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(54) Forming fabric having three layers of weft yarns

(57) A fabric for papermaking usable in the forming section of a paper making machine, having a first weft system, a second weft system and a third weft system; and a plurality of warp systems, each warp system having

at least one warp yarn, each warp yarn binding with one of the first weft system, the third weft system, the first and second weft systems, and the second and third weft systems; wherein a first warp system is an exchange warp system.

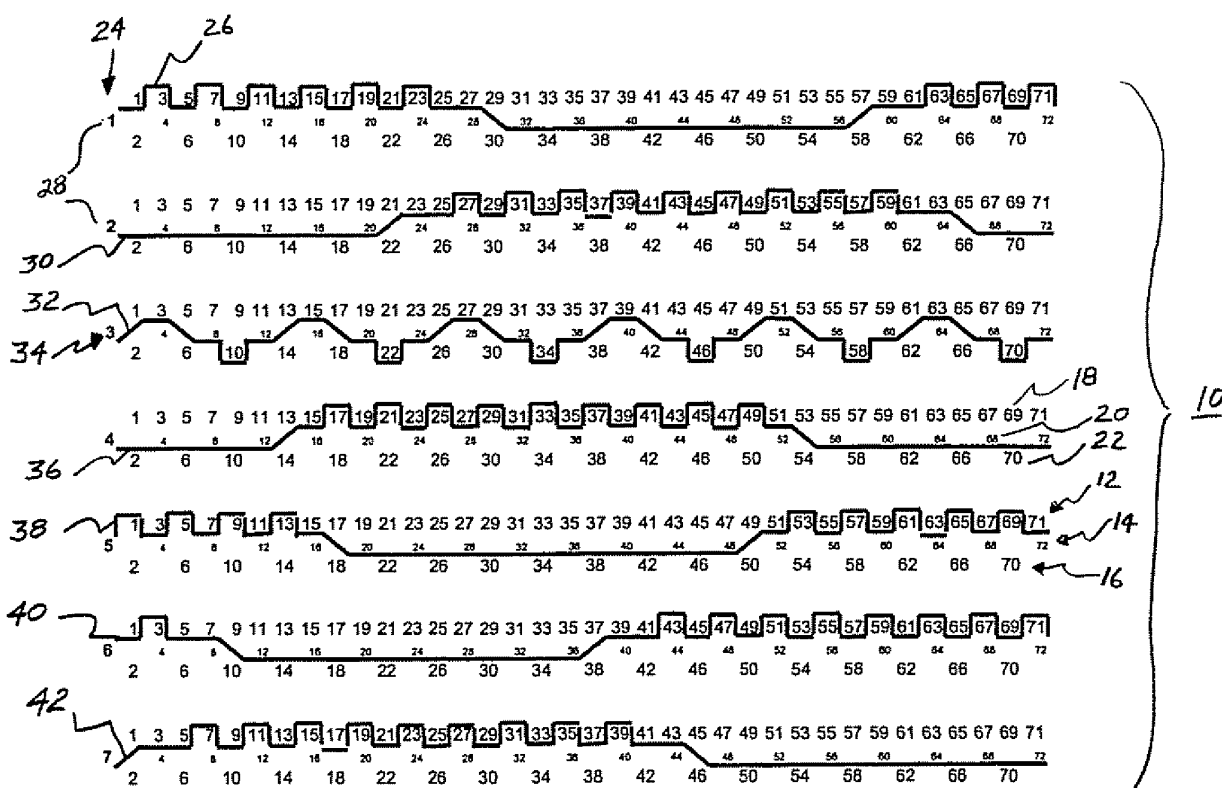


Fig. 1A

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The invention relates to a fabric used in papermaking. More specifically, the present invention relates to forming fabrics used in the forming section of a papermaking machine.

2. Description of Background

[0002] In the art of papermaking, multiple steps occur from the introduction of a pulp slurry to the output of a finished paper product. The initial introduction of the slurry is at the portion of a papermaking machine known as the wet end. Here, the slurry, or fiber suspension, is initially dewatered when the slurry is introduced onto a moving forming fabric, in the forming section of the papermaking machine. Varying amounts of water is removed from the slurry through the forming fabric, resulting in the formation of a fibrous web on the surface of the forming fabric.

[0003] Forming fabrics address not only the dewatering of the slurry, but also the sheet formation, and therefore the sheet quality, resulting from the formation of the fibrous web. More specifically, the forming fabric must simultaneously control the rate of drainage while preventing fiber and other solid components contained in the slurry from passing through the fabric with the water. The role of the forming fabric also includes conveyance of the fibrous web to the press section of the papermaking machine.

[0004] Additionally, if the drainage occurs too rapidly or too slowly, the quality of the fibrous web is reduced, and overall machine production efficiency is reduced. Controlling drainage by way of fabric void volume is one of the fabric design criteria.

[0005] Forming fabrics have been produced to meet the needs and requirements of the various papermaking machines for the various paper grades being manufactured. As the need arises to increase production speed of the papermaking machines and the quality of the paper being produced, the need for improved paper machine clothing allowing for increase production rates and improved quality resulted.

BRIEF SUMMARY OF THE INVENTION

[0006] Accordingly, the present invention is for a fabric used in papermaking, and more particularly, as a forming fabric. In the preferred embodiment, the fabric is a hybrid warp exchange triple layer forming fabric. The fabric has a first weft system, a second weft system and a third weft system, the second weft system between the first and third weft systems. In the finished fabric, the second and third weft systems are preferably in the same plane. The

fabric also has a plurality of warp systems, each warp system having at least one warp yarn. Each warp yarn binds with one of the first weft system, the third weft system, the first and second weft systems, and the second and third weft systems. A first warp system is an exchange warp system. Generally, machine direction (MD) yarns are warp yarns, and cross machine direction (CMD) yarns are weft yarns.

[0007] A weft system is a system of wefts that performs a function. As such, the first weft system can be a paper side weft, a wear side weft or an intermediate weft. In the preferred embodiment, the intermediate weft acts as a binding layer. Still further, the mesh density of the first weft system and the second weft system is independent from the mesh density of the third weft system and the second weft system.

[0008] Still further, the first weft system has a first yarn, the first yarn having a first diameter. Likewise, the second weft system has a second yarn, the second yarn having a second diameter, and the third weft system has a third yarn, the third yarn having a third diameter. The weft and warp yarn materials include, but are not limited to mono filament yarns, synthetic or polyester mono filament yarns, twisted mono filament yarns, twisted synthetic or twisted polyester or twisted polyamide mono filament yarns, twisted multi-filament yarns, twisted synthetic or twisted polyester multi-filament yarns, and others. Various yarn profiles can be employed, including but not limited to yarns having a circular cross sectional shape with one or more diameters, or other cross sectional shapes, for example, non-round cross sectional shapes such as oval, or a polygonal cross sectional shapes, for example diamond, square, pentagonal, hexagonal, septagonal, octagonal, and so forth, or any other shape that the yarns may be fabricated.

[0009] Still further, each warp system can be independent. Each warp layer, has at least one warp yarn, and the at least one warp yarn has a fourth diameter.

[0010] Additionally, each warp system has a predetermined number of warp repeats, ranging from 2 - 112, preferably 2 - 28.

[0011] The triple layer forming fabric of the present invention has exchange warps that do not bind with larger diameter bottom wefts. Rather, they bind with a smaller diameter intermediate weft. All of the warp yarns can be the same diameter or there can be two different warp yarn diameters. In contrast, the warp yarns in the prior art fabrics must all be of the same diameter.

[0012] As a result, the exchange points can be spread out farther than the prior art, resulting in a less obvious pattern. This can be done because the bottom warps bind with the intermediate wefts between the exchanges.

[0013] The warp that weaves only on the bottom, or wear side of the fabric can be of a larger diameter than those that weave on the top, or paper side of the fabric. In this manner the modulus of the fabric is enhanced, and allows for larger diameter bottom wefts to be employed.

[0014] In another embodiment, the fabric has a first weft system, a second weft system and a third weft system, the second weft system between the first and third weft systems. The fabric also has a plurality of warp systems, each warp system having at least one warp yarn. Each warp yarn binds with one of the second weft system and one of the first and third weft systems.

[0015] It is also understood that there are no limitations to the paper grades or former types where this invention can be applied. It is also understood that the fabric can be woven utilizing either two or three warp beams.

[0016] These and other features and advantages of this invention are described in or are apparent from the following detailed description of the preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The preferred embodiments of the present inventions will be described in detail, with reference to the following figures, wherein:

[0018] Figs. 1A-1 B depict a cross-sectional view of a triple layer fabric having a 2:1 warp ratio and a two shed / three shed arrangement according to the present invention;

[0019] Fig. 2 depicts a forming side plan view of a triple layer fabric having a 2:1 warp ratio and a two / three shed arrangement according to the present invention;

[0020] Figs. 3A-3B depict a cross-sectional view of a triple layer fabric having a 2:1 warp ratio and a three shed / three shed arrangement according to the present invention;

[0021] Fig. 4 depicts a forming side plan view of a triple layer fabric having a 2:1 warp ratio and a three / three shed arrangement according to the present invention;

[0022] Figs. 5A-5C depict a cross-sectional view of a triple layer fabric having a 2:1 warp ratio and a two shed / four shed arrangement according to the present invention;

[0023] Fig. 6 depicts a forming side plan view of a triple layer fabric having a 2:1 warp ratio and a two shed / four shed arrangement according to the present invention;

[0024] Figs. 7A-7C depict a cross-sectional view of a triple layer fabric having a 2:1 warp ratio and a two shed / six shed arrangement according to the present invention; and

[0025] Fig. 8 depicts a forming side plan view of a triple layer fabric having a 2:1 warp ratio and a two shed / six shed arrangement according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0026] Figs. 1A-1 B depict a cross-sectional view of a triple layer fabric 10 having a 2:1 warp ratio and a two shed / three shed arrangement according to the present invention, fabricated on a two beam loom. Fig. 2 depicts the forming side plan view of the same fabric 10.

[0027] A first weft system 12 is shown above a second

weft system 14. The first and second weft systems 12, 14 are shown above a third weft system 16. Each weft system 12, 14, 16 is made up of a plurality of yarns 18, 20, 22. First weft yarn 18 has a first yarn diameter, second weft yarn 20 has a second yarn diameter, and third weft yarn 22 has a third yarn diameter. The first, second and third yarn diameters 18, 20, 22 can be the same or different. Different size numerals for each of the different weft layer yarns 18, 20, 22 is indicative of a different weft yarn diameter in the preferred embodiment.

[0028] The first, second and third weft systems 12, 14, 16 are bound together by a plurality of warp systems 24. Figs 1A-1 B show fifteen warp systems 24 in a repeating pattern. Each warp system 24 has at least one warp yarn 26, and each warp yarn 26 is woven in a two shed / three shed repetition.

[0029] The weft and warp yarn materials include, but are not limited to mono filament yarns, synthetic or polyester mono filament yarns, twisted mono filament yarns, twisted synthetic or twisted polyester or twisted polyamide mono filament yarns, twisted multi-filament yarns, twisted synthetic or twisted polyester multi-filament yarns, and others. Various yarn profiles can be employed, including but not limited to yarns having a circular cross sectional shape with one or more diameters, or other cross sectional shapes, for example, non-round cross sectional shapes such as oval, or a polygonal cross sectional shapes, for example diamond, square, pentagonal, hexagonal, septagonal, octagonal, and so forth, or any other shape that the yarns may be fabricated into.

[0030] This first warp yarn 26 binds the top, or first weft 12 with the middle, or second weft 14. A second warp yarn 30 also binds the top, or first weft 12 with the middle, or second weft 14. The first and second warp yarns 26, 30 form what is called an exchange warp. An exchange warp is, for example, when one member of a pair of warp yarns 26, 30 is weaving with the first weft system 12 and the other member of the pair of warp yarns 26, 30 is weaving with the second weft system 14. Stated differently, an exchange warp allows for one warp yarn of a pair of warp yarns to weave in alternate fashion such that when the first warp yarn 26 is weaving with a first weft system 12, the second warp yarn 30 is not weaving with the first weft system 12, and both the first and the second warp yarns are not weaving the same weft at the same time.

[0031] In the present invention, while depicting a plurality of warp systems 24, some yarns of the warp systems form exchange warp pairs and some of the warp systems do not form exchange warp pairs. In Fig. 1, for example, the first warp yarn 26 and the second warp yarn 30 form the first warp system 28, which is an exchange warp pair. In contrast, warp yarn 32 forms a second warp system 34. Accordingly, warp yarn 32 does not cross the second warp yarn 30 of the first warp system 28, and no exchange warp is formed.

[0032] Fig. 2 depicts the forming side plan view of the triple layer fabric 10 having a 2:1 warp ratio and a two

shed / three shed arrangement according to the present invention. In this example, it can be readily seen that the first and second warp yarns 26, 30 form a first warp system, and therefore a warp pair that forms an exchange warp. The x notation marks where the first warp yarn 26 appears in the forming side view forming a knuckle, and y indicates where the second warp yarn 30 appears in the forming side view forming a knuckle. The third warp yarn 32, since it only binds the second weft system 14 with the third weft system 16, does not appear in the forming side plan view. The boxes with forward slash fill denote where warps exchange, and boxes with grey fill denote locations of bottom side warp knuckles. Since the invention is directed to a triple layer fabric, the weave has a separate forming or paper side and a wear side.

[0033] This pattern repeats throughout the forming side plan view. For example, a fourth warp yarn 36 forms an exchange warp with a fifth warp yarn 38. Similarly, a sixth warp yarn 40 forms a warp exchange with a seventh warp yarn 42. An eighth warp yarn 44 does not form an exchange warp with another yarn. Figs. 1A-1 B further show a ninth warp yarn 46, a tenth warp yarn 48, and eleventh warp yarn 50, a twelfth warp yarn 52, and thirteenth warp yarn 54, a fourteenth warp yarn 56, and a fifteenth warp yarn 58. Accordingly, Fig. 2 depicts fifteen warp repeats, with six pairs of exchanging warps and 3 bottom warps. The pattern repeats in both the forming side and the wear side layers. The double forward slashed areas in Fig. 2 show the crossover points of the warp exchange yarns below the forming side surface. The single grey areas in Fig. 2 show the warp yarn exposure on the wear side, that is, a wear side knuckle, not shown.

[0034] Accordingly, the views in Figs. 1A-1 B and 2 show one complete pattern in the machine direction.

[0035] Figs. 3A-3B depict a cross-sectional view of a triple layer fabric having a 2:1 warp ratio and a three shed / three shed arrangement according to the present invention. Fig. 4 depicts the forming side plan view of the triple layer fabric having a 2:1 warp ratio and a three shed / three shed arrangement according to the present invention. As in Figs. 1A-1 B and 2, the first warp yarn 26 forms an exchange warps with the second warp yarn 30. The difference is that the first and second warp yarns 26, 30 have a three shed weave pattern.

[0036] Figs. 5A-5C depict a cross-sectional view of a triple layer fabric having a 2:1 warp ratio and a two shed / four shed arrangement according to the present invention, and Fig. 6 depicts the forming side plan view. Twenty-four warp yarns are shown as 118, 120, 122, 124, 126, 128, 130, 132, 134, 136, 138, 140, 142, 144, 148, 150, 152, 154, 156, 158, 160, 162 and 164. In this embodiment, an additional warp is added that only binds to the top, or first weft system 112, and does not bind with the second or third weft systems 114, 116. These top binding only warps are designated 118, 126, 134, 142, 150 and 158. The boxes in Fig. 6 with the reverse hash fill indicate locations where the bottom warp binds with the binding

weft, or the second weft system.

[0037] Figs. 7A-7C depict a cross-sectional view of a triple layer fabric having a 2:1 warp ratio and a two shed / six shed arrangement according to the present invention, and Fig. 8 depicts the forming side plan view. Twenty-four warp yarns are shown as 218, 220, 222, 224, 226, 228, 230, 232, 234, 236, 238, 240, 242, 244, 246, 248, 250, 252, 254, 256, 258, 260, 262 and 264. In this embodiment, the fabric 10 is woven using a three beam configuration, and has a different weave pattern than that depicted in Figs. 5-6. This pattern shown in Fig. 8 has the additional notation of boxes containing horizontal or vertical fill lines, representing locations where an exchanging warp binds at the second weft layer according to the cross-sectional view of Figs. 7A-7C.

[0038] The invention has been described that can be fabricated on a three beam loom. Likewise, the triple layer fabric of the present invention can also be fabricated on a four beam loom. Use of four beams could result in similar fabrics, with the addition of at least one of a top only warp, a bottom only warp, a bottom warp that binds at the second weft system, and a top pair that binds with the second weft system.

[0039] While the present invention has been particularly shown and described with reference to the foregoing preferred embodiments, those skilled in the art will understand that many variations may be made therein without departing from the spirit and scope of the invention as defined in the following claims. This description of the invention should be understood to include all novel and non-obvious combinations of elements described herein, and claims may be presented in this or a later application to any novel and non-obvious combination of these elements. The foregoing embodiments are illustrative, and no single feature or element is essential to all possible combinations that may be claimed in this or a later application. Where the claims recite "a" or "a first" element or the equivalent thereof, such claims should be understood to include incorporation of one or more such elements, neither requiring nor excluding two or more such elements.

Claims

1. A fabric for papermaking comprising:

- a first weft system, a second weft system and a third weft system; and
- a plurality of warp systems, each warp system having at least one warp yarn, each warp yarn binding with one of the first weft system, the third weft system, the first and second weft systems, and the second and third weft systems;

wherein a first warp system is an exchange warp system.

2. The fabric for papermaking of claim 1, wherein the first weft system is one of a paper side weft, a wear side weft and an intermediate weft.
3. The fabric for papermaking of claim 1, wherein each warp system is independent.
4. The fabric for papermaking of claim 1, wherein mesh density of the first weft system and the second weft system is independent from a mesh density of the third weft system and the second weft system.
5. The fabric for papermaking of claim 1, wherein the fabric is fabricated using a plurality of shafts ranging from 4 to 56.
6. The fabric for papermaking of claim 1, wherein the first weft system has a first yarn having a first diameter, the second weft system has a second yarn having a second diameter and the third weft system has a third yarn having a third diameter.
7. The fabric for papermaking of claim 1, wherein the at least one warp yarn has a fourth diameter.
8. The fabric for papermaking of claim 1, wherein the yarn is one of a mono filament and a twisted pair.
9. The fabric for papermaking of claim 1, wherein warp repeats range from 2 to 112.
10. The fabric for papermaking of claim 1, wherein the fabric is fabricated using a loom having at least three warp beams.
11. A fabric for papermaking comprising:
 - a first weft system, a second weft system and a third weft system,
 - the second weft system between the first and third weft systems; and
 - a plurality of warp systems, each warp system having at least one warp yarn, each warp yarn binding with the second weft system and one of the first and third weft systems.
12. The fabric for papermaking of claim 11, wherein the first weft system is one of a paper side weft, a wear side weft and an intermediate weft.
13. The fabric for papermaking of claim 11, wherein each warp system is independent.
14. The fabric for papermaking of claim 11, wherein mesh density of the first weft system and the second weft system is independent from a mesh density of the third weft system and the second weft system.
15. The fabric for papermaking of claim 11, wherein the fabric is fabricated using a plurality of shafts ranging from 4 to 56.
16. The fabric for papermaking of claim 11, wherein the first weft system has a first yarn having a first diameter, the second weft system has a second yarn having a second diameter and the third weft system has a third yarn having a third diameter.
17. The fabric for papermaking of claim 11, wherein the at least one warp yarn has a fourth diameter.
18. The fabric for papermaking of claim 11, wherein the yarn is one of a mono filament and a twisted pair.
19. The fabric for papermaking of claim 11, wherein warp repeats range from 2 to 112.
20. The fabric for papermaking of claim 11, wherein the fabric is fabricated using a loom having at least three warp beams.

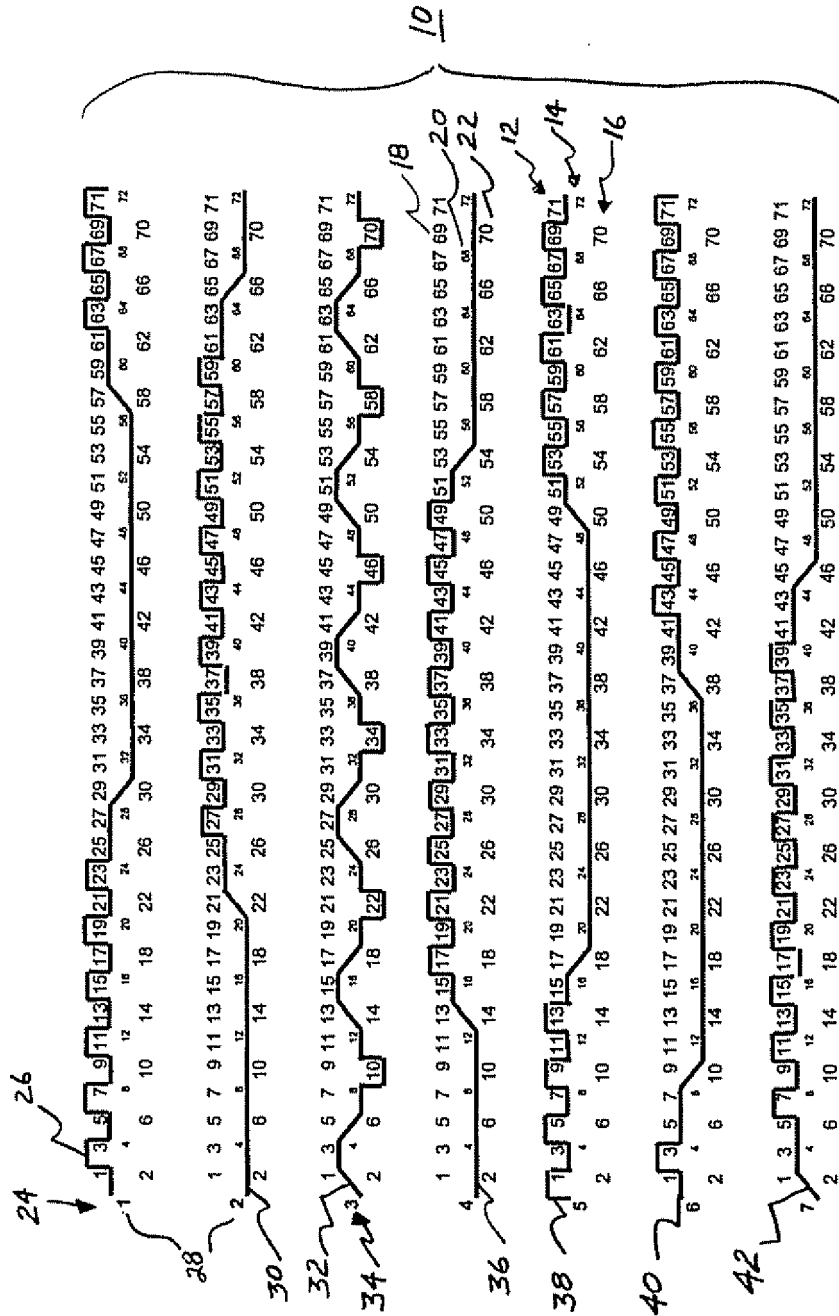


Fig. 1A

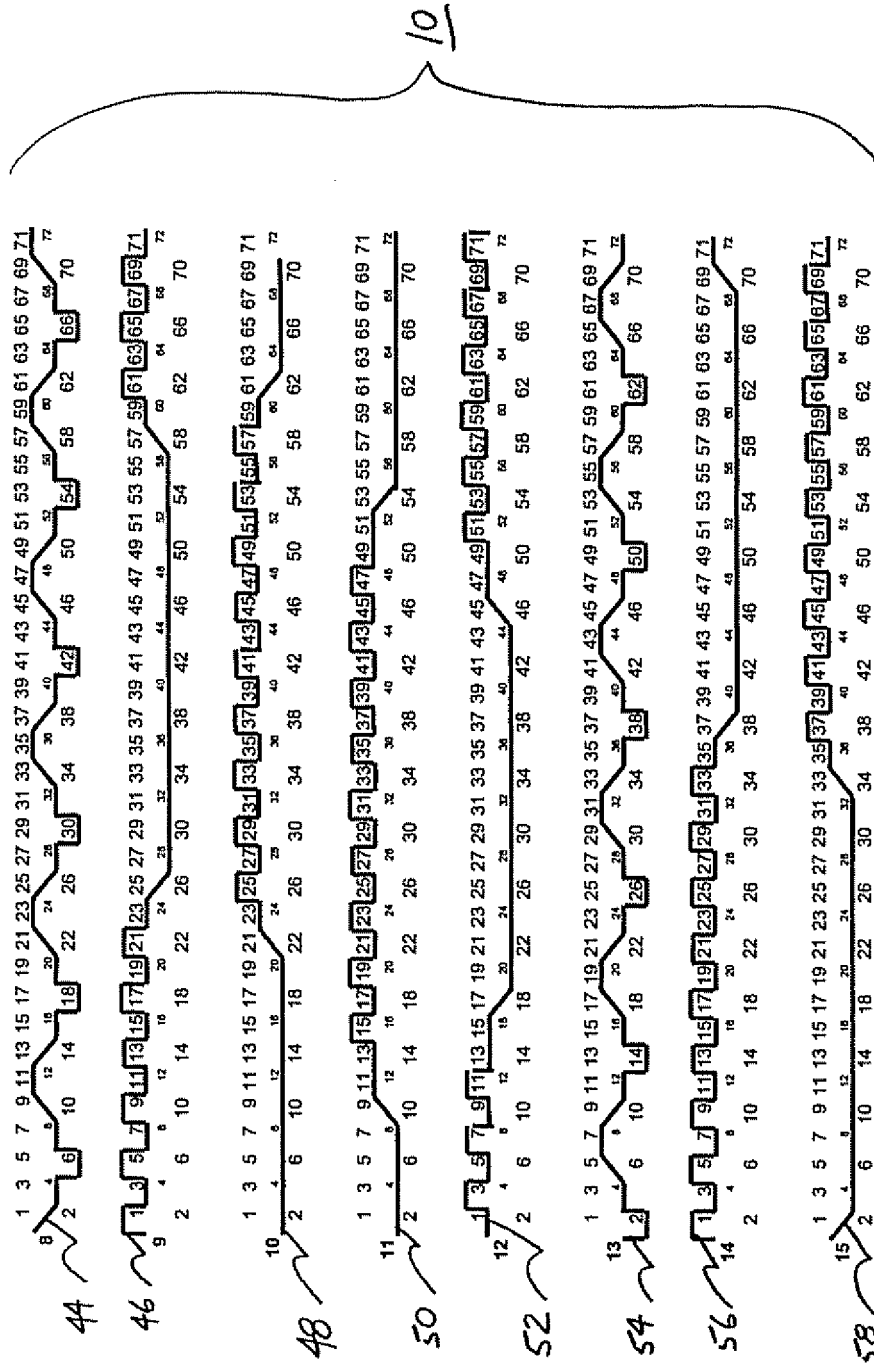


Fig. 1B

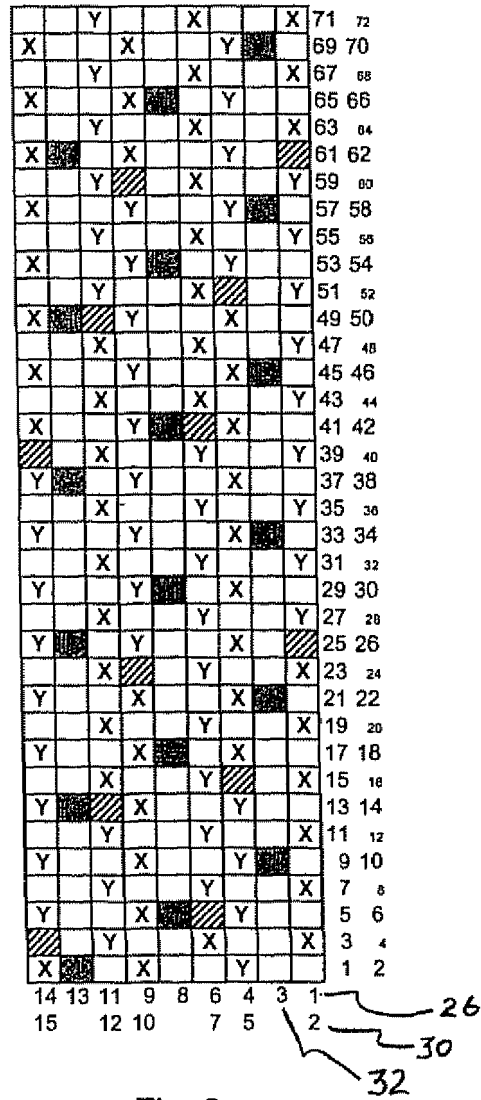


Fig. 2

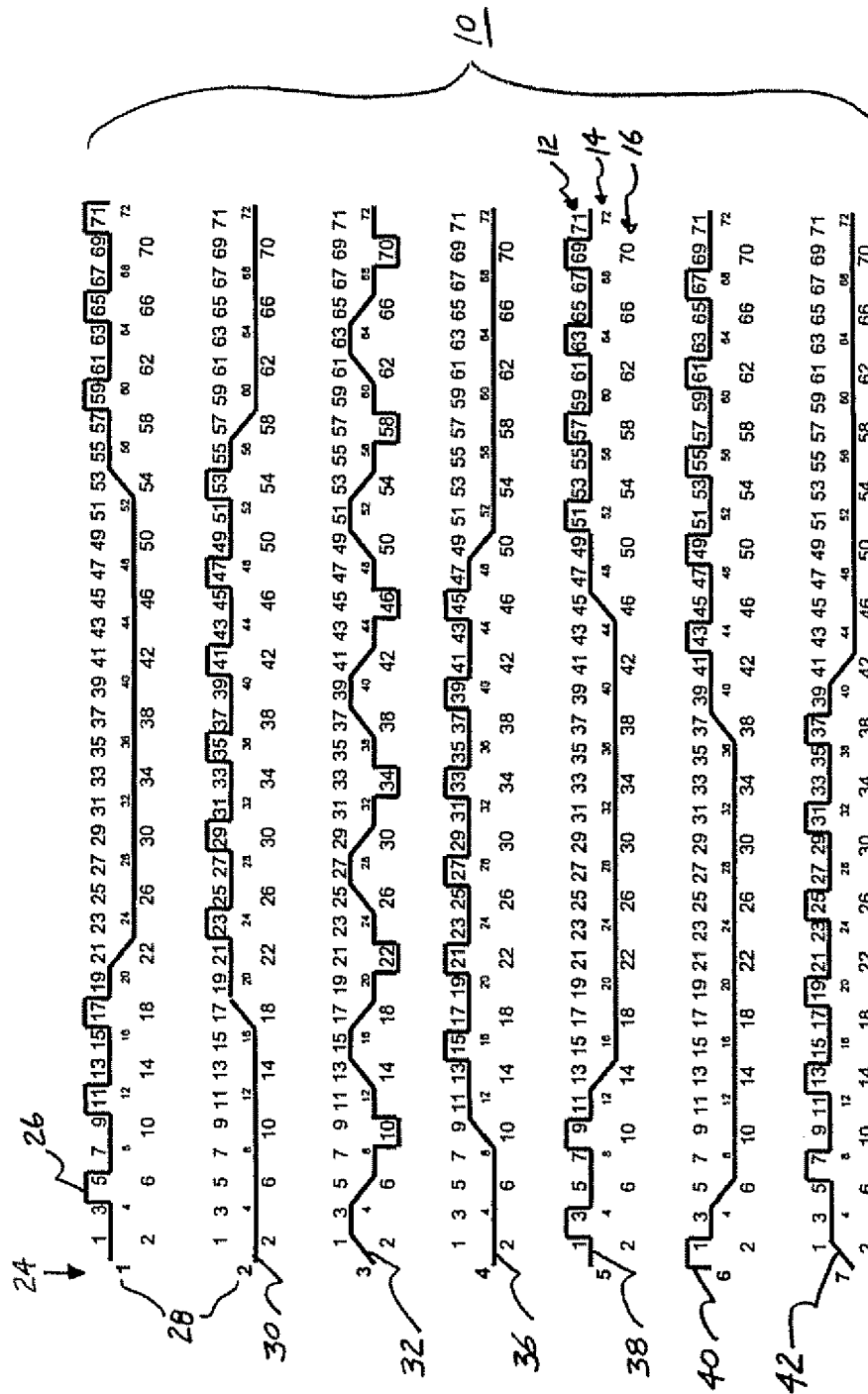
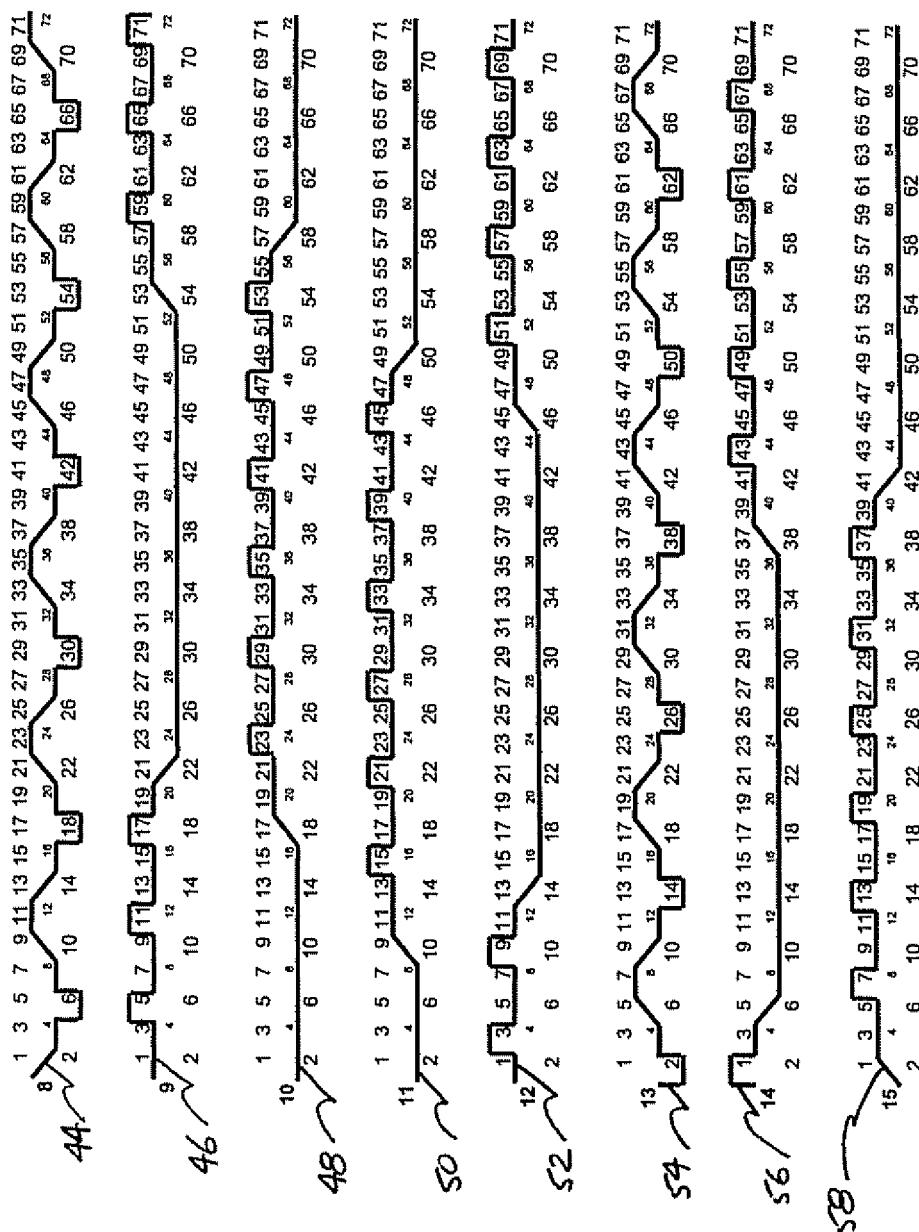
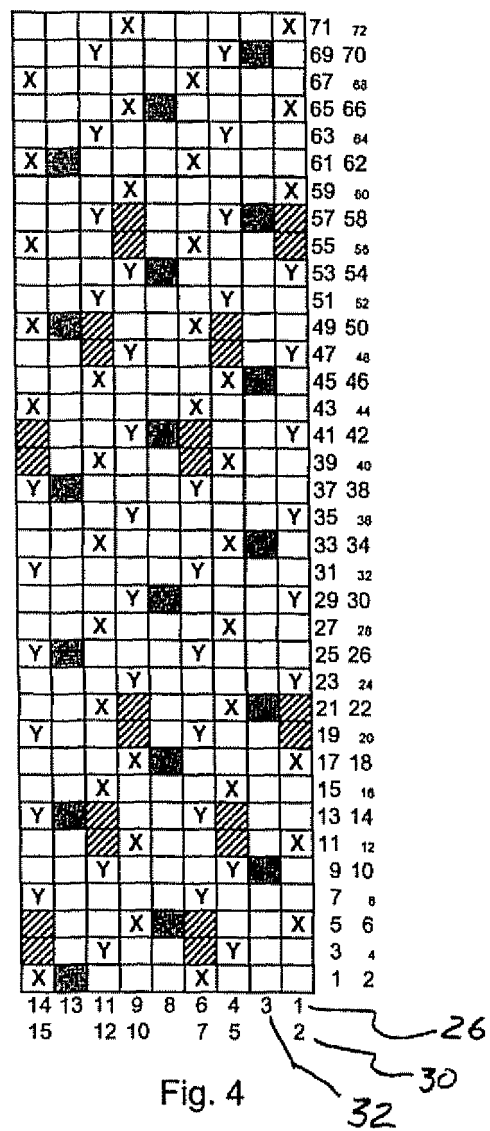


Fig. 3A





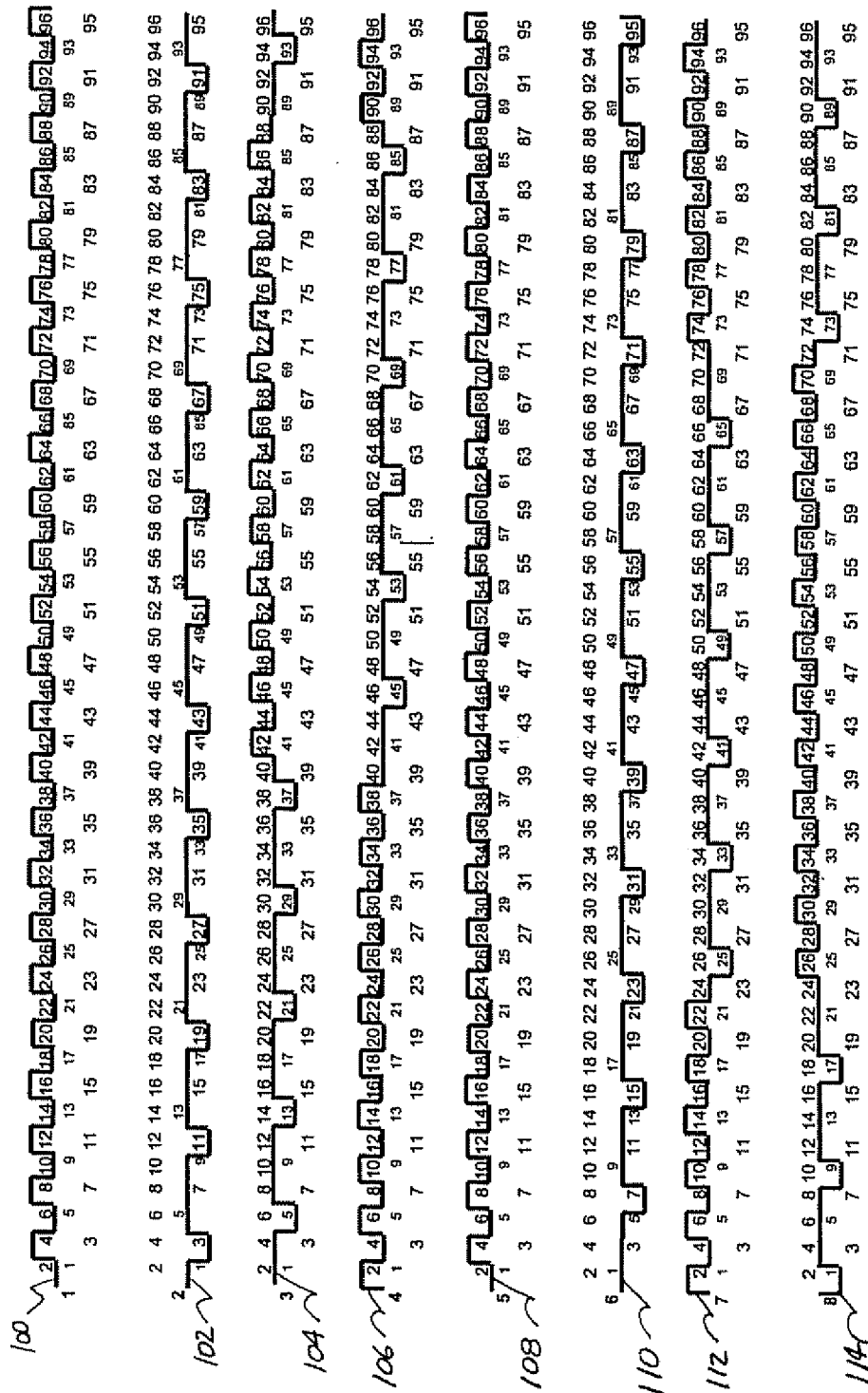


Fig. 5A

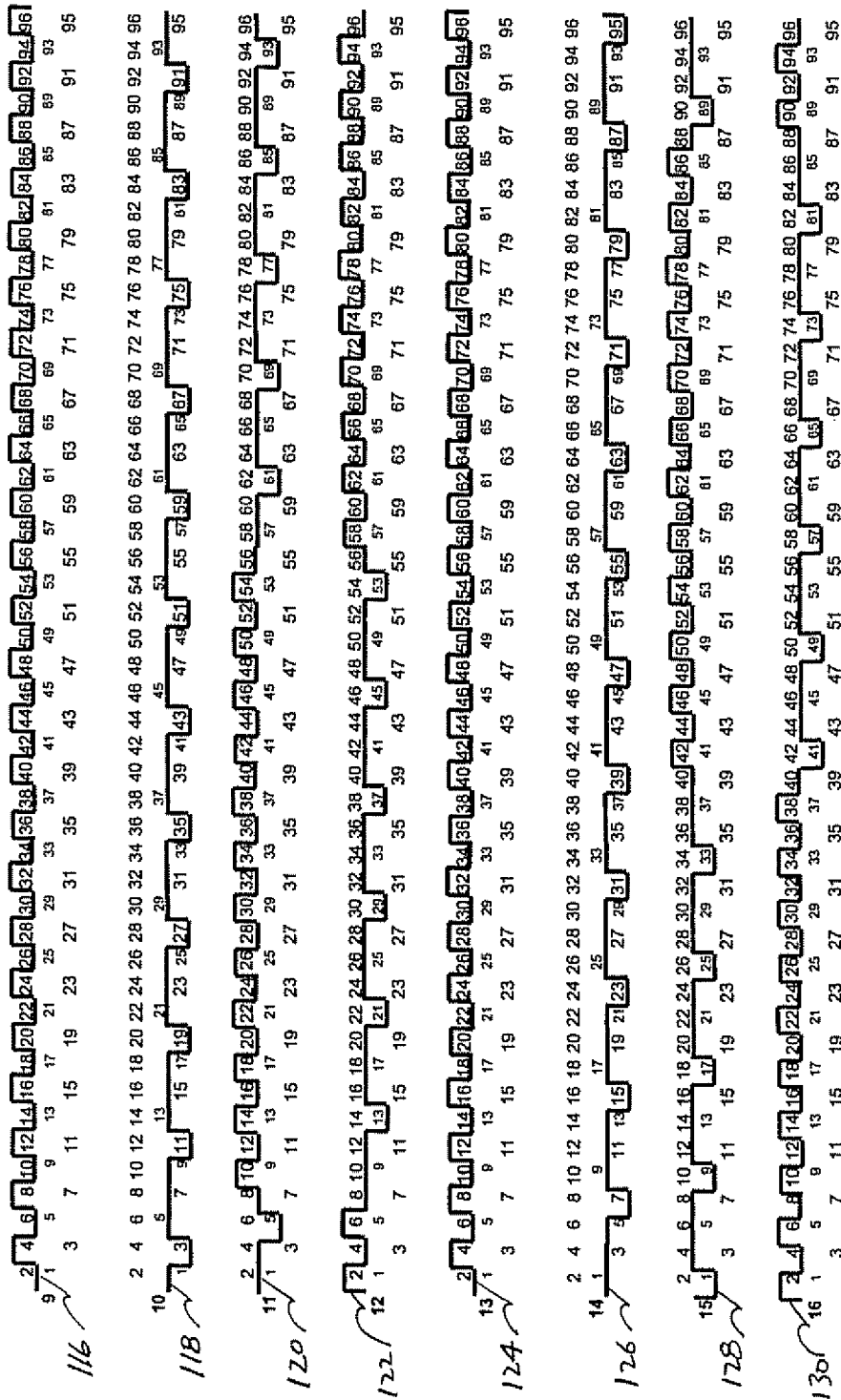


Fig. 5B

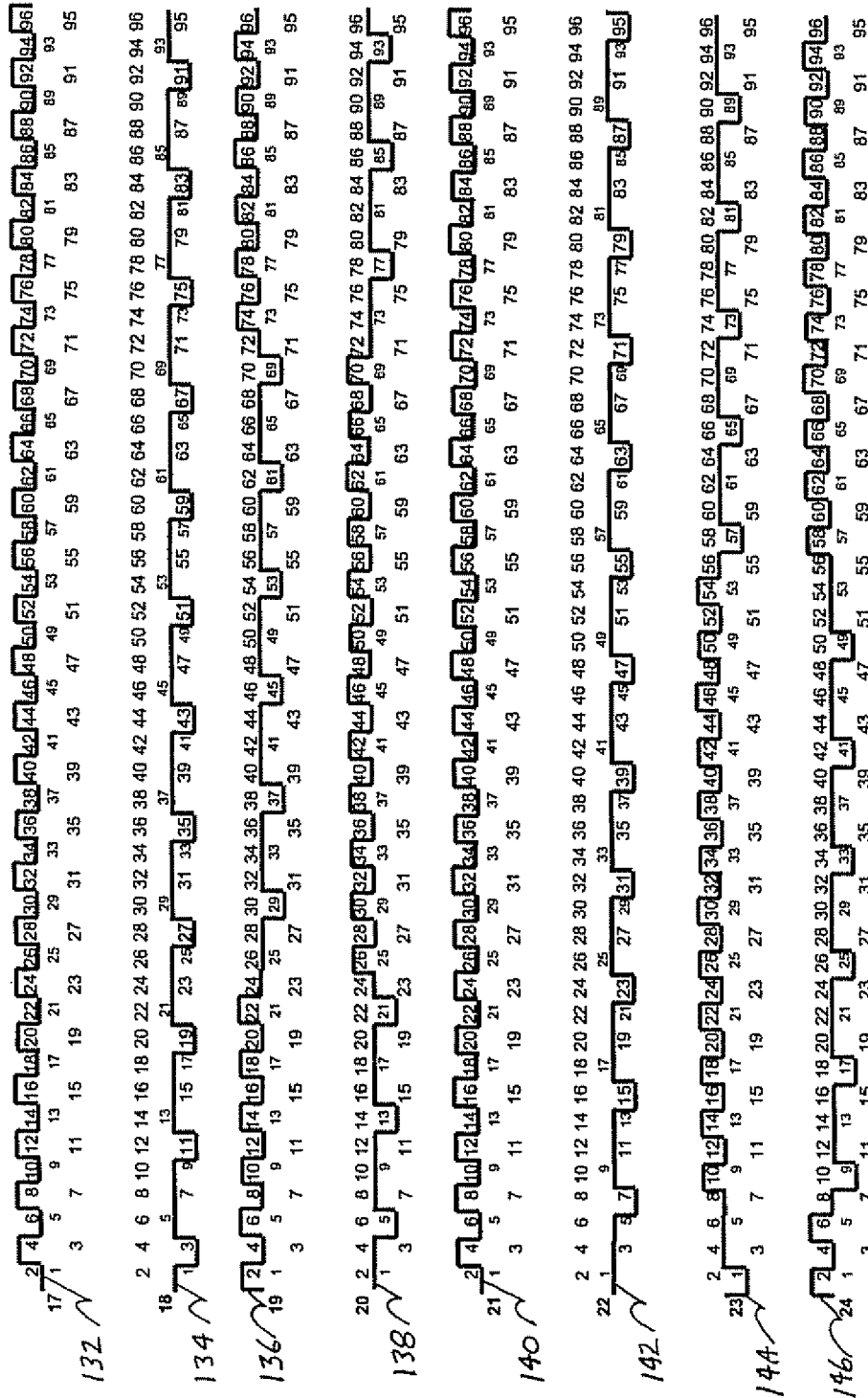


Fig. 5C

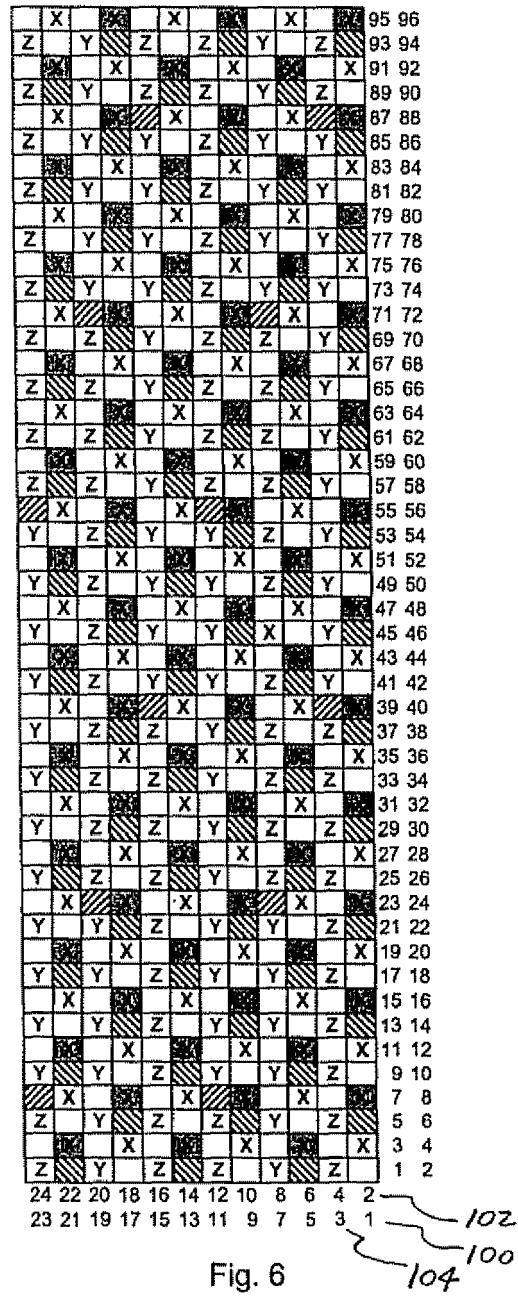
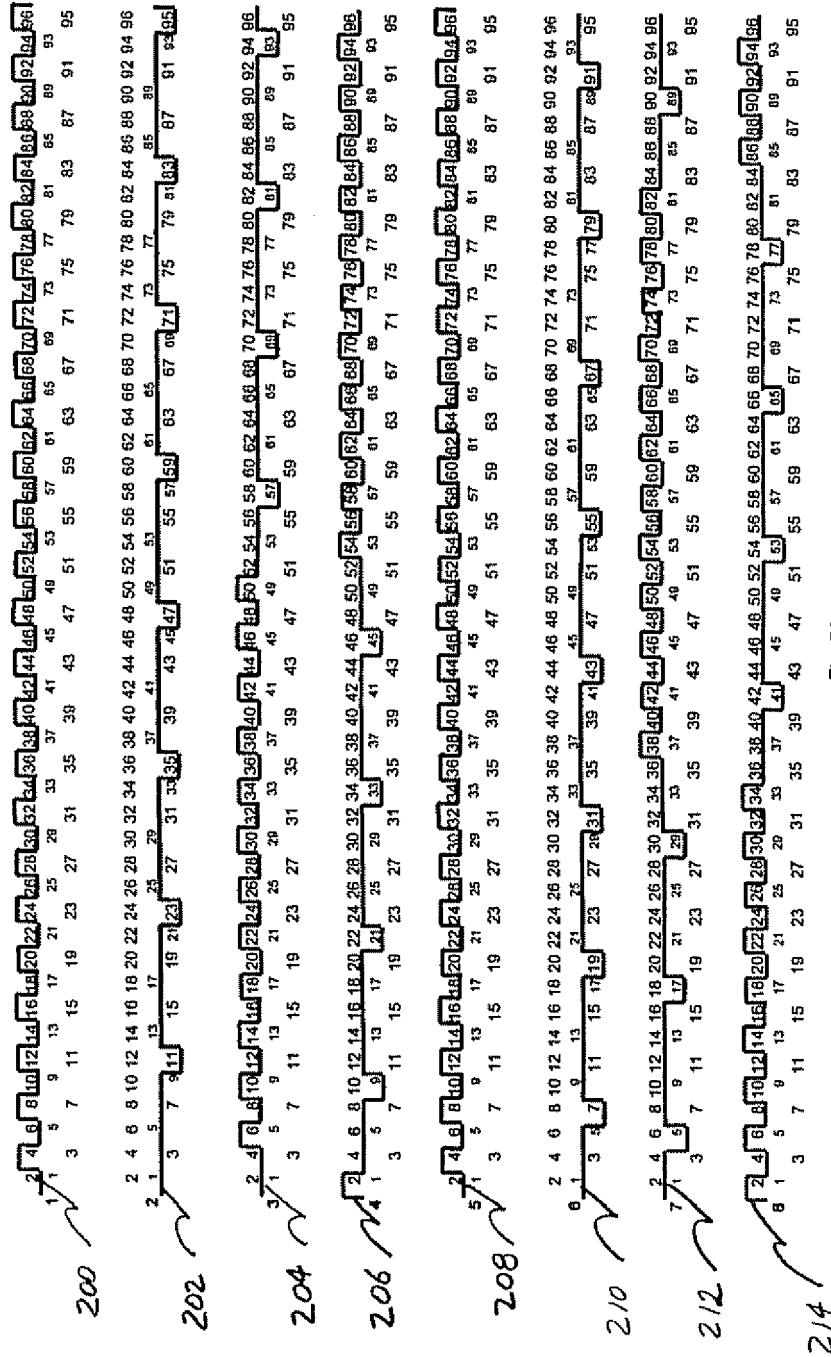


Fig. 6



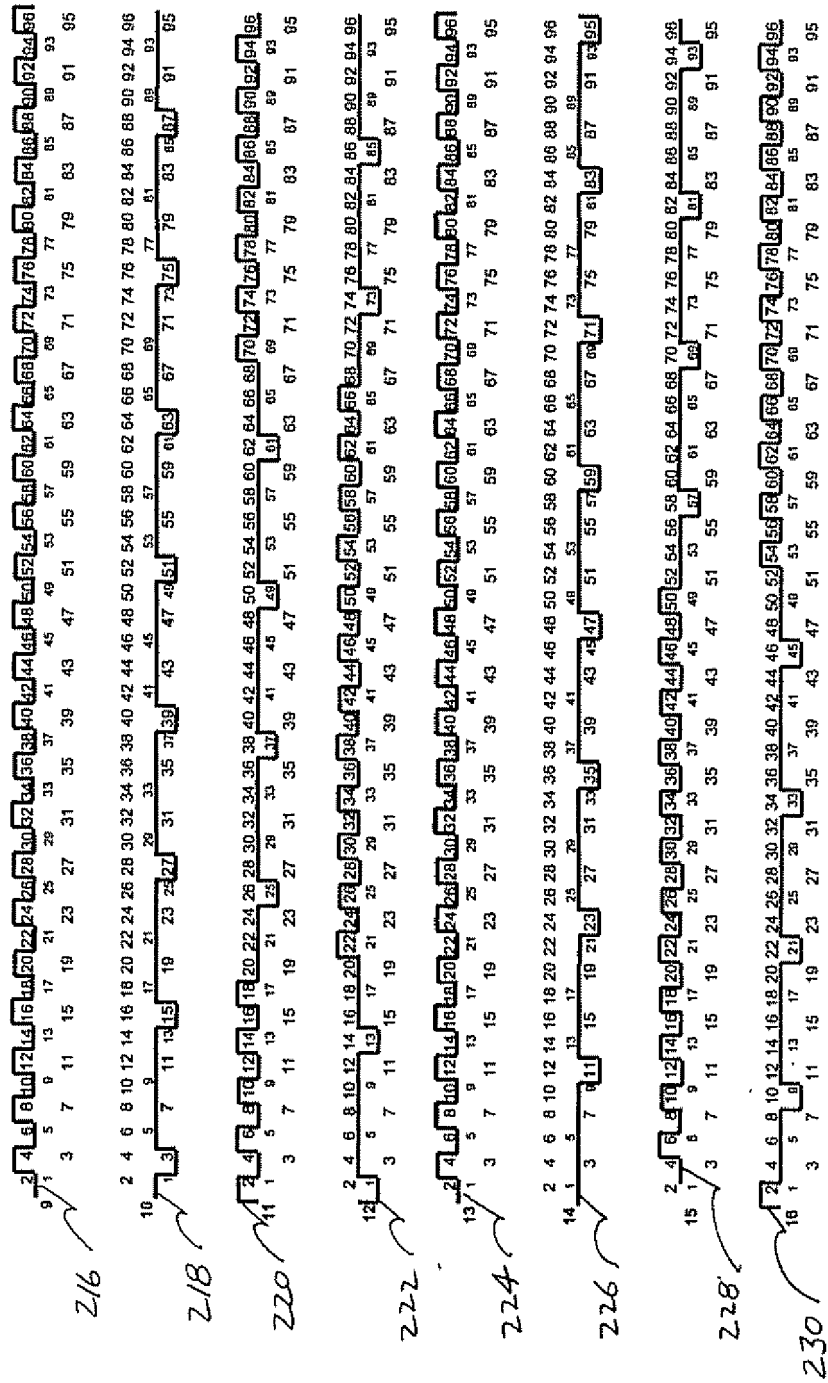


Fig. 7B

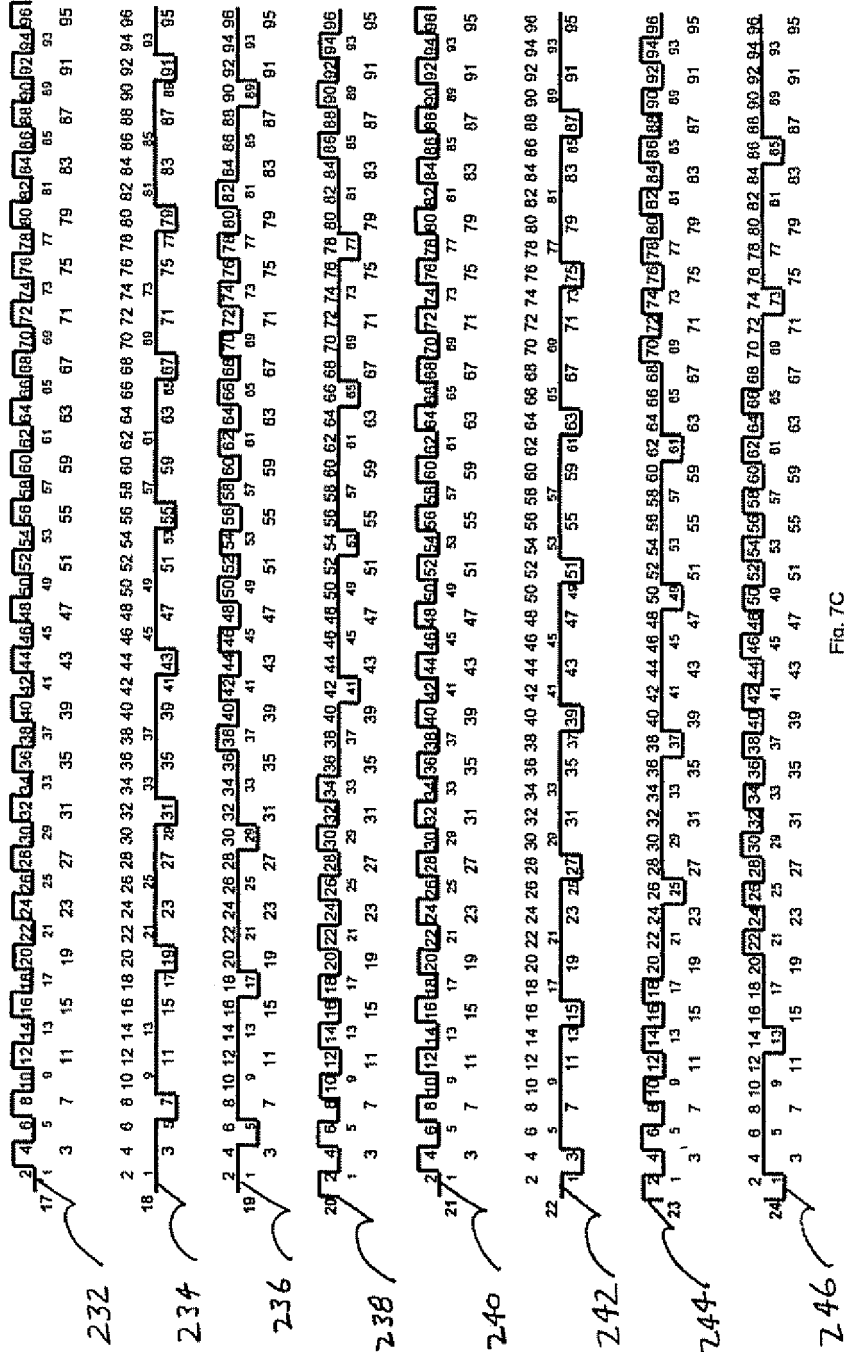
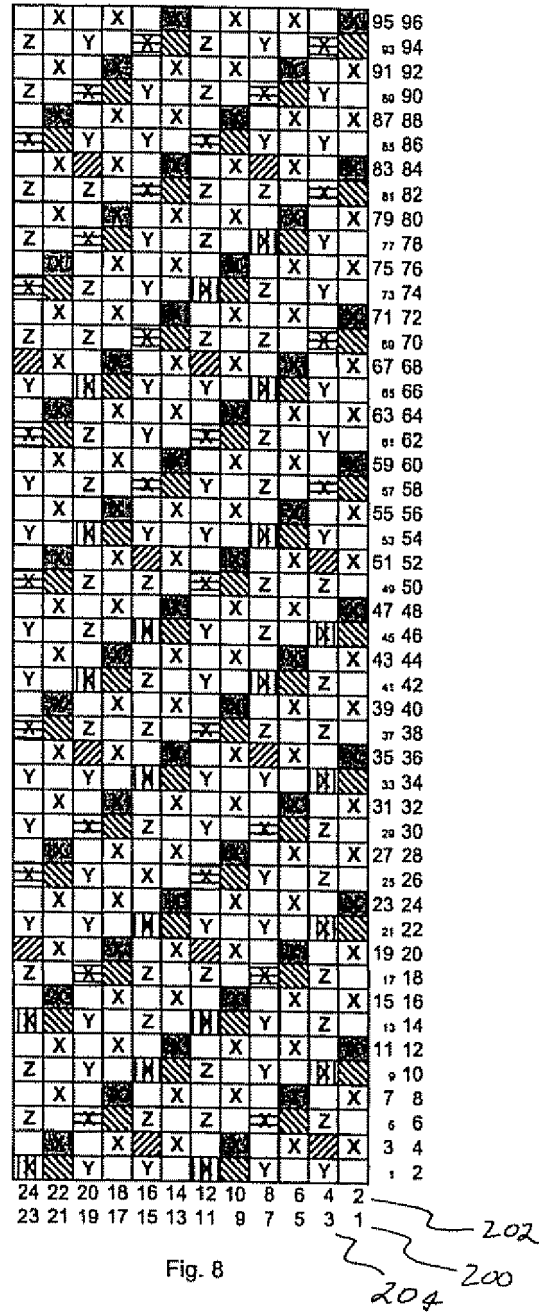


Fig. 7C





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 11 September 2006	Examiner Maisonnier, Claire
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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