, **characterized in that** said plies are joined to each other by means of glue. 5
11. Product as claimed in claim 10, **characterized in that** a first glue is applied on the embossing pattern of the first ply and a second glue is applied on the embossing pattern of the second ply. 10
12. Product as claimed in claim 11, **characterized in that** said first and second glues are of different colors from each other. 15
13. Product as claimed in claim 10, **characterized in that** a first glue is applied on at least one of said plies and a color is applied on the other of said plies in correspondence of the embossing. 20
14. Product as claimed in claim 13, **characterized in that** said glue is colored and has a different coloring with respect to said color. 25
15. Product as claimed in claim 10, **characterized in that** on at least one of said plies a glue and a dye is applied. 30
16. Product as claimed in claim 15, **characterized in that** on said ply is applied a colored glue and a dye of color different with respect to said glue. 35
17. Product as claimed in claim 15 or 16, **characterized in that** said glue is applied on embossing patterns of a first sequence and said dye is applied on embossing patterns of a second sequence. 40
18. Product as claimed in one or more of claims 7 to 17, **characterized in that:** 45
 - along a first ply of said web a first sequence of embossing motifs is provided, with a first number of patterns at least partially different from each other, each of which is applied on at least one of said sheets;
 - along a second ply of said web a second sequence of embossing motifs is provided, with a second number of patterns at least partially different from each other, each of which is applied on at least one of said sheets, said second number being different from said first number;
 - each sheet is decorated with a combination of a first pattern of the first embossed sequence on the first ply and of a second pattern of the second sequence embossed on the second ply. 50

19. Product as claimed in one or more of the previous claims, **characterized in that** said first sequence and said second sequence of patterns are applied in a repetitive manner.
20. Product as claimed in one or more of the previous claims, **characterized in that** said first and said second sequence of patterns present respective successions of patterns at least partially different from each other.
21. Product as claimed in one or more of the previous claims, **characterized in that** the patterns of the first sequence are all different from each other and the patterns of the second sequence are all different from each other.
22. Product as claimed in one or more of the previous claims, **characterized in that** the patterns of the second sequence are at least partially different from the patterns of the first sequence.
23. An embossing unit comprising at least a first embossing roller and a second embossing roller, said first and second embossing roller being provided with protuberances defining embossing patterns; **characterized in that:**
 - on said first embossing roller at least a first sequence of embossing patterns is provided along the circumferential extension of the roller;
 - on said second embossing roller at least a second sequence of embossing patterns is provided along the circumferential extension of the roller;
 - said first sequence and said second sequence have a length equal respectively to a first multiple and to a second multiple of a base length, said first and second multiples being different from each other.
24. Embossing unit as claimed in claim 23, **characterized in that** said first multiple and said second multiple are numbers prime to each other.
25. Embossing unit as claimed in claim 23 or 24, **characterized in that** said first embossing roller and said second embossing roller have diameters different from each other and such that the circumferential extensions of said two rollers differ by a multiple of said base length.
26. Embossing unit as claimed in claim 23 or 24 or 25, **characterized in that** said first embossing roller cooperates with a first pressure roller and said second embossing roller cooperates with a second pressure roller.

27. Embossing unit as claimed in one or more of claims 23 to 26, **characterized in that** said multiple of the base length by which differ the circumferential extensions of said two embossing rollers is equal to 1.
28. Embossing unit as claimed in one or more of claims 23 to 27, **characterized in that** said two sequences of embossing patterns present pattern at least partially different from each other.
29. Embossing unit as claimed in one or more of claims 23 to 28, **characterized in that** each of said sequences is formed by patterns different from each other.
30. Embossing unit as claimed in one or more of claims 23 to 29, **characterized in that** it comprises two paths for at least two plies, a first path developing about the first embossing roller and a second path developing about the second embossing roller.
31. Embossing unit as claimed in claim 30, **characterized in that** a glue dispenser is associated with at least one of said embossing rollers.
32. Embossing unit as claimed in claim 30 or 31, **characterized in that** a respective glue dispenser is associated with each of said first and second embossing rollers.
33. Embossing unit as claimed in claim 32, **characterized in that** said glue dispensers dispense glue of different colors from each other.
34. Embossing unit as claimed in claim 30 or 31, **characterized in that** with one of said embossing rollers is associated a glue dispenser and with the other of said embossing roller is associated a dye dispenser.
35. Embossing unit as claimed in one or more of claims 23 to 34, **characterized in that** each of said first and second embossing roller comprises a plurality of sequences of embossing patterns adjacent to each other along the axial extension of the embossing roller.
36. Embossing unit as claimed in claim 35, **characterized in that** the sequences of patterns adjacent along at least one of said embossing rollers are different from each other with regard to the type of pattern or for arrangement of the sequence of patterns.
37. Embossing unit as claimed in claim 36, **characterized in that** the sequences of embossing patterns axially aligned on each of said embossing rollers present an equal number of embossing patterns.
38. A web material converting line for a, in particular for paper, comprising an embossing unit as claimed in

one or more of claims 23 to 37.

39. A converting line as claimed in claim 38, comprising a perforating unit and a rewinding machine.
40. A conversion line as claimed in claim 38 or 39, comprising a severing machine.
41. An embossing method for embossing a web material, **characterized by** embossing said web material by means of at least a first sequence of embossing patterns and a second sequence of embossing patterns, said two sequences presenting lengths different from each other, so that on said web material a succession of variable combinations of the patterns of said first and second sequence is produced.
42. Method as claimed in claim 41, **characterized in that** said web material is subdivided into a plurality of sheets, each sheet presenting a combination of patterns of said at least a first and a second sequence of patterns.
43. Method as claimed in claim 42, **characterized by** subdividing the web material in single sheets through transverse perforation lines.
44. Method as claimed in claim 43, **characterized by** winding said web material in rolls.
45. Method as claimed in one or more of claims 41 to 44, **characterized in that** said first and said second sequence comprise patterns at least partially different from each other.
46. Method as claimed in one or more of claims 41 to 45, **characterized in that** said first sequence presents a length equal to a first multiple of a base length and said second sequence presents a length equal to a second multiple of a base length, said first and second multiple being different from each other.
47. Method as claimed in claim 46, **characterized in that** said first multiple and said second multiple are numbers prime to each other.
48. Method as claimed in claim 46 or 47, **characterized in that** said first and said second multiple differ by a length equal to said base length.
49. Method as claimed in one or more of claims 41 to 48, **characterized by** applying said patterns of the first and of the second sequence on a same ply of web material.
50. Method as claimed in one or more of claims 41 to 48, **characterized by** embossing a first ply with said first sequence of patterns and a second ply with said

second sequence, and by joining said plies to each other.

51. Method as claimed in claim 50, **characterized in that** said plies are joined by gluing. 5
52. Method as claimed in claim 51, **characterized in that** a first glue is applied on at least a part of the embossing of the first ply and a second glue on at least a part of the embossing of the second ply. 10
53. Method as claimed in claim 52, **characterized in that** said first and second glue present colors different from each other. 15
54. Method as claimed in claim 50 or 51, **characterized by** applying a glue on a first ply and at least a dye on the second ply. 20
55. Method as claimed in claim 54, **characterized by** applying on said ply both a glue and a dye, on different portions of the embossing pattern. 25
56. Method as claimed in claim 51, 54 or 55, **characterized in that** said glue is colored. 30

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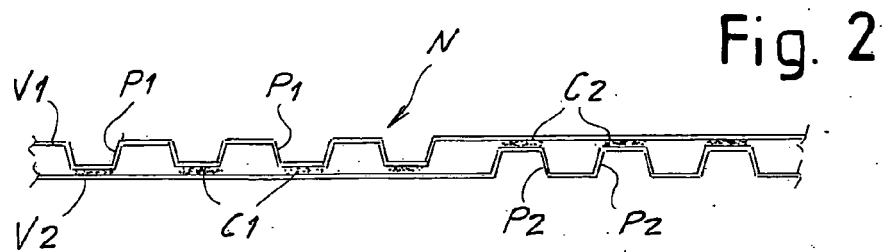
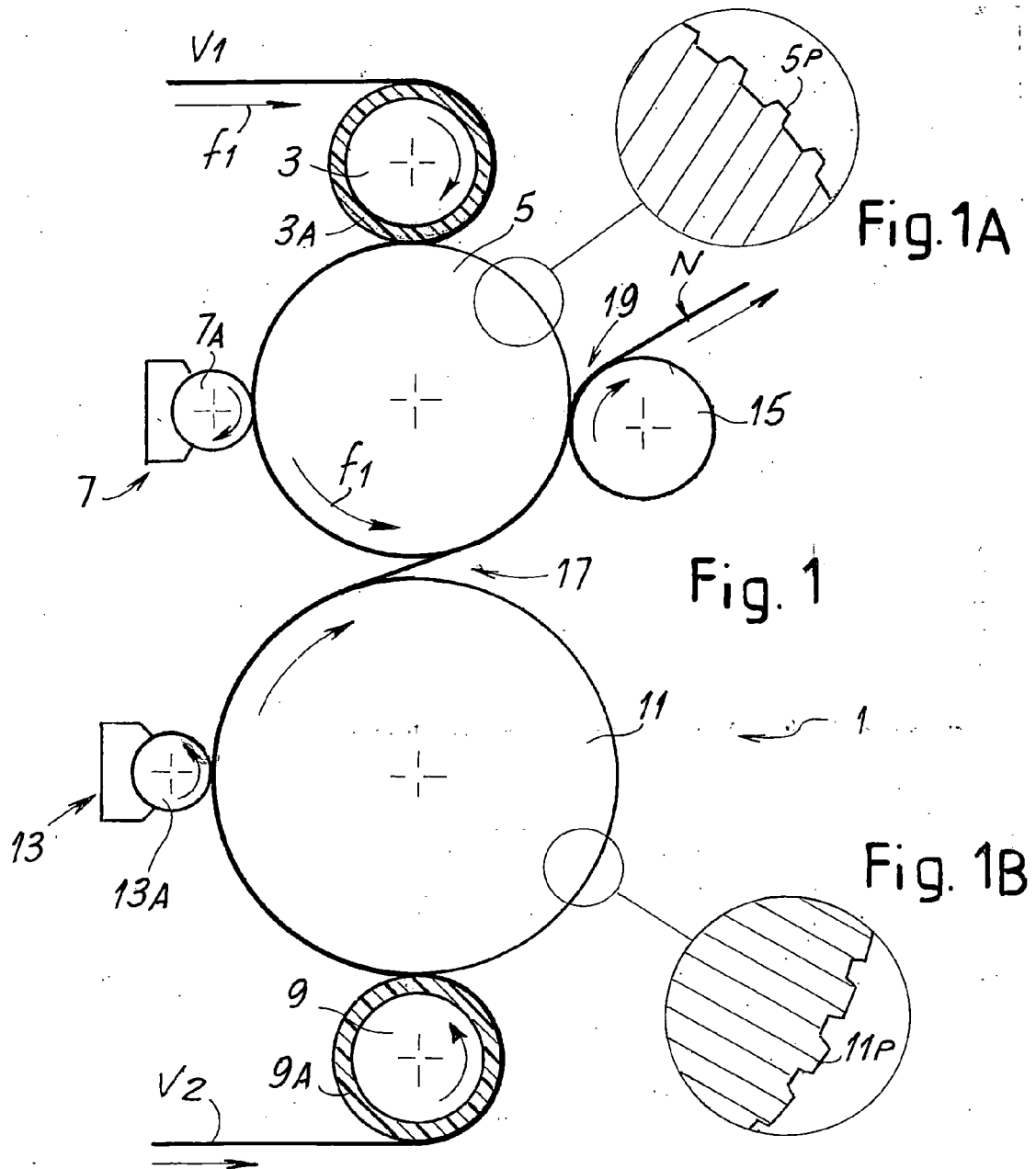
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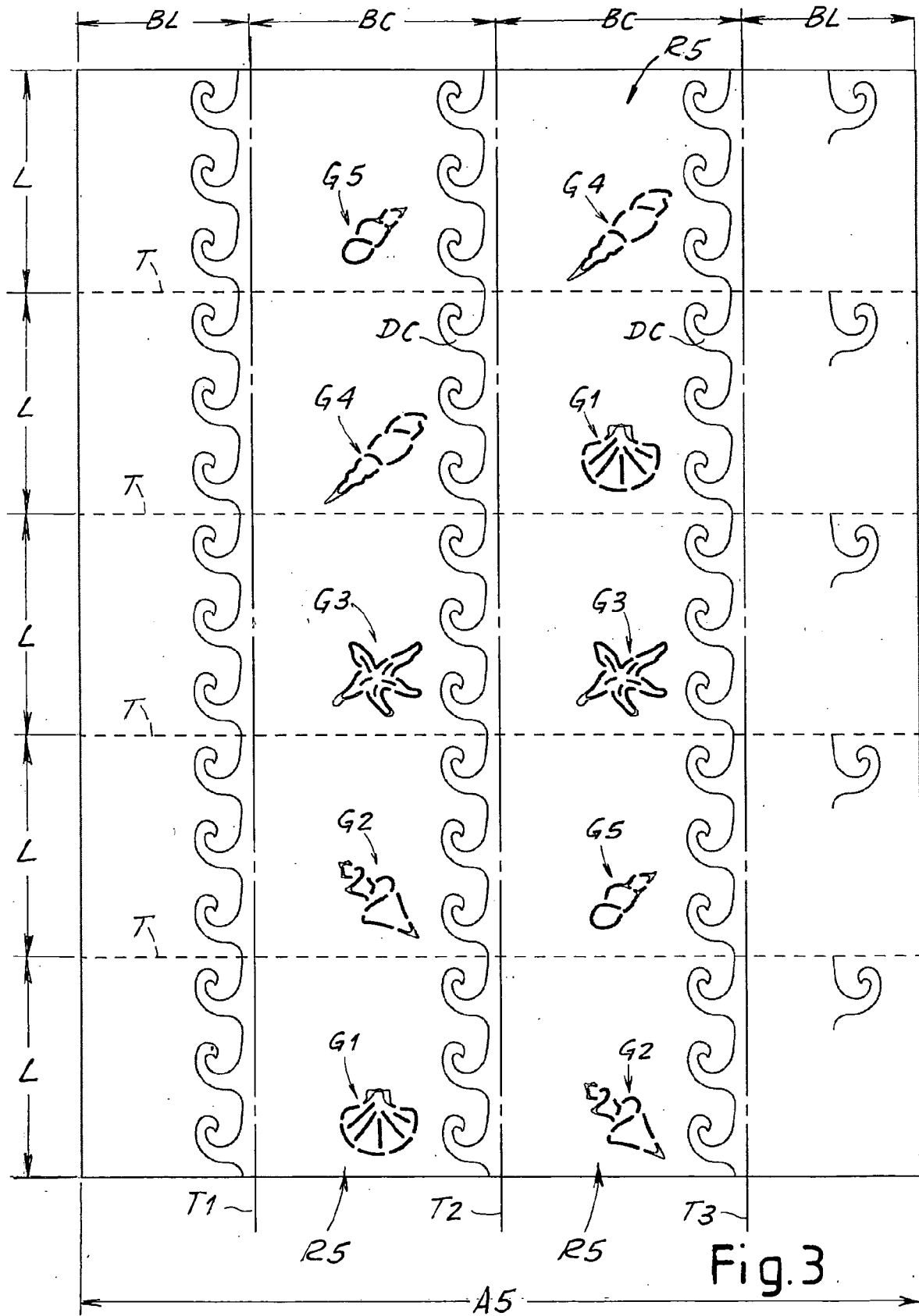
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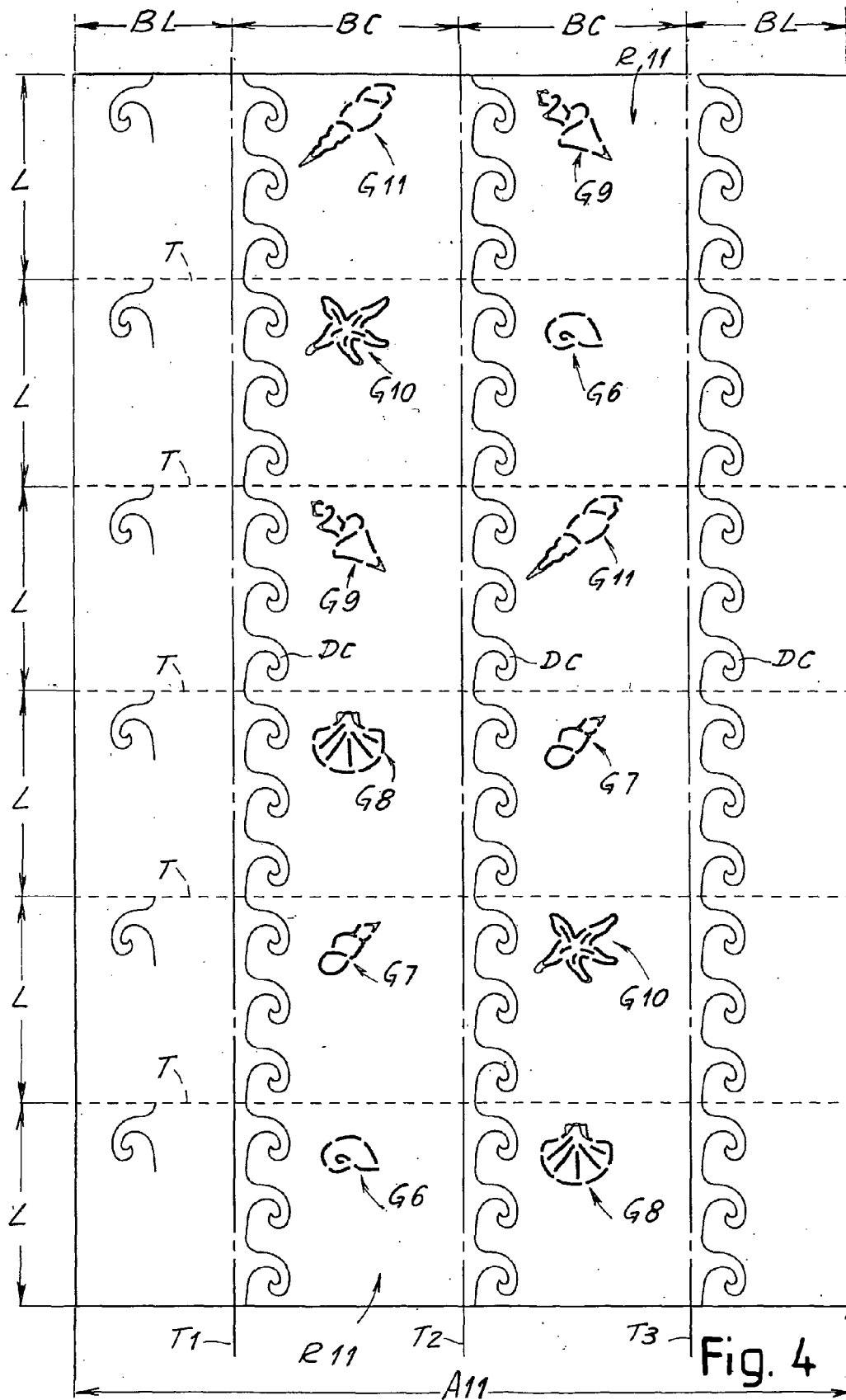
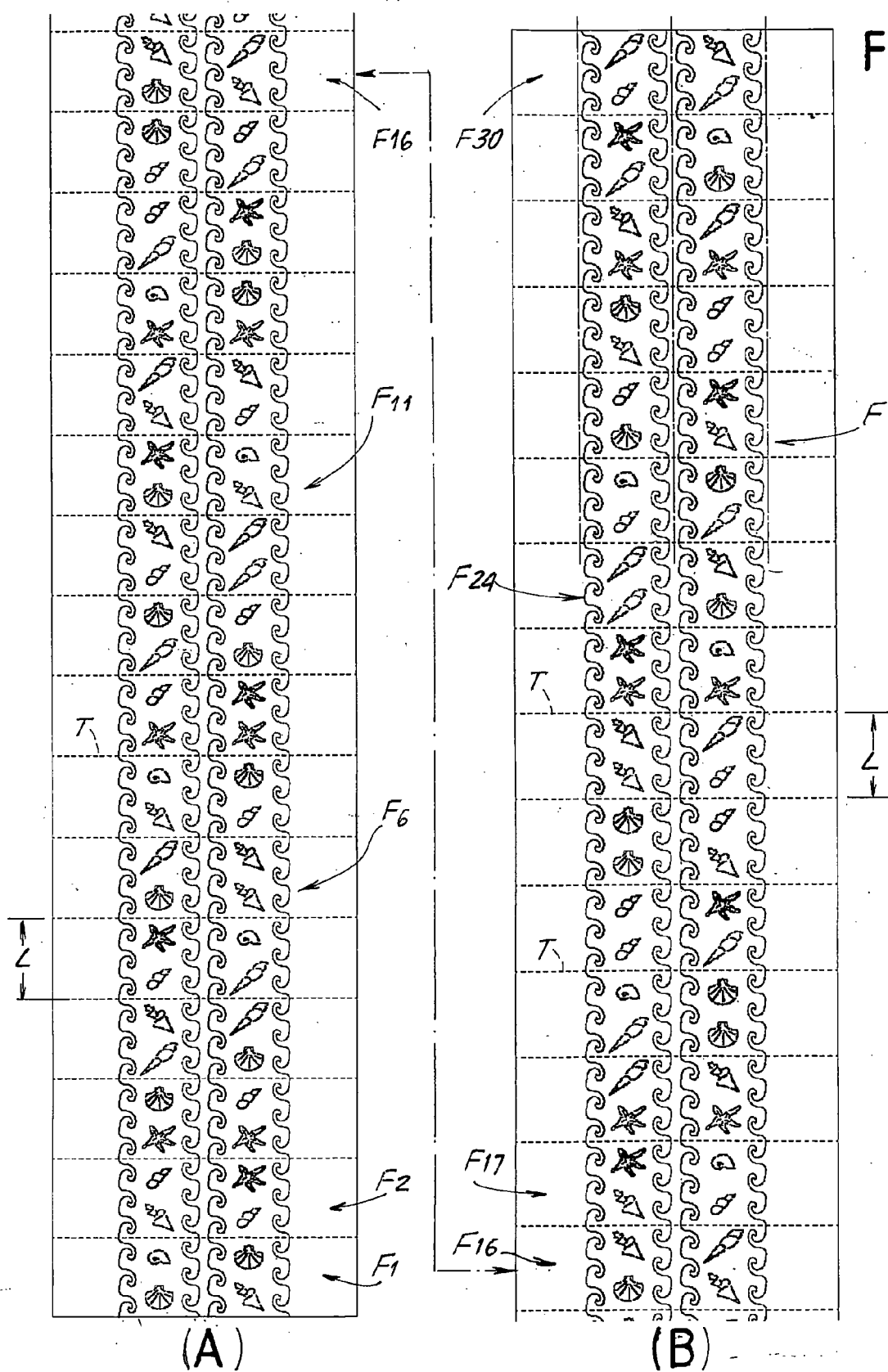
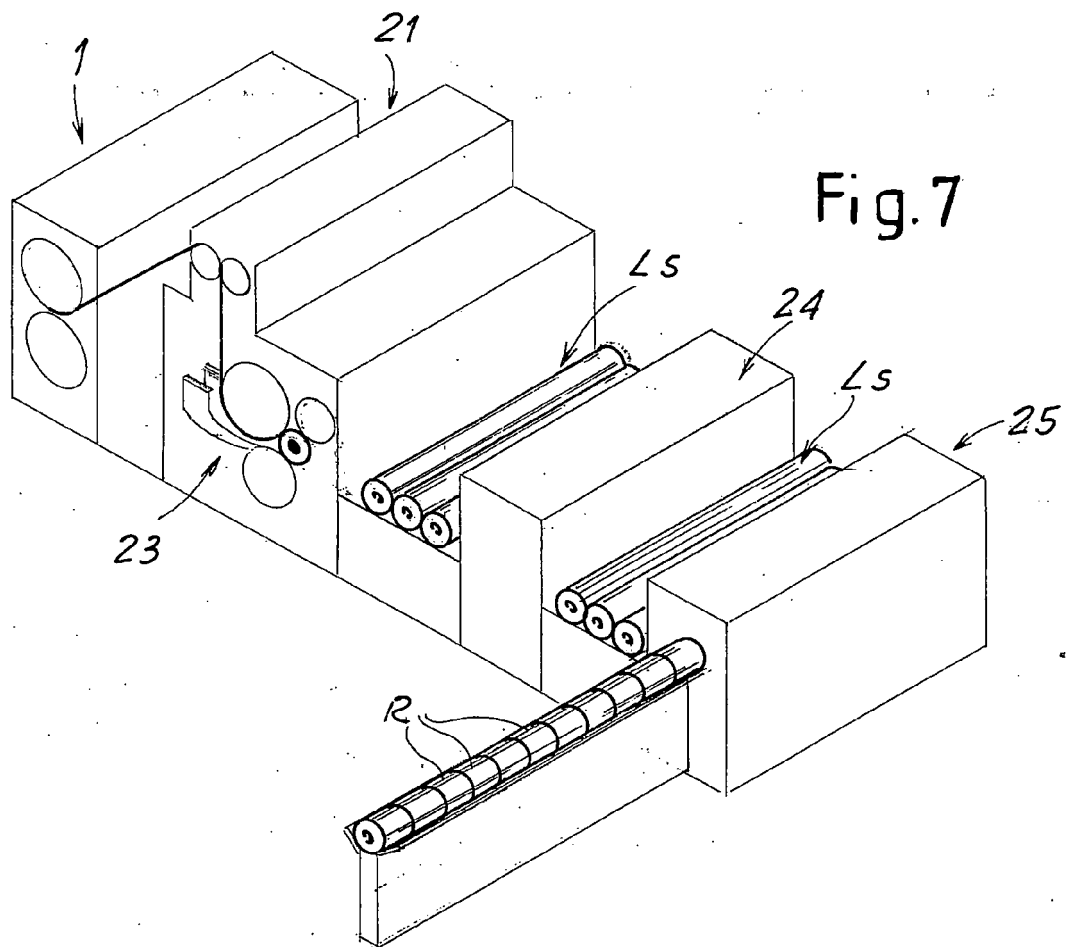
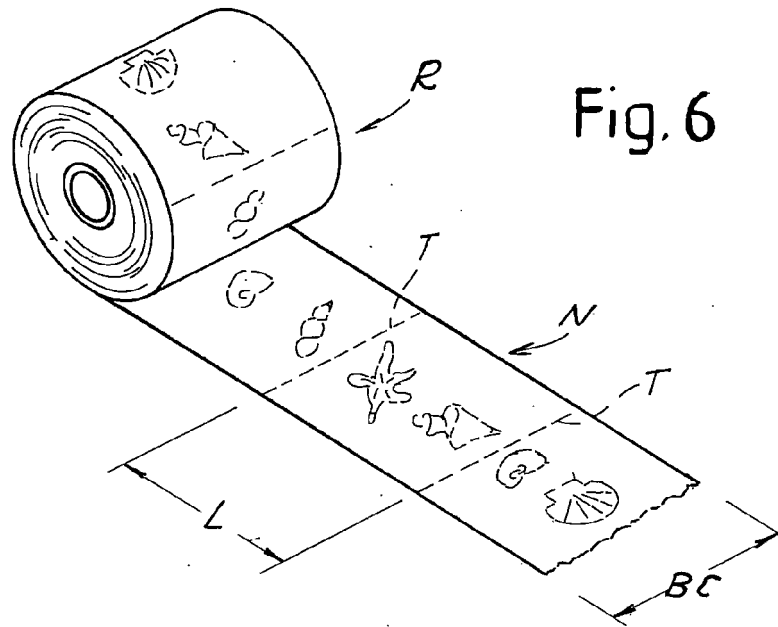
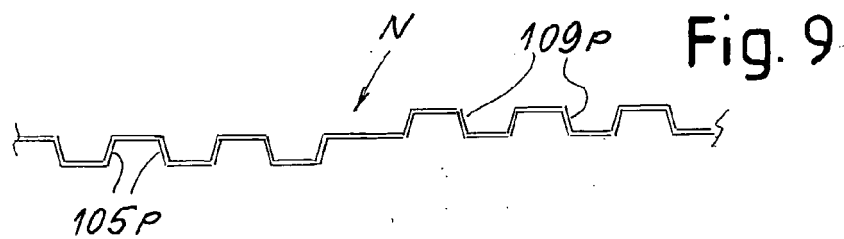
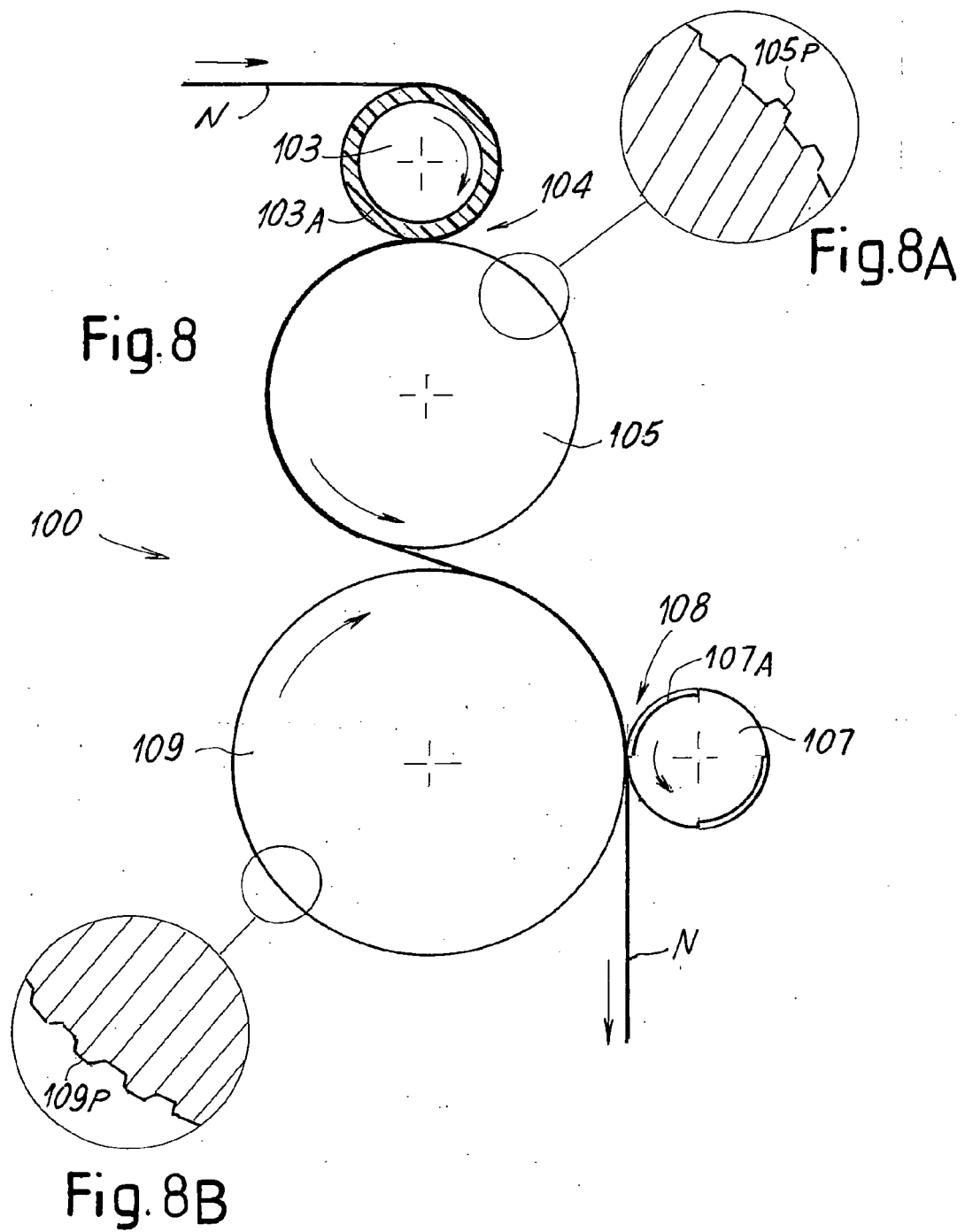
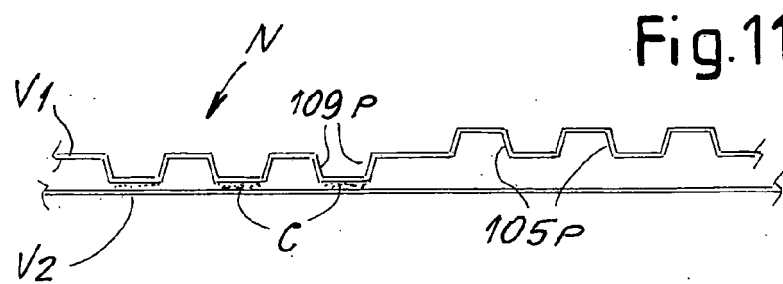
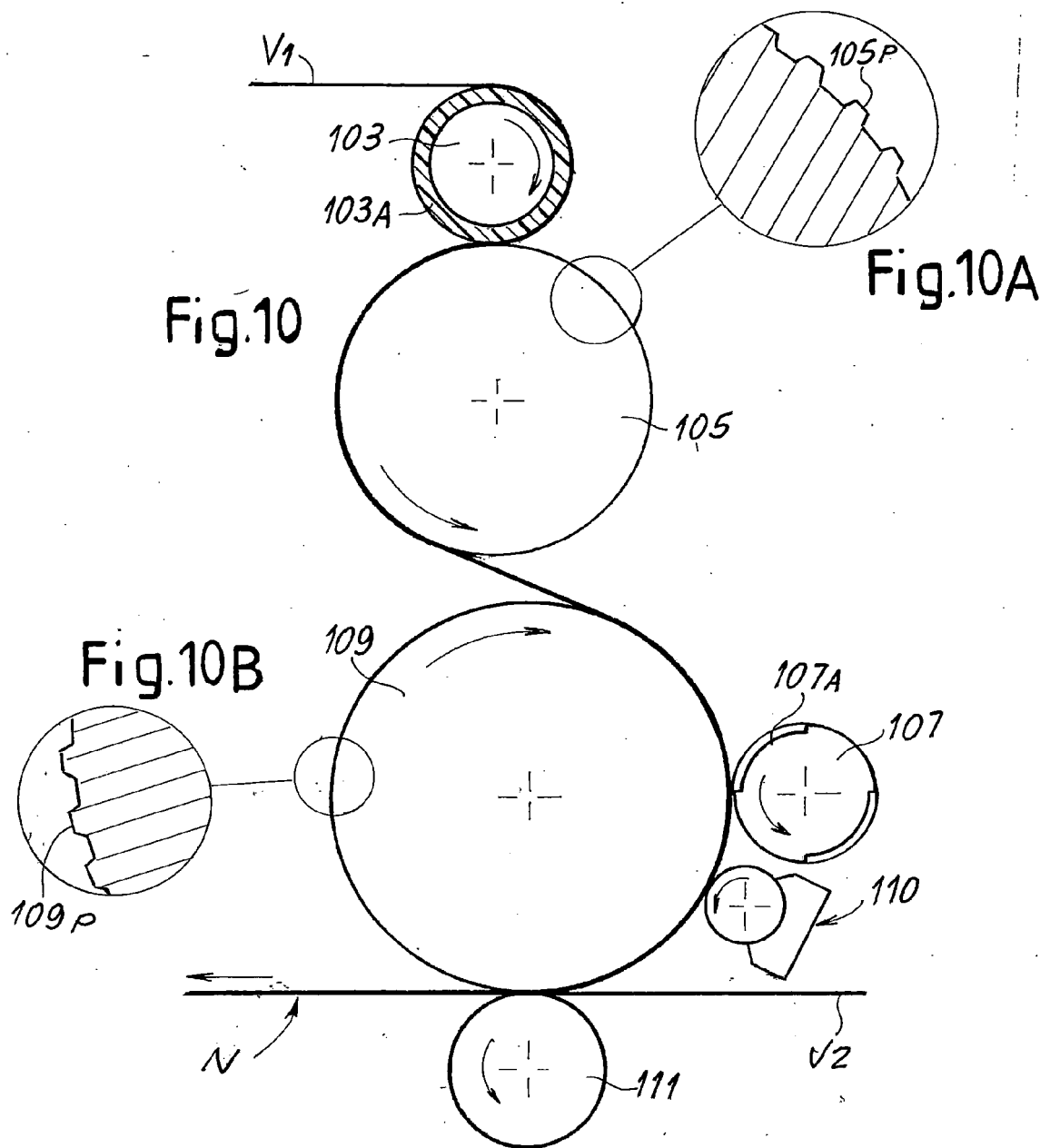


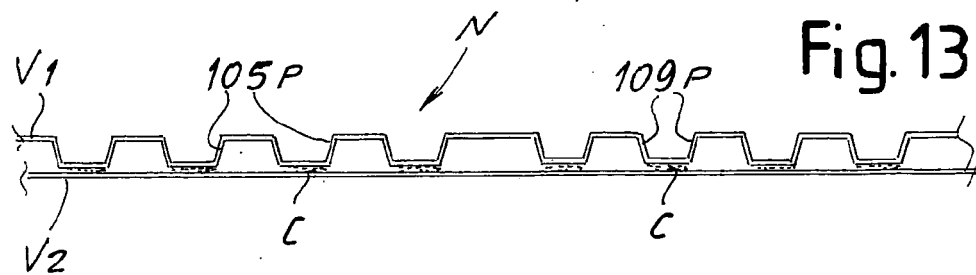
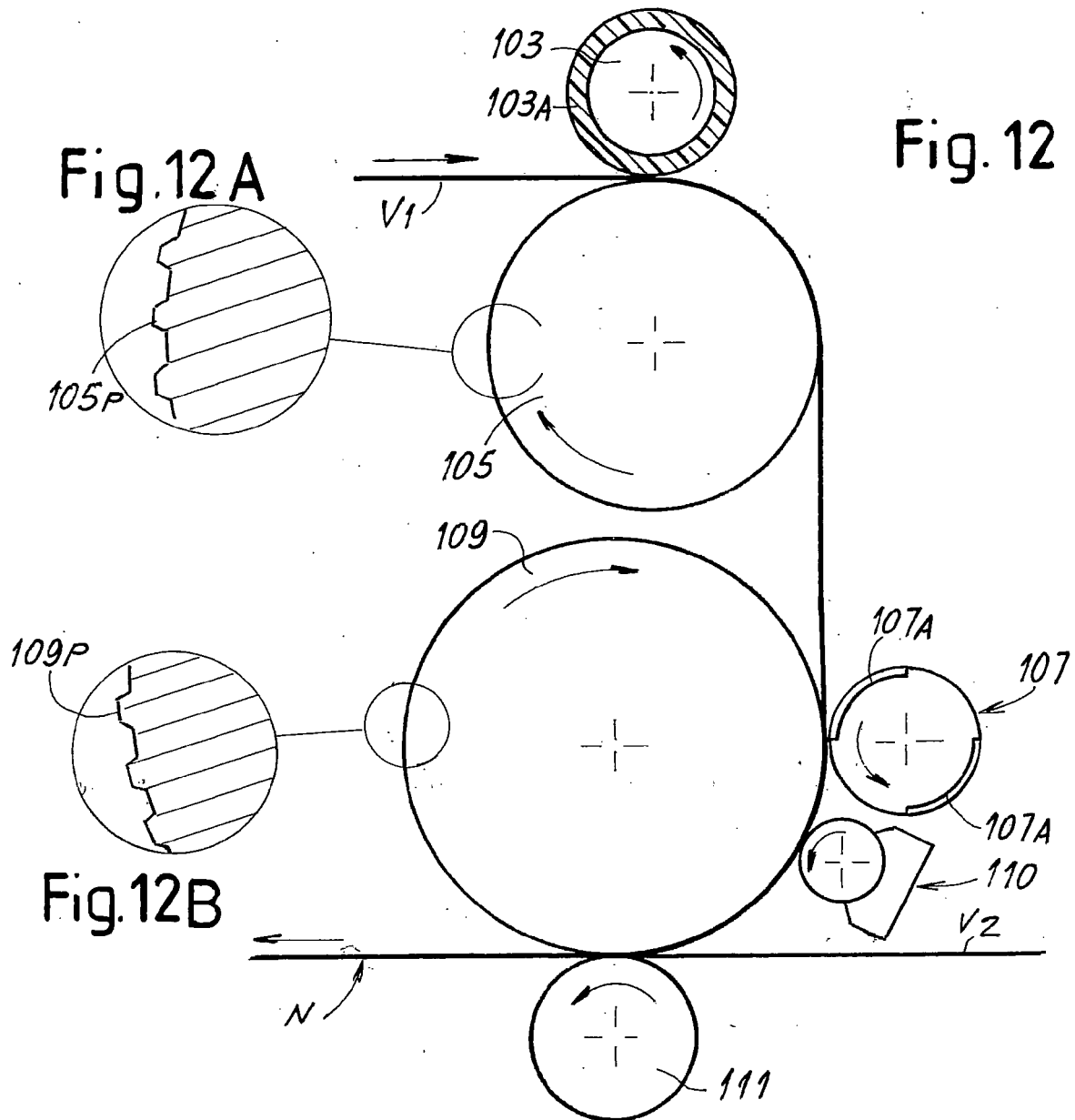
Fig.5

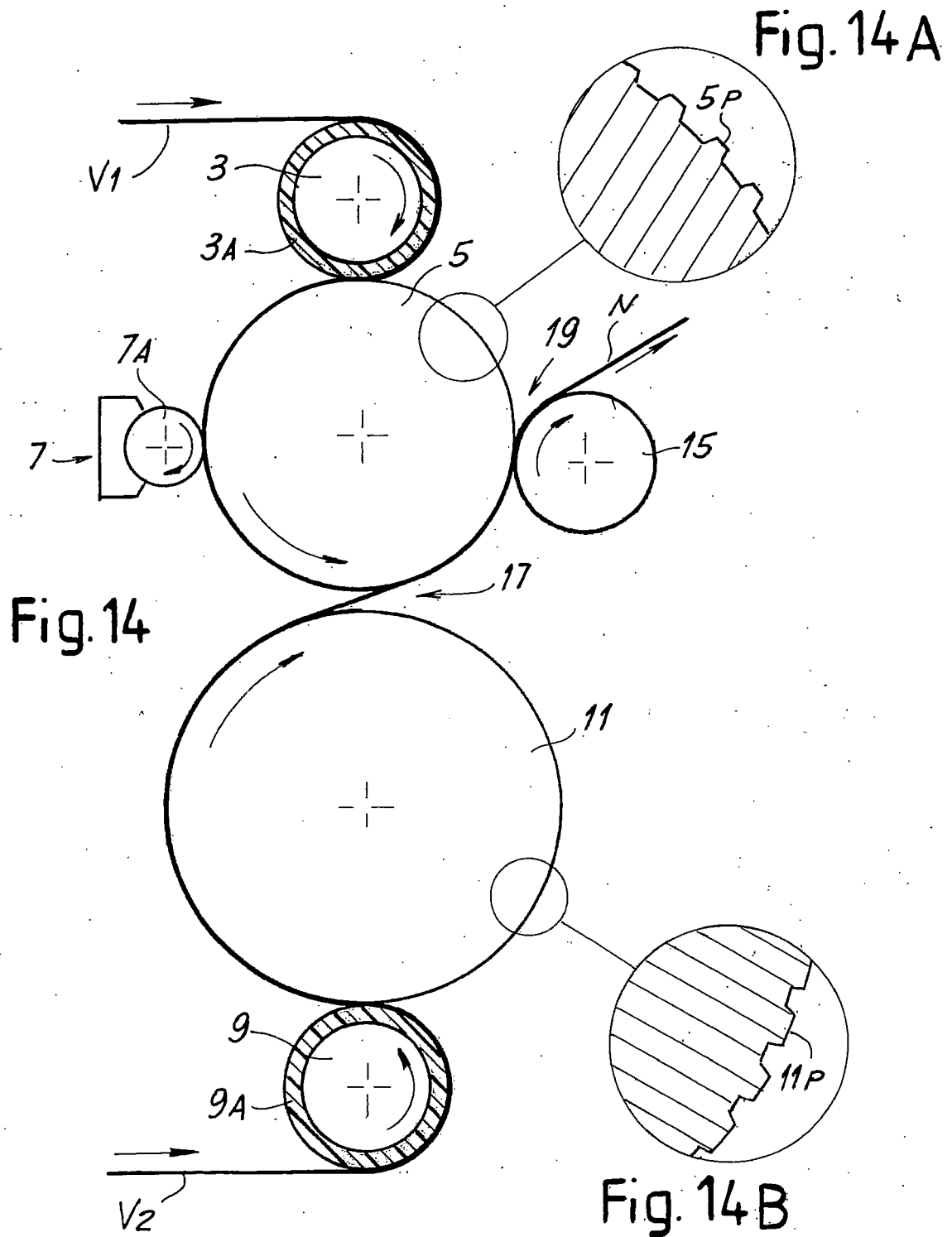












A		A
	A	
A		A
B		B
	B	
B		B
C		C
	C	
C		C
D		D
	D	
D		D

	D	
D		D
	D	
	E	
E		E
	E	
	F	
F		F
	F	
	G	
G		G
	G	
	H	
H		H
	H	

A	D	A
D	A	D
A	D	A
B	E	B
E	B	E
B	E	B
C	F	C
F	C	F
C	F	C

Fig. 15

Fig. 16

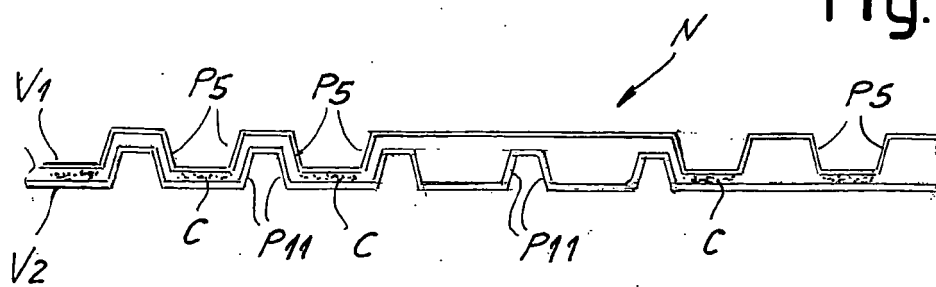
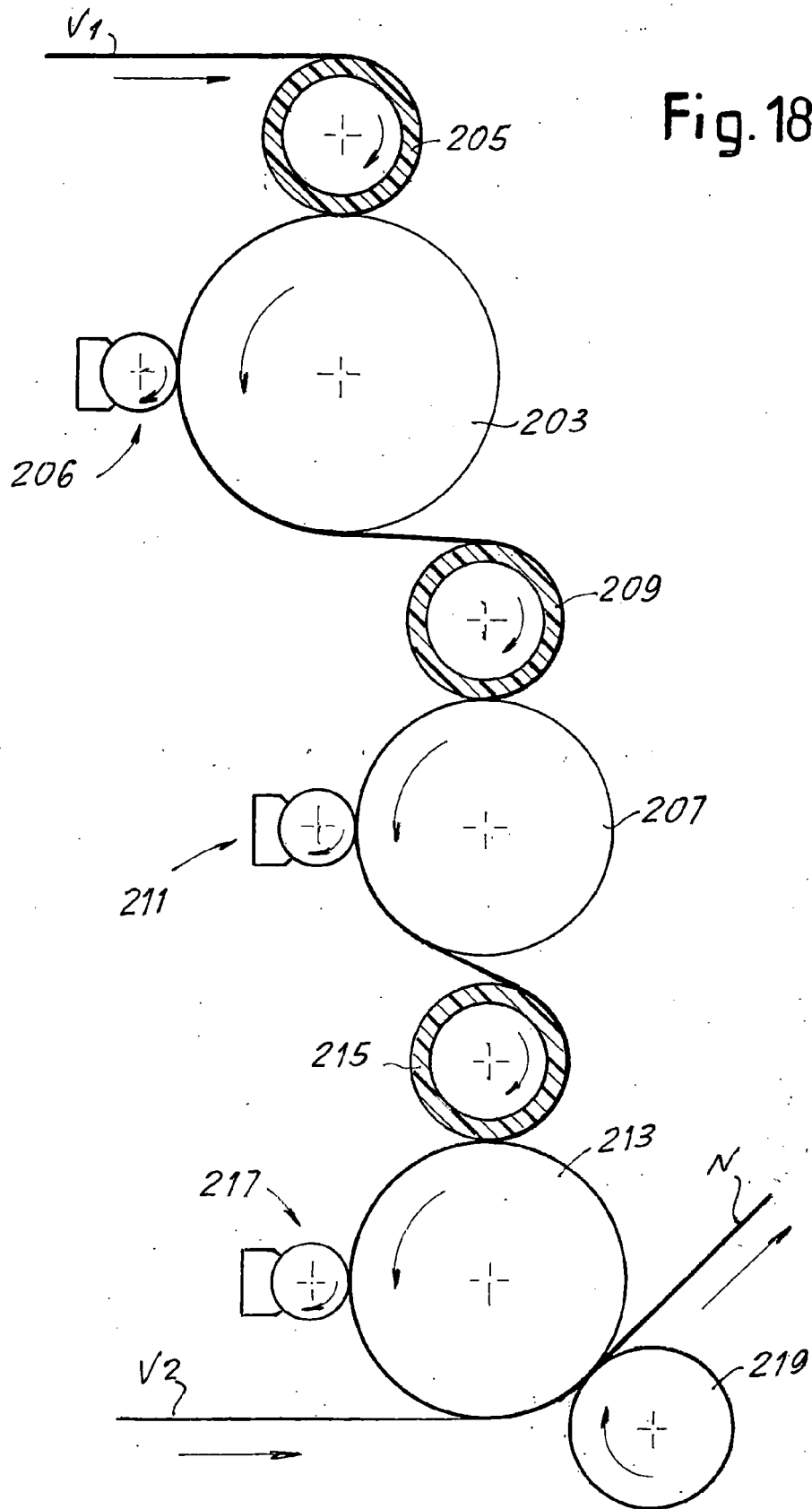


Fig. 17

Fig.18



REFERENCES CITED IN THE DESCRIPTION

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