

(or contract) a subject's palate. Described herein are appliances (e.g., lateral correction aligners) comprising a shell having a palate-spanning region. As previously described, the shell typically includes an outer surface and an inner surface, and at least a portion of the inner surface is configured to contact a subject's teeth. Lateral correction aligners typically include one or more regions that span at least a portion of a subject's palate (e.g., a palate-spanning region).. This palate-spanning region may contact the anterior portion of the palate, such as the hard palate region.

[00283] Figure 31a and 31b show a cross-section through a lateral correction aligner. In Figure 31a, the aligner 3107 is worn on the upper dental arch. In Fig. 31A this could be a subject's actual dental arch, or a model of the dental arch which includes both the teeth 3105 and anterior palate region 3101. This lateral correction aligner 3107 includes a palate-spanning region 3109 that connects region of the shell 3107 that contact the teeth. Figure 31b shows the lateral correction aligner (in cross-section) of Figure 31a without the upper dental arch.

[00284] When the lateral correction dental aligner is worn, as shown in Figure 31a, the palate-spanning region 3107 applies force to remodel the palate region of the upper dental arch. In some variations, the palate-spanning region may also provide additional support for the other region of the shell to enhance remodeling of the teeth 3015. In some variations, the palate-spanning region may push against the palate at one or more contact sites (or over the entire surface) of the palate-spanning region. Thus, the palate-spanning region may substantially conform to the palate or engage the palate. The palate-spanning region may engage the grooves (e.g., the longitudinal palatine grooves and canals).

[00285] As described previously for other types of dental aligners, the lateral correction dental aligner may be designed to remodel the palate in a series of steps in which the subject wears (for an appropriate treatment time) each of a series of aligners that proceed towards a final configuration. A practitioner (e.g., an orthodontist) determines the final configuration for the patient's dental arch (including teeth and palate). The practitioner designs a treatment plan that specifies movement paths for the patient's teeth and arch with or without the use of a computer, and the movement paths are divided into a plurality of successive treatment steps in step (e.g., three to forty treatment steps). Each step may correspond to one or more dental aligners to be worn.

[00286] In designing the treatment steps, as well as the final configuration, the practitioner may be guided by an awareness (or a model) of how the dental arch itself may

move. For example, as would be known by one of skill in the art, different regions of the palate may be more easily modified by treatment than other regions. In general, the more lateral regions of the hard palate may be more easily moved than the upper (e.g., central) region of the hard palate. Thus, a lateral correction dental aligner may be configured to expand the palate from the regions closer to the teeth than the more central region. Treatment steps may be planned using empirical information about remodeling the palate. For example, predictions about how any particular subject's palate may be remodeled may be based on comparing information about the subject (e.g., age, gender, size of the palate, etc.) with measurements or treatments performed on other, similar subjects. Treatment may also be based on models for the expansion (or contraction) of the palate based on published data. For example, see Carmen M, Marcella P, Giuseppe C, Roberto A., "Periodontal evaluation in patients undergoing maxillary expansion" (J Craniofac Surg. 2000 Sep;11(5):491-4); Ramieri GA, Spada MC, Austa M, Bianchi SD, Berrone S., "Transverse maxillary distraction with a bone-anchored appliance: dento-periodontal effects and clinical and radiological results" (Int J Oral Maxillofac Surg. 2005 Jun;34(4):357-63. Epub 2005 Jan 24); Davidovitch M, Efstathiou S, Sarne O, Vardimon AD., "Skeletal and dental response to rapid maxillary expansion with 2- versus 4-band appliances" (Am J Orthod Dentofacial Orthop. 2005 Apr;127(4):483-92); and Ferrario VF, Garattini G, Colombo A, Filippi V, Pozzoli S, Sforza C., "Quantitative effects of a nickel-titanium palatal expander on skeletal and dental structures in the primary and mixed dentition: a preliminary study" (Eur J Orthod. 2003 Aug;25(4):401-10). Each of these articles is herein incorporated in its entirety.

[00287] Treatment plans and the design of lateral correction aligners may be generated either manually or automatically. For example, software may be used to suggest treatment plans (and aligner designs), or it may be used to design the aligners used for treatment. As described above, software may be used to digitally model the dental arch (including the upper palate), as well as to manipulate the position of the teeth and upper palate. The software may include constraints on the remodeling of the upper palate, consistent with either empirical data using similar aligners or appliances, or based on models of a generic upper palate. In some variations, the software may derive a model for remodeling the upper palate based on data taken from the individual patient, such as X-ray or other scanning data, as well as molds or casts made of the hard palate region (and/or other regions of the subject's head and mouth).

[00288] Figures 32a and 32b show views of one variation of a lateral correction aligner as described herein. In Figure 32a, the lateral correction aligner 3207 is shown positioned on a subject's upper dental arch. The shell portion of the dental aligner contacts the subject's teeth, while the palate-spanning region 3205 contacts a portion of the subject's hard palate 3203. As described above, the palate-spanning region may be a single piece that connects to the teeth-contacting region of the shell, or it may be multiple pieces, (e.g., leaving one or more holes or gaps) exposing regions of the palate. The palate-spanning region may be a strip or a plurality of strips spanning the palate from any two or more points on the perimeter of the dental arch, where the palate-spanning region attaches to the tooth/gum-contacting region of the aligner.

[00289] In operation, the lateral correction aligner may be used to remodel the palate by applying force to both the teeth. It may be beneficial to distribute the force applied by the palate-spanning region over the entire dental arch (e.g., by including a palate-spanning region with a shell that covers most or all of the upper teeth). The force applied by the palate-spanning region may contribute to the movement of the teeth as well as the palate, just as the force applied by the shell against the teeth may contribute to the remodeling of the palate. In addition, the palate may be remodeled in any appropriate direction by a lateral correction aligner, including the anterior/posterior direction (e.g., from the front of the mouth to the back of the mouth) and the left/right direction. A lateral correction aligner may also remodel the dental arch by distalization of the teeth.

[00290] A lateral correction dental aligner may be used even it is not necessary or desirable to remodel the subject's palate. The lateral correction aligner may add support to the region of the aligner shell contacting (e.g., moving) the teeth. One or more steps of a treatment series may include a lateral correction aligner (other steps in the treatment may include aligners that do not have a palate-spanning region). In general, different types of aligners described herein (or aligners with different features, e.g., wrinkled aligners, aligners having palate-spanning regions, etc.) may be used at different steps of a treatment. In some variations, it may be desirable to use a lateral correction dental aligner in the same step as an aligner that does not include a palate-spanning region. For example, a subject may wear a dental aligner without a palate-spanning region during the day and a lateral alignment dental aligner when sleeping. The shell regions of both aligners may be identical except for the presence or absence of the palate-spanning region.

[00291] The palate-spanning region of the aligner may provide force against the teeth as well as the palate. Thus the palate-spanning region may comprise a material capable of providing sufficient force to effect movement of the palate and/or teeth. For example, the palate-spanning region may comprise a support piece or brace. The support piece typically gives structural support to the aligner, permitting it to maintain force against the palate and/or teeth.

[00292] A support piece may comprise any material having sufficient strength, stiffness (or elasticity), and durability. For example, the support piece may comprise a metal (including alloys such as nickel titanium alloys), ceramic, polymer (e.g., polypropylenes, polycarbonates, etc.), or some combination thereof. The shape of the support pieces may also provide support. For example, the support piece may be a spring (e.g., coiled spring, leaf spring, etc.), or may be layered to provide additional support. In some variations, the palate-spanning region does not include an additional support piece, because the material from which the palate-spanning region is made has sufficient strength to remodel the dental arch (e.g., teeth and/or palate) as desired.

[00293] The entire palate-spanning region of the shell may include a support piece, or the support piece may be included in only a portion of the palate-spanning region. In some variations, the palate-spanning region comprises only a support piece. The support piece may be attached to the upper or lower portions of the palate-spanning region, or it may be embedded within the palate-spanning region. More than one support piece may be used.

[00294] Figure 33a and 33b shows one example of a palate-spanning region of an aligner 3107 in which the support piece 3307 is sandwiched between an inner 3303 and outer 3305 shell layer of the aligner. As described above, a lateral-correction aligner may be fabricated using any of the methods described herein. For example, the aligner may be fabricated as a multi-layered aligner in which the layers (including the support piece) are vacuum-formed onto a model of the upper dental arch. A lateral correction aligner may include any of the features previously described, including fluid permeable features, snap-on features, wrinkles, etc.

[00295] The palate-spanning region (including the support piece) may be configured to minimize discomfort. For example, the palate-spanning region may comprise a coating to smooth the palate-spanning region, particularly the portion of the aligner that may contact the tongue. Coatings may smooth the surface of the aligner, and may have

additional beneficial effects. Coatings may include wetting coatings (e.g., silicones, etc.), hygienic coatings (e.g., antibacterial coatings, etc.), friction-reducing coatings (e.g., waxes, lubricious coatings), odor-absorbent coatings (e.g., containing activated charcoal, etc.), or the like.

[00296] As described, the plate spanning region (including the support piece) may be made of any appropriate material. For example, the plate-spanning region may be made of any of the layered materials described herein. In some variations, the plate-spanning region comprises a fluid (e.g., water or gas) permeable material, and may include one or more passages. Aligners with plate spanning regions may be more comfortable for a user when at least a portion of the plate spanning region comprises a permeable material.

[00297] The above detailed description is provided to illustrate exemplary embodiments and is not intended to be limiting. For example, any of the features of an embodiment may be combined with some or all of the features of other embodiments. It will be apparent to those skilled in the art that numerous modifications and variations within the scope of the present invention are possible. Throughout this description, particular examples have been discussed, including descriptions of how these examples may address certain disadvantages in related art. However, this discussion is not meant to restrict the various examples to methods and/or systems that actually address or solve the disadvantages. Accordingly, the present invention is defined by the appended claims and should not be limited by the description herein.

CLAIMS

What is claimed is:

1. A device for producing corrective movement in a subject's teeth, the device comprising:
 - a dental aligner configured to be worn on a subject's teeth, the dental aligner comprising:
 - a shell portion having an outer surface and an inner surface, wherein at least a portion of the inner surface is configured to contact the subject's tooth;
 - and
 - one or more through-holes passing from the outer surface to the inner surface of the shell portion of the dental device.
2. The device of claim 1, wherein the through-hole is configured to mate with a connector.
3. A system for producing corrective movement in a subject's teeth, comprising:
 - a dental aligner device having one or more through-holes, wherein the dental aligner device is configured to be worn on the subject's teeth; and
 - one or more connectors, wherein the connector is configured to engage the through-hole when the dental aligner is worn on the subject's teeth.
4. The system of claim 3, wherein the one or more connectors include one or more of posts, nodules, and bumps.
5. The system of claim 3, wherein the dental aligner contacts the subject's teeth when the connector is engaged with the through-hole in the dental aligner.
6. The system of claim 3, wherein the dental aligner is fabricated by one or more of vacuum forming, milling, stereo lithography, laser machining, molding, and CNC based manufacturing.
7. The system of claim 3, wherein the dental aligner comprises:

- a shell portion having an outer surface and an inner surface to be in contact with the subject's tooth;
- a bottom portion to be placed near the gingival line of the subject's tooth; and
- a tip portion on the opposite side of the bottom portion.
8. The system of claim 7, wherein the through-hole of the dental aligner device passes through the bottom portion or the tip portion.
9. The system of claim 3, wherein the connector is configured to be secured to a subject's tooth.
10. A system for producing a snap-on dental aligner for dental treatment, comprising:
a guide to indicate the locations of through-holes to be formed in a dental aligner;
a positioner to position a hole-maker with respect to the dental aligner based on the indication of the guide; and
a hole-maker to produce through-holes in the dental aligner at the positions indicated by the guide to produce the snap-on dental aligner.
11. The system of claim 10, wherein the guide comprises a computer to store the locations of through-holes to be formed in a dental aligner.
12. The system of claim 11, wherein the computer is further configured to store locations of one or more connectors to be secured to the subject's teeth, so that the one or more connectors engage the through-holes when the dental aligner is worn on the subject's teeth.
13. The system of claim 10, wherein the hole-maker is configured to drill through-holes in the dental aligner.
14. The system of claim 10, wherein the hole-maker comprises a mechanical drill bit or a laser.
15. A method for moving a subject's teeth in a dental treatment, comprising:

fabricating a dental aligner to be worn on the subject's teeth;
producing one or more through-holes in the dental aligner;
fixing one or more connectors on the subject's teeth to engage the through-holes;
and
engaging the one or more connectors on the subject's teeth with the through-holes
of the dental aligner to secure the dental aligner on the subject's teeth.

16. The method of claims 15, further comprising fixing the one or more connectors on the subject's teeth at locations in registration with the through-holes when the dental aligner is worn on the subject's teeth.
17. The method of claim 16, wherein the connector comprises a pre-formed connector.
18. The method of claim 16, wherein the connector comprises an adhesive or a UV cross-linkable polymer.
19. The method of claim 16, wherein the one or more connectors include one or more of protrusions, nodules, and bumps.
20. The method of claim 15, further comprising securing the dental aligner against the subject's teeth to engage the connectors secured on the subject's teeth into the through-holes of the dental aligner.
21. The method of claim 15, further comprising fabricating the dental aligner device by one or more of vacuum forming, milling, stereo lithography, laser machining, and molding.
22. The method of claim 15, further comprising drilling the one or more through-holes in the dental aligners.
23. A shell-shaped dental aligner for producing predetermined movement in a patient's tooth, comprising:
 - a shell portion comprising a fluid-permeable material;
 - an outer surface of the shell portion; and

an inner surface of the shell portion, the inner surface to be in contact with the patient's tooth, wherein the fluid-permeable material can allow fluid to communicate between the patient's tooth and the vicinity of the outer surface.

24. The shell-shaped dental aligner of claim 23, wherein the fluid-permeable material allows air and liquid to communicate between the patient's tooth and the vicinity of the outer surface.

24. The shell-shaped dental aligner of claim 23, wherein the fluid-permeable material allows the permeation of oxygen from the vicinity of the outer surface to the patient's tooth.

25. The shell-shaped dental aligner of claim 23, wherein the fluid-permeable material allows the permeation of saliva between the outer surface and the inner surface.

26. The shell-shaped dental aligner of claim 23, further comprising:
a bottom portion to be placed near the gingival of the patient's tooth; and
a tip portion on the opposite side of the bottom portion.

27. The shell-shaped dental aligner of claim 23, wherein the fluid-permeable material comprises a porous polymeric material.

28. The shell-shaped dental aligner of claim 23, wherein the fluid-permeable material comprises pores that are drilled by a laser beam.

29. The shell-shaped dental aligner of claim 23, wherein the fluid-permeable material comprises micro-channels or pore having diameters in the range of 50 Å to 400 μM.

30. A method for treating a patient's teeth, comprising
determining an initial configuration of the patient's teeth;
determining a final configuration of the patient's teeth;
designing a movement path for at least one of the patient's teeth from the initial configuration to the final configuration;

dividing the movement path into a plurality of successive treatment steps, each having a target configuration for the patient's teeth; and
producing a dental aligner comprising a fluid-permeable material to move the patient's teeth to the target configuration associated with a treatment step.

31. The method of claim 30, wherein the fluid-permeable material comprises a porous polymeric material.
32. The method of claim 30, further comprising drilling holes by a laser beam in a dental-aligner material to form a fluid-permeable dental aligner.
33. The method of claim 31, wherein the target configuration comprises the target positions and the target orientations of one or more of the patient's teeth.
34. The method of claim 31, further comprising molding the dental aligner having the fluid-permeable material using in a casting chamber.
35. The method of claim 31, further comprising producing two dental aligners comprising the fluid-permeable material and having substantially identical shape.
36. The method of claim 31, wherein the fluid-permeable material comprises pores are formed by subliming a low density granular compound by pressure and/or elevated temperature in a base material.
37. A system for treating a patient's teeth, comprising:
 - a computer configured to determine a target configuration for the patient's teeth;
 - and
 - an apparatus configured to produce a dental aligner comprising a shell portion that comprises a fluid-permeable material, an outer surface, and an inner surface to be in contact with one of the patient's teeth, wherein the fluid-permeable material can allow fluid to communicate between the one of the patient's teeth and the vicinity of the outer surface and the dental aligner is configured to move the patient's teeth to the target configuration.

38. The system of claim 37, wherein the fluid-permeable material comprises a porous polymeric material.
39. The system of claim 37, wherein the apparatus is configured to drill holes by a laser beam in a dental-aligner material to form a fluid-permeable dental aligner.
40. The system of claim 37, wherein the apparatus is configured to mold the dental aligner having the fluid-permeable material using in a casting chamber.
41. The system of claim 37, wherein the apparatus is configured to produce fluid-permeable dental aligner comprising micro-channels or pore having diameters in the range of 50 Å to 400 μM.
42. A method for making a multi-layer dental aligner, comprising:
placing a first layer of a first aligner-making material over one or more physical tooth models;
conforming the first layer of the first aligner-making material to the surfaces of the one or more physical tooth models;
placing a second layer of a second aligner-making material over the first layer of the first aligner-making material; and
conforming the second layer of the second aligner-making material to the surfaces of the first layer of the first aligner-making material over the one or more physical tooth models to produce the multi-layer dental aligner.
43. The method of claim 42, further comprising:
heating the first layer of the first aligner-making material;
holding the first layer of the first aligner-making material against the one or more physical tooth models;
heating the second layer of the second aligner-making material; and
holding the second layer of the second aligner-making material against the first layer of the first aligner-making material over the one or more physical tooth models to produce the multi-layer dental aligner.

44. The method of claim 43, further comprising:
holding the first layer of the first aligner-making material or the second layer of the second aligner-making material against the one or more physical tooth models by vacuum suction.
45. The method of claim 42, further comprising:
cutting the first layer of the first aligner-making material and/or the second layer of the second aligner-making material along the gingival lines of the physical tooth models to produce the multi-layer dental aligner.
46. The method of claim 42, further comprising:
cutting the first layer of the first aligner-making material along the gingival lines of the physical tooth models before placing the second layer of the second aligner-making material over the first layer of the first aligner-making material; and
cutting the second layer of the second aligner-making material along the gingival lines of the physical tooth models to produce the multi-layer dental aligner.
47. The method of claim 42, wherein the first layer of the first aligner-making material has a higher hardness than the second layer of the second aligner-making material.
48. The method of claim 42, wherein the first aligner-making material or the second aligner-making material comprises one or more of acrylic, polycarbonate, urethane, and epoxy.
49. The method of claim 42, wherein the first aligner-making material is the same as the second aligner-making material.
50. The method of claim 42, wherein the second layer of the second aligner-making material has substantially the same color as the patient's teeth.
51. The method of claim 42, wherein the one or more tooth models are assembled to form a physical arch model.

52. The method of claim 51, wherein the one or more tooth models are attached to a dental base to form the physical arch model.
53. A method for making a multi-layer dental aligner, comprising:
heating a first layer of the first aligner-making material;
holding the first layer of the first aligner-making material against one or more physical tooth models by vacuum suction;
cutting the first layer of the first aligner-making material along the gingival lines of the physical tooth models;
heating a second layer of the second aligner-making material;
holding the second layer of the second aligner-making material against the first layer of the first aligner-making material over the physical tooth models by vacuum suction; and
cutting the second layer of the second aligner-making material along the gingival lines of the physical tooth models to produce the multi-layer dental aligner.
54. The method of claim 53, wherein the first aligner-making material has a higher hardness than the second aligner-making material.
55. The method of claim 53, wherein the first aligner-making material or the second aligner-making material comprises one or more of acrylic, polycarbonate, urethane, and epoxy.
56. The method of claim 53, wherein the first aligner-making material is the same as the second aligner-making material.
57. A multi-layer dental aligner, comprising:
a first layer of a first aligner-making material; and
a second layer of a second aligner-making material, wherein at least one of the first layer and the second layer is formed by heating a layer of an aligner-making material and holding the layer of the aligner-making material against one or more physical tooth models.

58. The multi-layer dental aligner of claim 57, wherein the first layer is formed by heating and holding the first layer of the first aligner-making material against one or more physical tooth models by vacuum suction.
59. The multi-layer dental aligner of claim 57, wherein the second layer is formed by heating and holding the second layer of the first aligner-making material against the first layer of the first aligner-making material over the physical tooth models by vacuum suction.
60. The multi-layer dental aligner of claim 57, wherein the first layer has a higher hardness than the second layer.
61. The multi-layer dental aligner of claim 57, wherein the first aligner-making material is the same as the second aligner-making material.
62. A method for making a non-uniform dental aligner, comprising:
non-uniformly heating the sheet of aligner-making material; and
holding the sheet of aligner-making material against one or more physical tooth models to produce the non-uniform dental aligner.
63. The method of claim 62, further comprising:
heating a first section of the sheet of aligner-making material at a higher temperature than a second section of the sheet of aligner-making material.
64. The method of claim 62, further comprising:
heating a first section of the sheet of aligner-making material for a longer period of time than a second section of the sheet of aligner-making material.
65. The method of claim 62, wherein one or more elastic properties of the aligner-making material vary as a function of the temperature or the length of the heating.
66. The method of claim 62, further comprising:

holding the sheet of aligner-making material against the one or more physical tooth models by vacuum suction.

67. The method of claim 66, further comprising:

holding the sheet of aligner-making material against the one or more physical tooth models by a non-uniform distribution of vacuum suction.

68. The method of claim 62, further comprising:

cutting the sheet of aligner-making material along the gingival lines of the physical tooth models to produce the non-uniform dental aligner.

69. The method of claim 62, wherein a first section of the sheet of aligner-making material has a higher hardness than a second section of the sheet of aligner-making material.

70. The method of claim 62, wherein the aligner-making material comprises one or more of acrylic, polycarbonate, urethane, and epoxy.

71. The method of claim 62, wherein the one or more tooth models are assembled to form a physical arch model.

72. The method of claim 71, wherein the one or more tooth models are attached to a dental base to form the physical arch model.

73. A method for making a non-uniform dental aligner, comprising:

heating a first section of a sheet of aligner-making material at a first temperature for a first period of time;

heating a second section of the sheet of aligner-making material at a second temperature for a second period of time;

holding the sheet of aligner-making material against the one or more physical tooth models to produce the non-uniform dental aligner by vacuum suction; and

cutting the sheet of aligner-making material along the gingival lines of the physical tooth models to produce the non-uniform dental aligner.

74. The method of claim 73, wherein one or more elastic properties of the aligner-making material vary as a function of the temperature or the length of the heating.

75. The method of claim 73, wherein the first section of a sheet of aligner-making material has one or more different elastic constants different from the second section of a sheet of aligner-making material.

76. The method of claim 73, further comprising:
holding the sheet of aligner-making material against the one or more physical tooth models by a non-uniform distribution of vacuum suction.

77. The method of claim 73, wherein the aligner-making material comprises one or more of acrylic, polycarbonate, urethane, and epoxy.

78. A non-uniform dental aligner, comprising:
a layer of aligner-making material shaped to fit on a patient's teeth, wherein the layer of aligner-making material comprise a first section characterized by a first elastic constant and a second section characterized by a second elastic constant.

79. A non-uniform dental aligner of claim 78, wherein the layer of aligner-making material is shaped to fit a patient's teeth by non-uniformly heating a sheet of aligner-making material and holding the sheet of aligner-making material against the one or more physical tooth models by vacuum suction.

80. The non-uniform dental aligner of claim 78, wherein the aligner-making material in the first section has a higher hardness than the aligner-making material in the second section.

81. The non-uniform dental aligner of claim 78, wherein the aligner-making material comprises one or more of acrylic, polycarbonate, urethane, and epoxy.

82. A dental aligner for producing predetermined movement in a patient's tooth, comprising:
- a shell-shaped portion including an outer surface and an inner surface to be in contact with the patient's tooth;
 - a bottom portion to be placed near the gingival of the patient's tooth;
 - a tip portion on the opposite side of the bottom portion; and
 - one or more wrinkles formed over at least one of the outer surface, the inner surface, and the bottom portion.
83. The dental aligner of claim 82, wherein the wrinkles are formed over the outer surface or the inner surface of the shell portion and aligned substantially from the tip portion to the bottom portion.
84. The dental aligner of claim 82, wherein the wrinkles are aligned substantially across the direction from the tip portion to the bottom portion.
85. The dental aligner of claim 82, wherein the wrinkles include a corrugated structure over the bottom portion.
86. The dental aligner of claim 82, wherein the wrinkles are formed by a material that is different from the material in the shell portion.
87. The dental aligner of claim 82, wherein the shell portion comprises a material selected from the group consisting of plastics, polymers, urethane, epoxy, plaster, stone, clay, acrylic, metals, wood, paper, ceramics, and porcelain.
88. The dental aligner of claim 82, wherein the shell portion comprises varying thicknesses in different areas.
89. The dental aligner of claim 82, wherein the shell portion comprises a plurality of layers each comprising the same or different materials.
90. A method for manufacturing wrinkled dental aligner for a patient's arch, comprising:

producing a physical dental aligner for the patient's arch, wherein the physical dental aligner comprises substantially smooth surfaces; and
producing at least one wrinkle over one of the substantially smooth surfaces on the physical dental aligner to form a wrinkled surface on the dental aligner.

91. The method of claim 90, further comprising: simultaneously producing the physical dental aligner and the wrinkled surface on the physical dental aligner.
92. The method of claim 90, further comprising: producing the wrinkled surface on the physical dental aligner by one or more of vacuum forming, cutting, milling, etching by a thermal applier, a laser, and CNC based manufacturing.
93. A system for manufacturing shell-shaped dental aligner for producing predetermined movement in a patient's tooth, comprising:
a computer configured to store a digital dental aligner model that specifies a shell portion including an outer surface and an inner surface to be in contact with the patient's tooth, a bottom portion to be placed near the gingival of the patient's tooth, a tip portion on the opposite side of the bottom portion, and one or more wrinkles formed over at least one of the outer surface of the shell portion, the inner surface of the shell portion, and the bottom portion; and
an apparatus configured to produce a physical dental aligner having a wrinkled surface in accordance with the digital dental aligner model.
94. The system of claim 93, wherein the computer is configured to simulate the physical dental aligner having a wrinkled surface using the digital dental aligner model to optimize the properties of the one or more wrinkles.
95. The system of claim 94, wherein the properties of the wrinkles include one or more of the locations and orientations of the wrinkles, the spacing between adjacent wrinkles, and the depths of the wrinkles.
96. The system of claim 93, wherein the apparatus configured to produce the wrinkled surface on the physical dental aligner by one or more of vacuum forming, cutting,

milling, etching by a thermal applier, cutting by a laser beam, and CNC based manufacturing.

97. The system of claim 93, wherein the wrinkles are formed over the outer surface or the inner surface of the shell portion and aligned substantially from the tip portion to the bottom portion.
98. The system of claim 93, wherein the wrinkles are aligned substantially across the direction from the tip portion to the bottom portion.
99. The system of claim 93, wherein the wrinkles include a corrugated structure over the bottom portion.
100. The system of claim 93, wherein the shell portion comprises varying thicknesses in different areas.
101. The system of claim 93, wherein the shell portion comprises a plurality of layers.
102. A method for manufacturing wrinkled dental aligner for a patient's tooth, comprising:
developing a digital dental aligner model specifying at least one wrinkled surface on a dental aligner; and
producing a dental aligner having the wrinkled surface in accordance with digital dental aligner model.
103. The method of claim 102, further comprising: producing the physical dental aligner having the wrinkled surface by vacuum forming over a dental arch model of the patient, wherein at least one surface of the dental arch model includes features to produce wrinkled surface on the dental aligner.
104. The method of claim 102, further comprising: producing the wrinkled surface on the physical dental aligner by embedding a high-tension material under the surface of the physical dental aligner.

105. The method of claim 102, further comprising: producing the wrinkled surface on the physical dental aligner by cutting the surface of a physical dental aligner.
106. The method of claim 102, further comprising: producing the wrinkled surface on the physical dental aligner etching the surface of the physical dental aligner by a thermal applier or a laser beam.
107. The method of claim 102, further comprising:
 fabricating aligner components using CNC based manufacturing in accordance with the digital dental aligner model; and
 producing the physical dental aligner having the wrinkled surface by assembling the aligner components.
108. The method of claim 107, wherein the CNC based manufacturing includes one or more of milling, stereo lithography, laser machining, molding, and casting.
109. The method of claim 107, further comprising: producing physical features on the aligner components to permit the aligner components to be assembled into the physical dental aligner having at least one wrinkled surface.
110. The method of claim 102, further comprising:
 simulating the dental aligner having the wrinkled surface using the digital dental aligner model; and
 optimizing the properties of the wrinkles on the wrinkled surface.
111. The method of claim 110, wherein the properties of the wrinkles include one or more of the locations of the wrinkles, the orientations of the wrinkles, the spacing between adjacent wrinkles, and the depths of the wrinkles.
112. The method of claim 102, further comprising: developing the digital dental aligner model based on a digital dental arch model.
113. A method for manufacturing wrinkled dental aligner for a patient's arch, comprising:

developing a digital dental arch model based the patient's arch;
developing a digital dental aligner model based on the digital dental arch model,
wherein the digital dental aligner model specifies one or more wrinkles on a
surface; and
producing a wrinkled dental aligner in accordance with the digital dental aligner
model.

114. The method of claims 113, further comprising:

segmenting the digital dental aligner model into a plurality of manufacturable
digital aligner components;
producing physical aligner components using Computer Numerical Control (CNC)
based manufacturing in accordance with the digital aligner components; and
assembling the physical aligner components to form the wrinkled dental aligner.

115. The method of claim 114, wherein the CNC based manufacturing includes one or
more of milling, stereo lithography, laser machining, molding, and casting.

116. The method of claim 114, further comprising: producing physical features on the
aligner components to permit the aligner components to be assembled into the physical
dental aligner having at least one wrinkled surface.

117. A system for manufacturing a wrinkled dental aligner for a patient, comprising:
a computer configured to store a digital dental aligner model specifying at least one
wrinkled surface on the wrinkled dental aligner; and
an apparatus configured to produce the wrinkled dental aligner in accordance with
digital dental aligner model.

118. The system of claim 117, wherein the computer is configured to simulate the wrinkled
dental aligner using the digital dental aligner model and to optimize the properties of
the wrinkled surface.

119. The system of claim 118, wherein the properties of the wrinkled surface include one or more of the locations of the wrinkles, the orientations of the wrinkles, the spacing between adjacent wrinkles, and the depths of the wrinkles.
120. The system of claim 117, wherein the apparatus is configured to produce the wrinkled dental aligner by one or more of vacuum forming, cutting, etching by a thermal applicator, cutting by a laser beam, and CNC based manufacturing.
121. A method for treating a patient's teeth, comprising
determining an initial configuration of the patient's teeth;
determining a final configuration of the patient's teeth;
designing a movement path for at least one of the patient's teeth from the initial configuration to the final configuration;
dividing the movement path into a plurality of successive treatment steps, each having a target configuration for the one of the patient's teeth; and
producing two or more dental aligners of substantially identical shape to move the one of the patient's teeth to the target configuration.
122. The method of claim 121, further comprising
estimating the amount of time a treatment step will take; and
estimating an optimal wearing interval for the dental aligners.
123. The method of claim 122, wherein the step of producing two or more dental aligners of substantially identical shape comprises producing the number of dental aligners needed for the treatment step based on the estimated amount of time the treatment step will take and the estimate of the optimal wearing interval.
124. The method of claim 121, further comprising:
simulating the dental aligners of substantially identical shape needed for the target configuration at the treatment steps using a digital aligner model; and
producing two or more dental aligners of substantially identical shape in accordance with the digital aligner model.

125. A method for treating a patient's teeth, comprising
determining a target configuration for the patient's teeth;
producing at least two dental aligners having substantially identical shape; and
using the two dental aligners to move the patient's teeth to the target configuration.
126. The method of claim 125, wherein the two dental aligners comprise different material compositions.
127. The method of claim 125, wherein each dental aligner is used for not longer than three days.
128. A lateral correction dental aligner for remodeling a subject's upper dental arch including the palate, the aligner comprising:
a shell having an outer surface and an inner surface, the shell comprising:
a tooth contacting region configured to contact the teeth of the subject's upper arch; and
a palate-spanning region, wherein the palate-spanning region is configured to contact the subject's upper palate and provide force to remodel the subject's upper arch.
129. The lateral correction dental aligner of claim 128, wherein the palate-spanning region further comprises a support piece configured to provide structural support to the palate-spanning region.
130. The lateral correction dental aligner of claim 128, wherein the palate-spanning region comprises a fluid-permeable material.
131. The lateral correction dental aligner of claim 128, wherein the palate-spanning region spans the majority of the hard palate.
130. A method for reshaping a patient's dental palate, comprising
determining an initial configuration of the patient's teeth and upper palate region;
determining a final configuration of the patient's teeth and upper palate region;

designing a movement path for at least a portion of the upper palate region from the initial configuration to the final configuration;
dividing the movement path into a plurality of successive treatment steps; and
producing a plurality of dental aligners including a palate-spanning region to remodel the upper palate region to the target configuration.

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Figure 1A

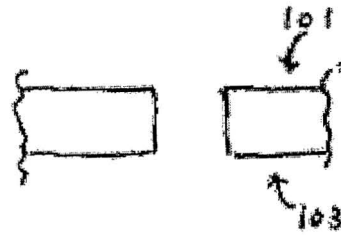


Figure 1B

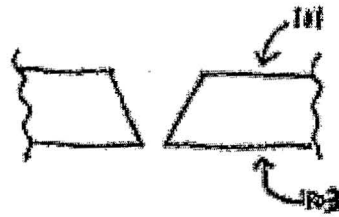


Figure 1C

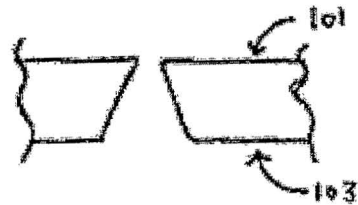


Figure 1D

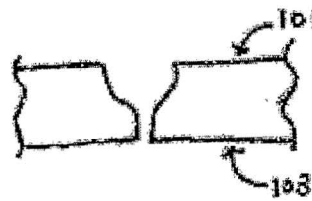


Figure 1E

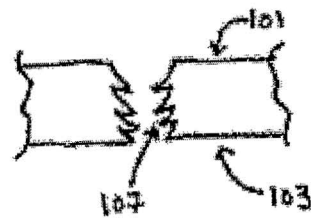
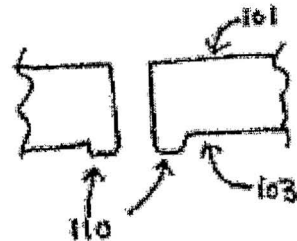


Figure 1F



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Figure 2A

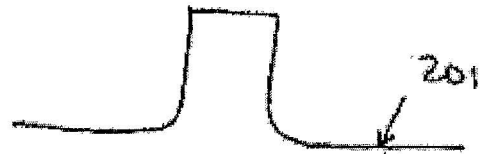


Figure 2B



Figure 2C

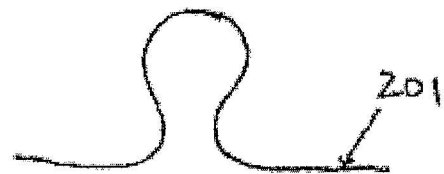


Figure 2D

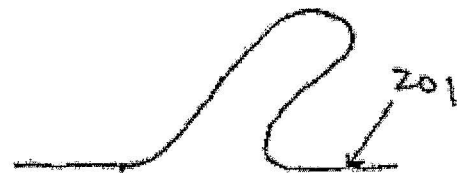
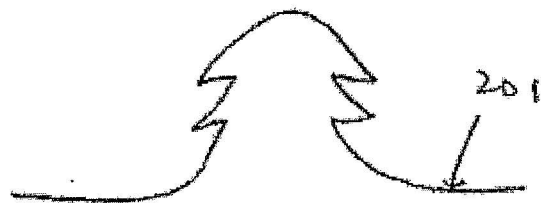


Figure 2E



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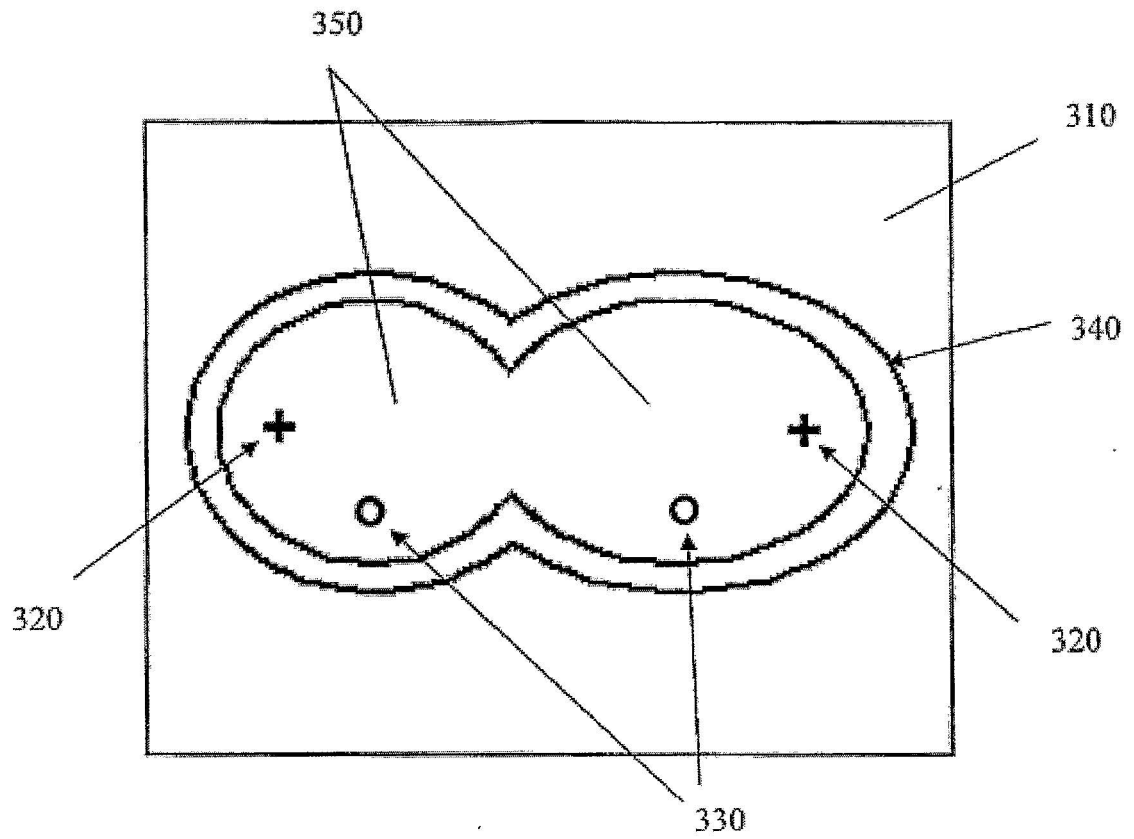


Figure 3

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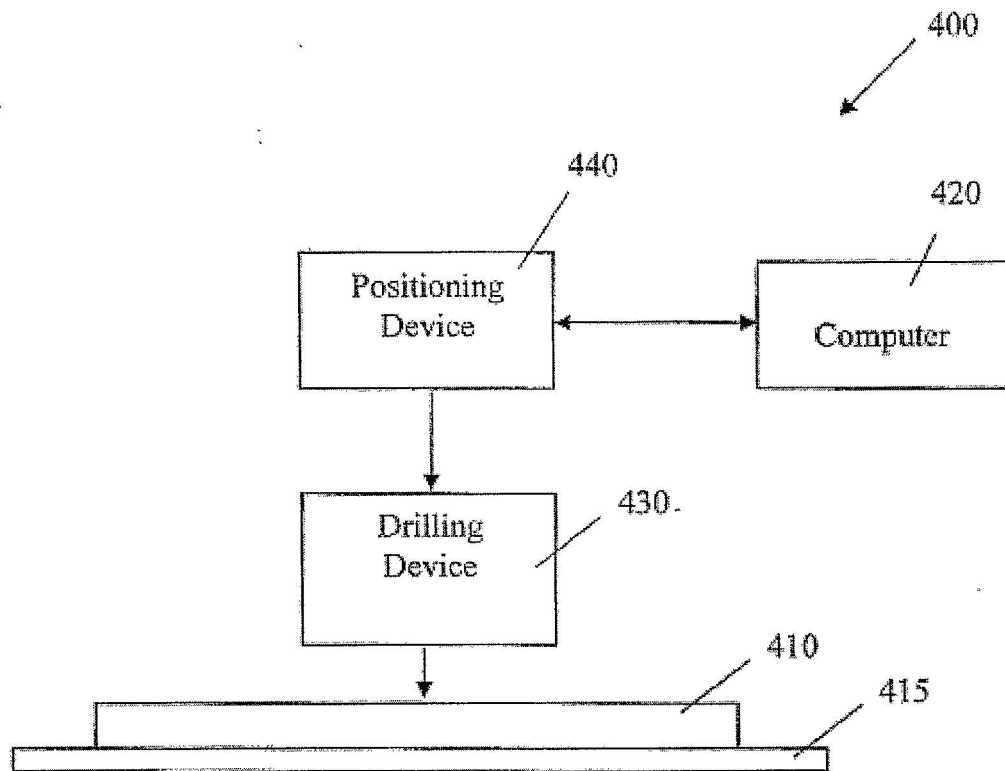


Figure 4

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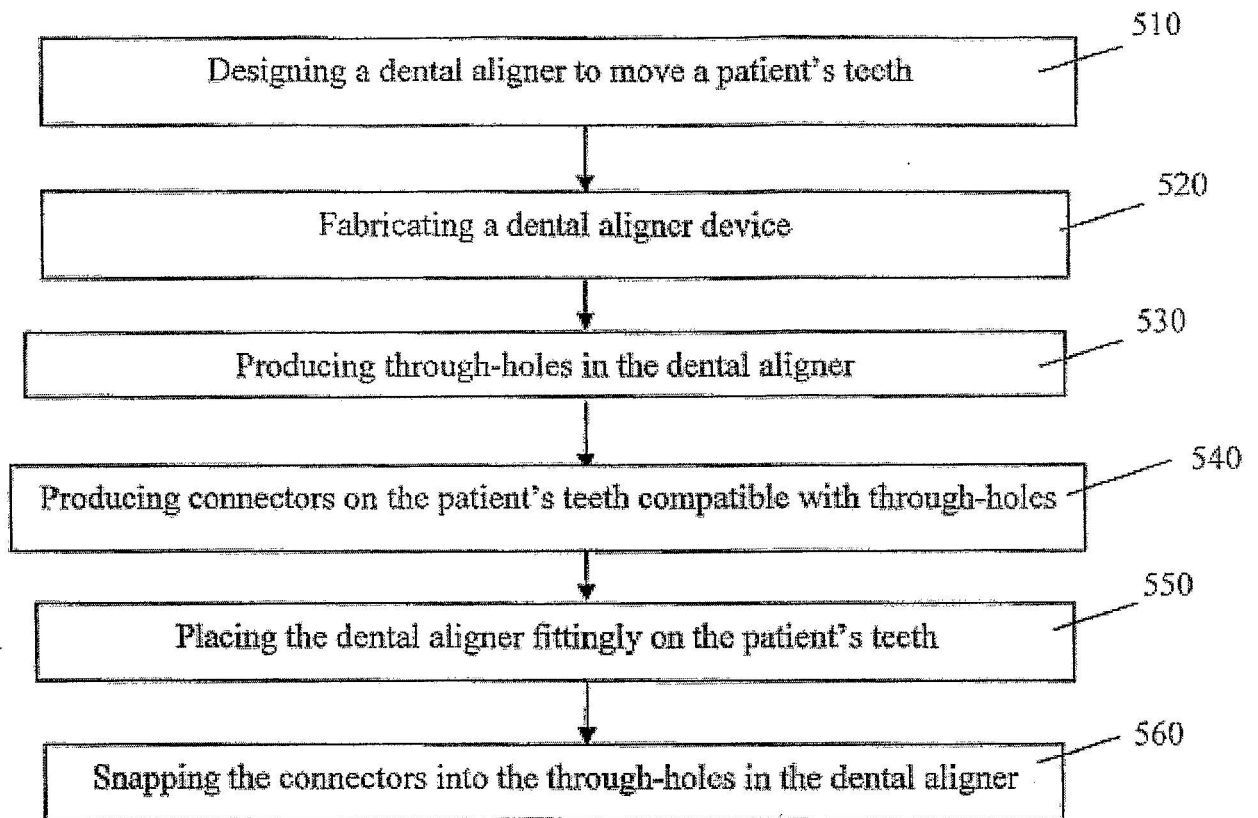


Figure 5

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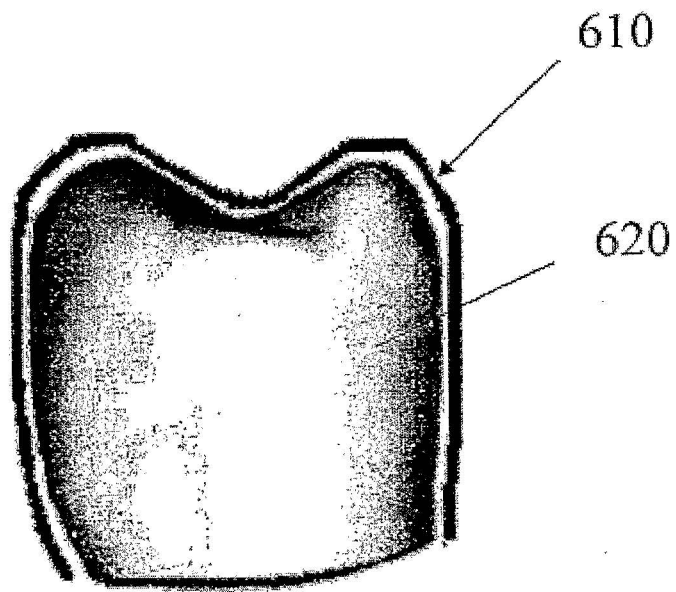


Figure 6

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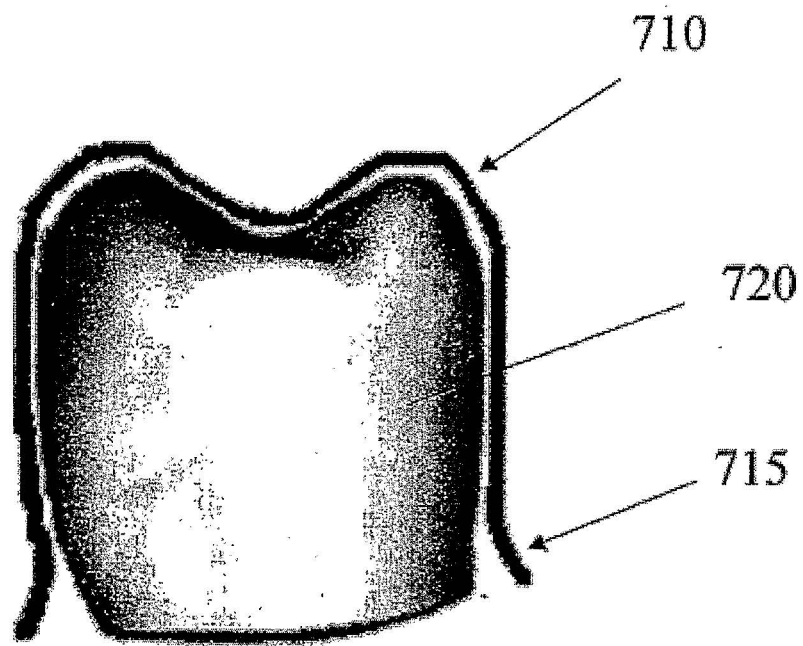


Figure 7

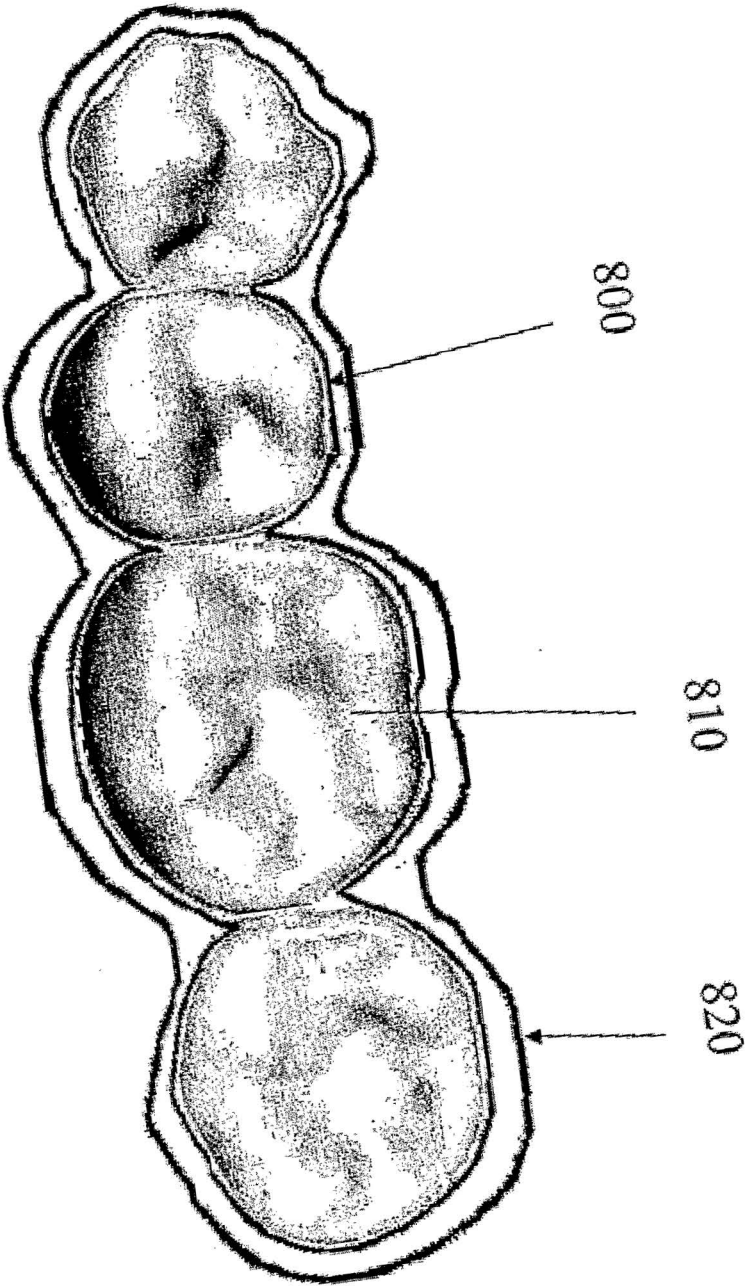


Figure 8

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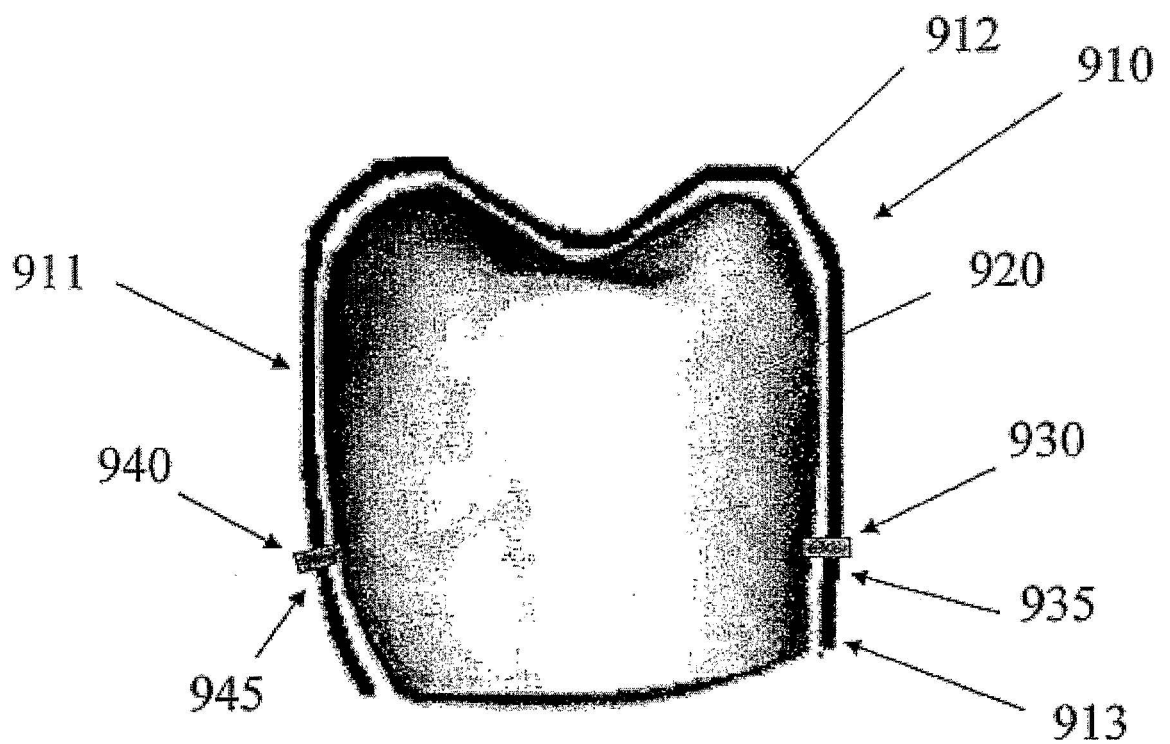
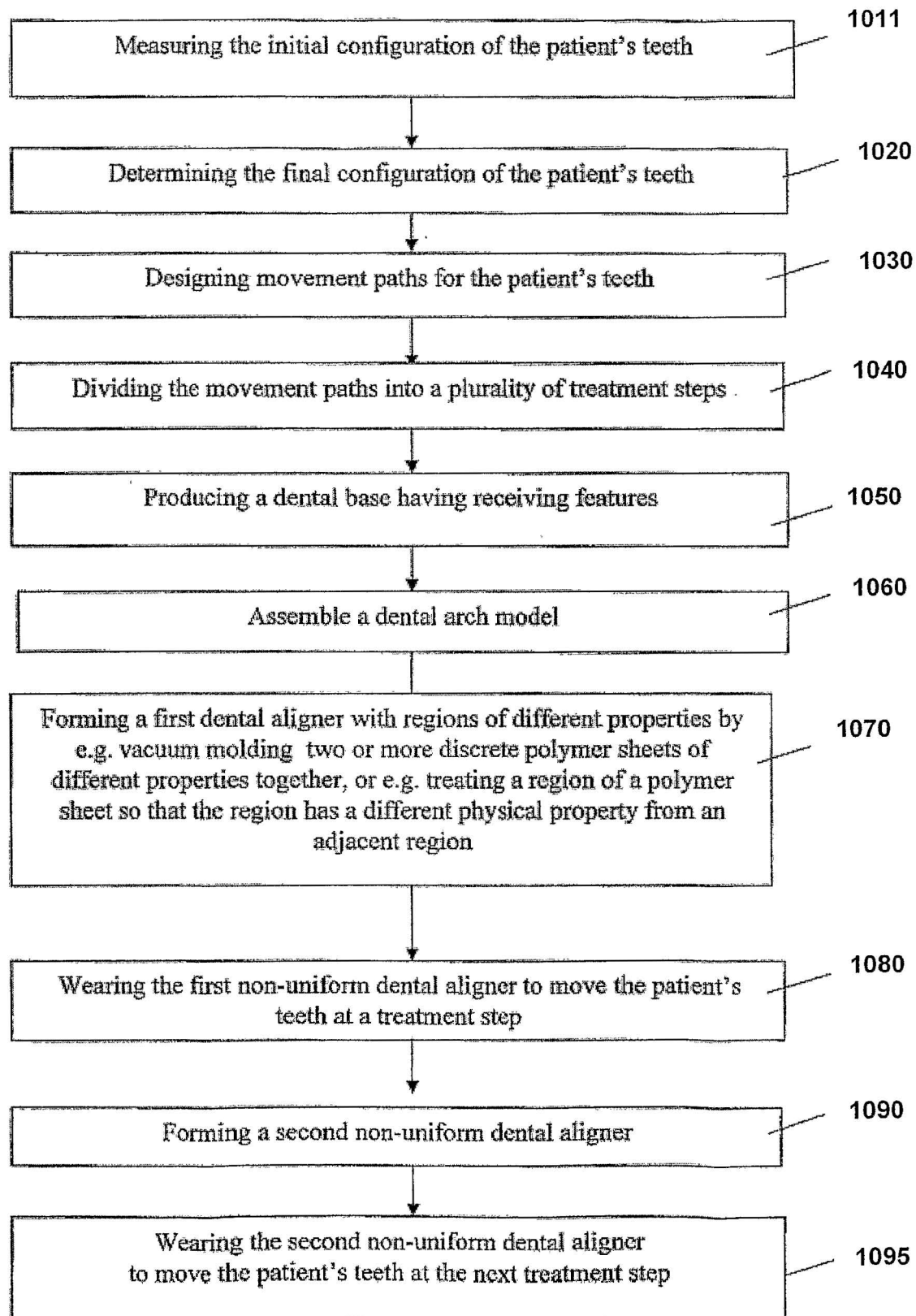


Figure 9

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Figure 10



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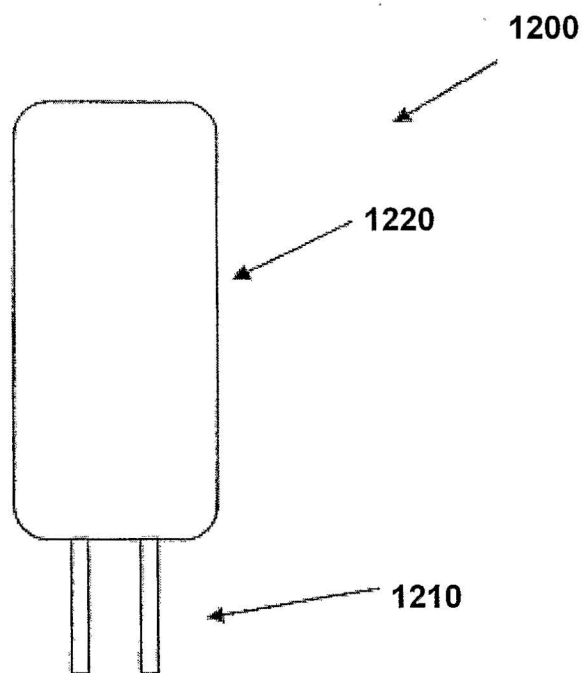


Figure 11

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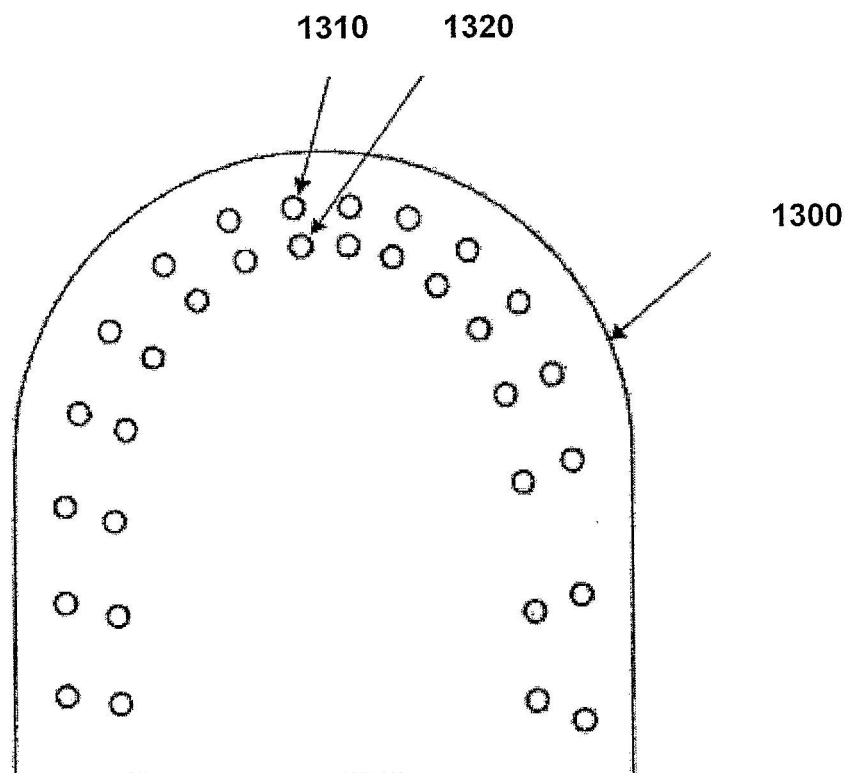


Figure 12

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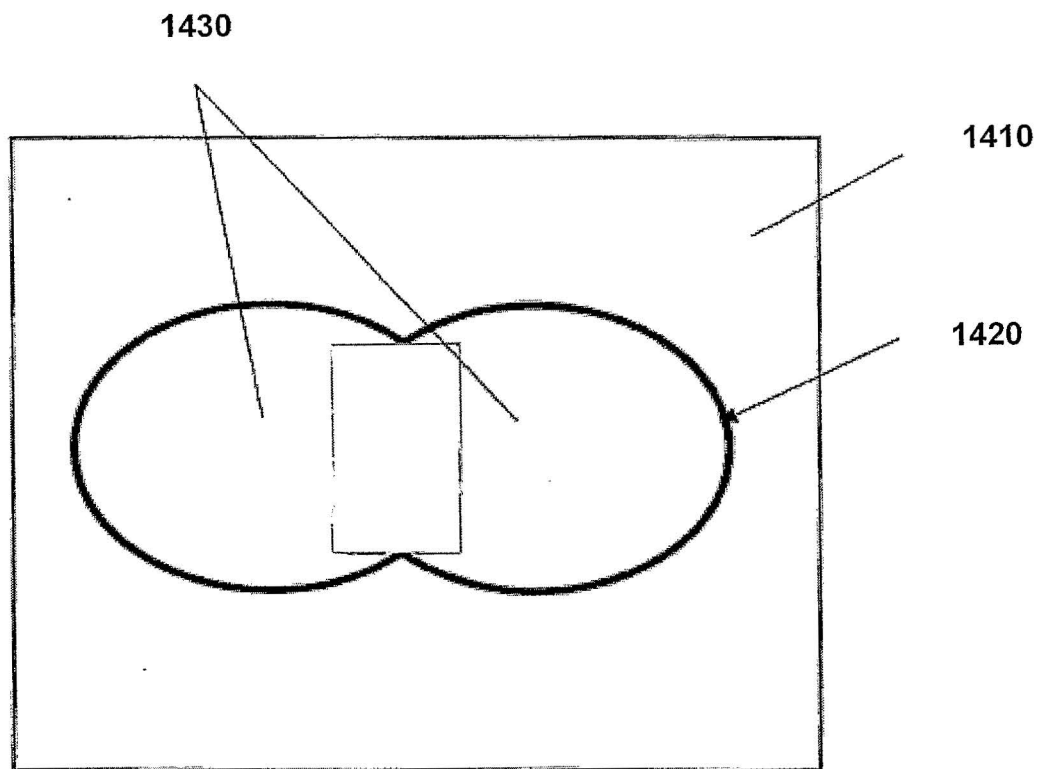


Figure 13

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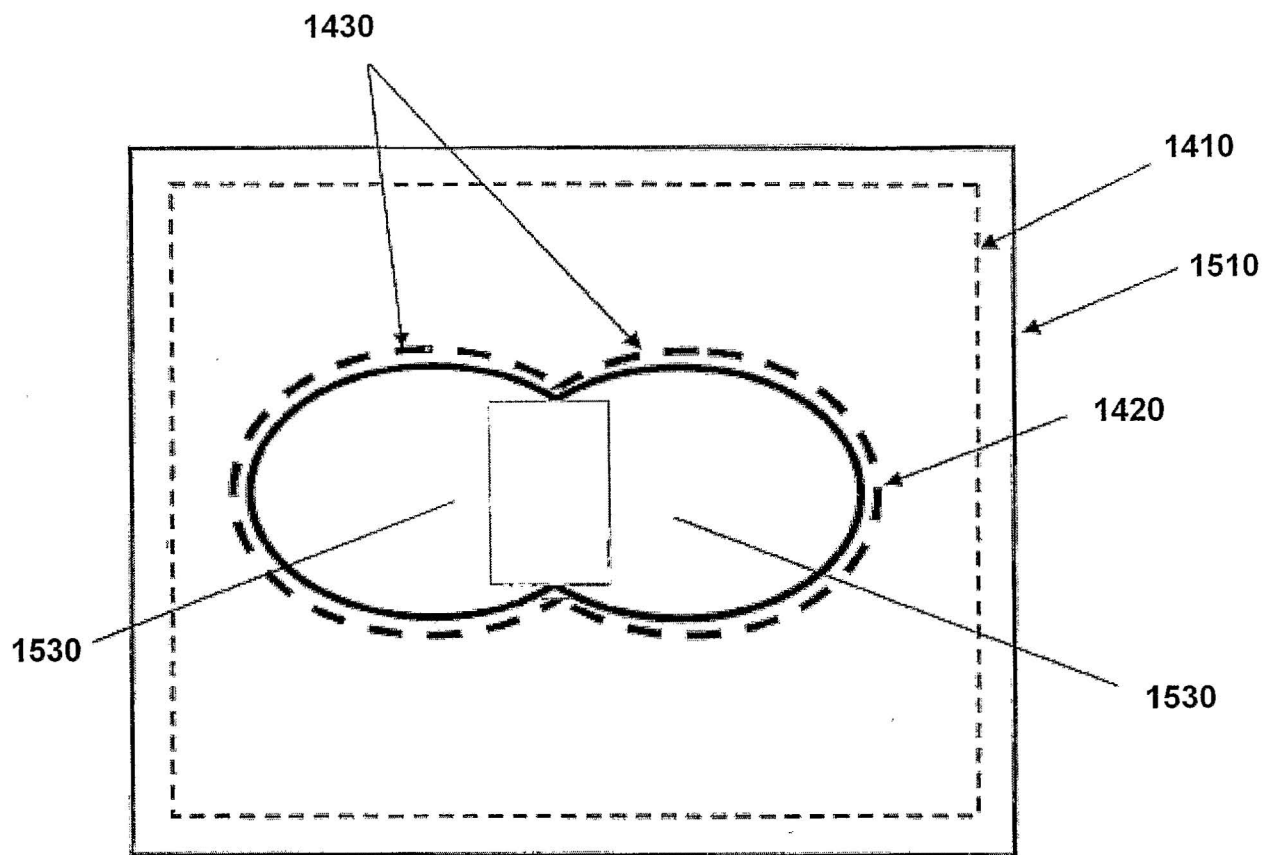


Figure 14

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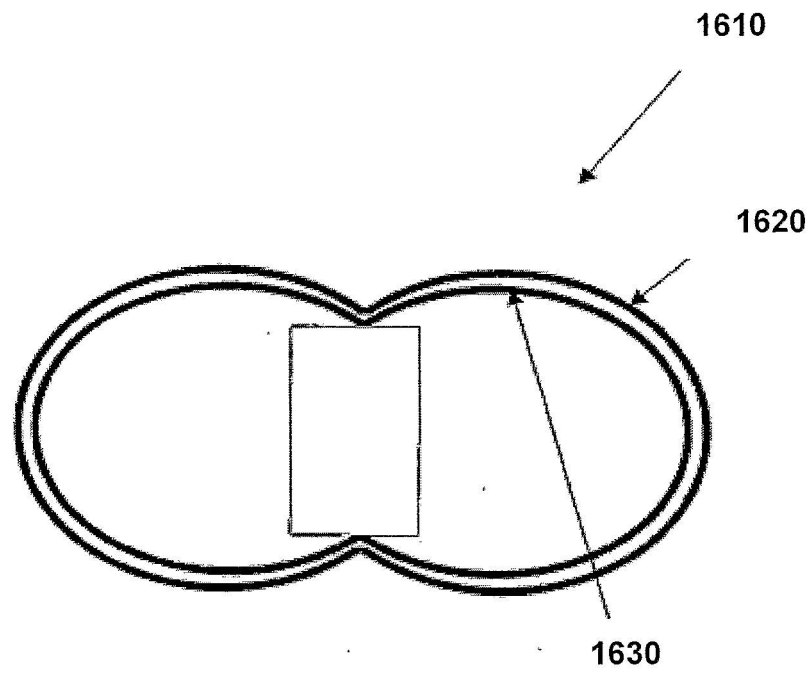


Figure 15

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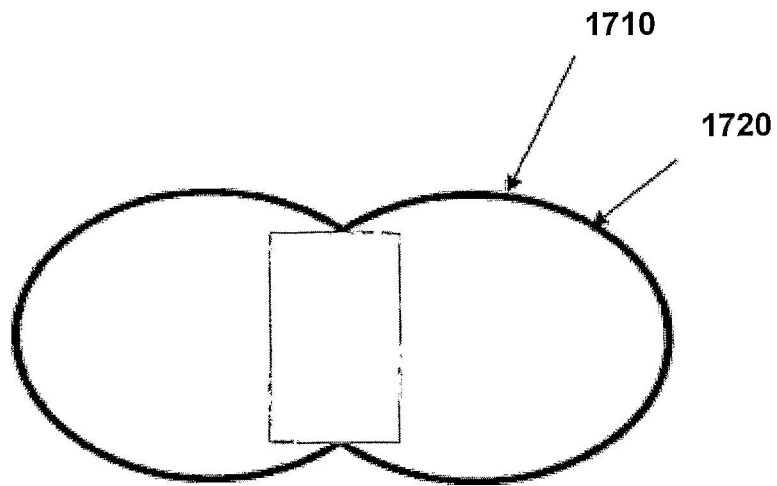


Figure 16

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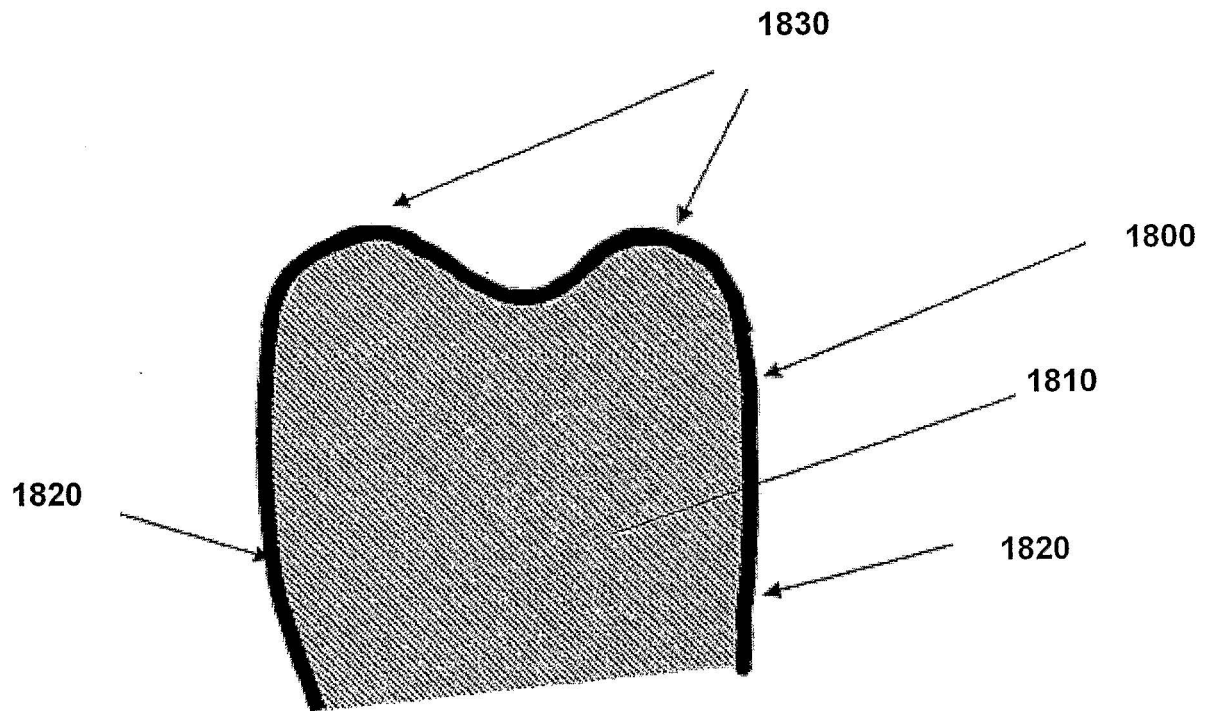


Figure 17

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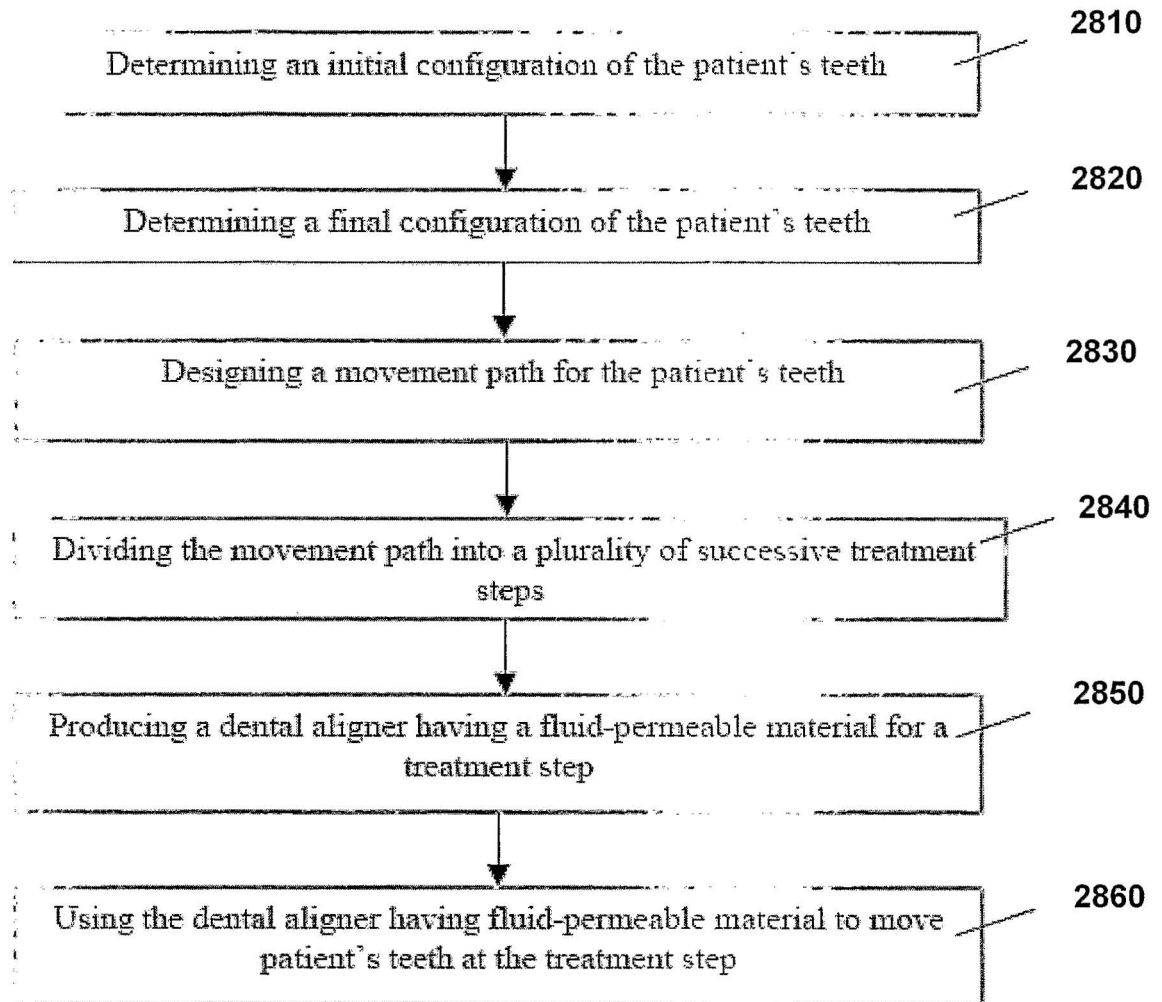


Figure 18

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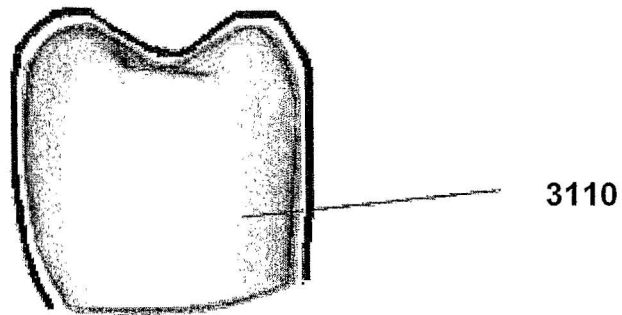


Figure 19a

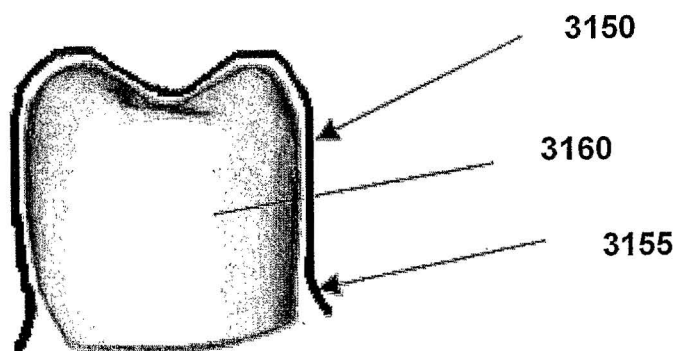


Figure 19b

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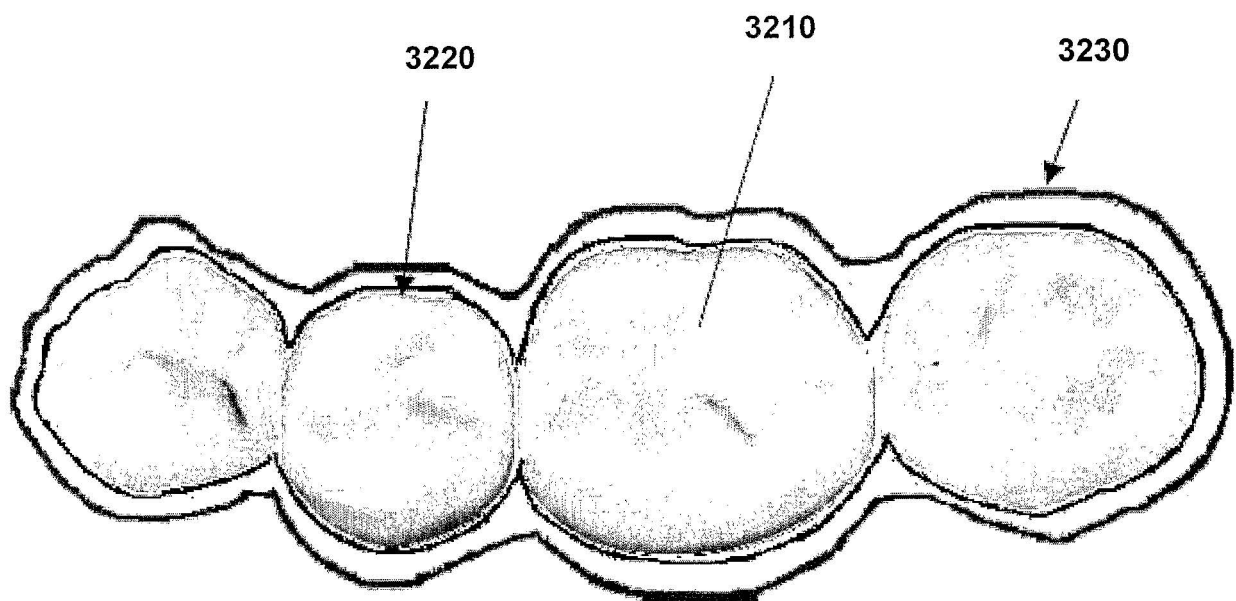


Figure 20

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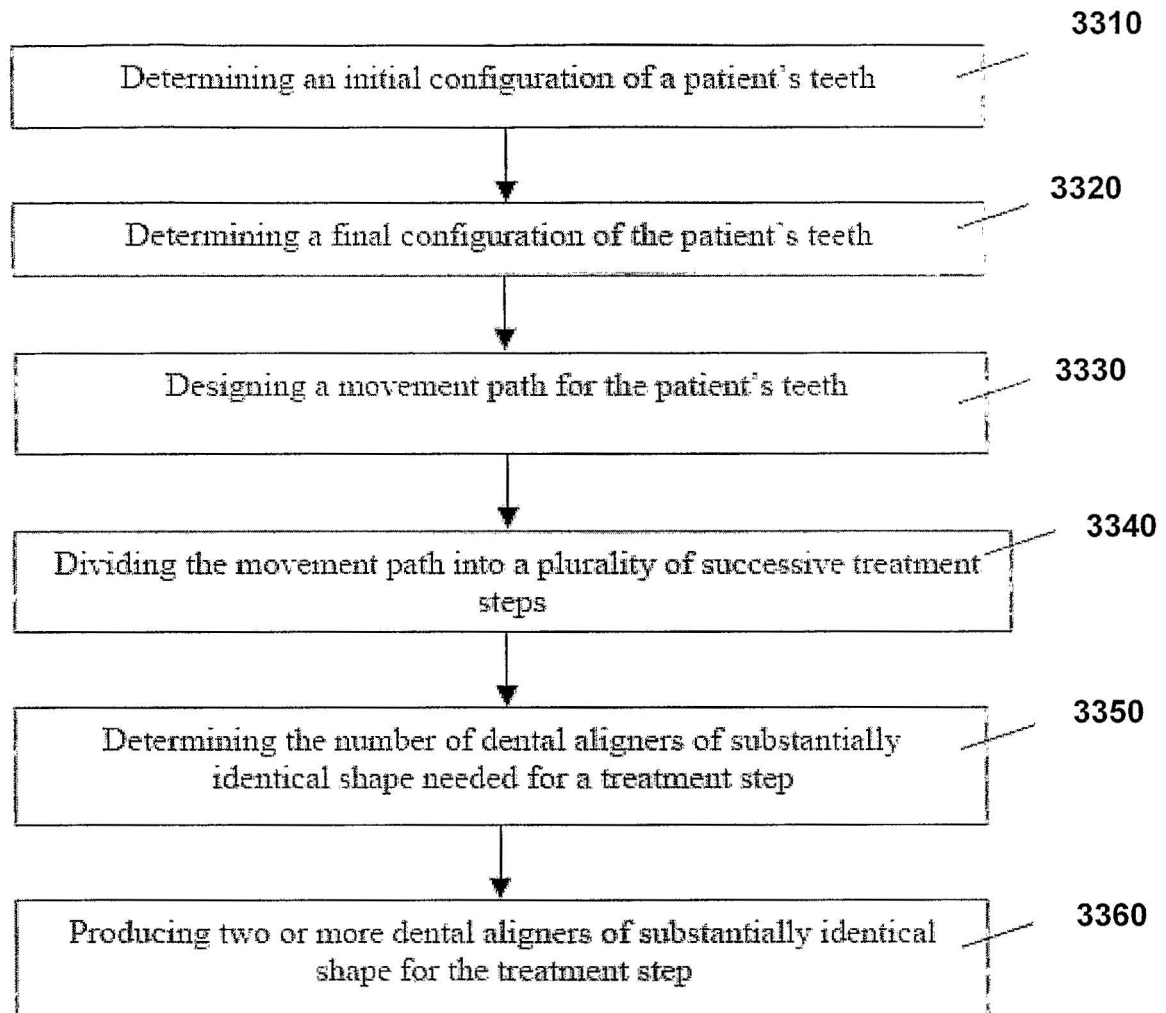


Figure 21

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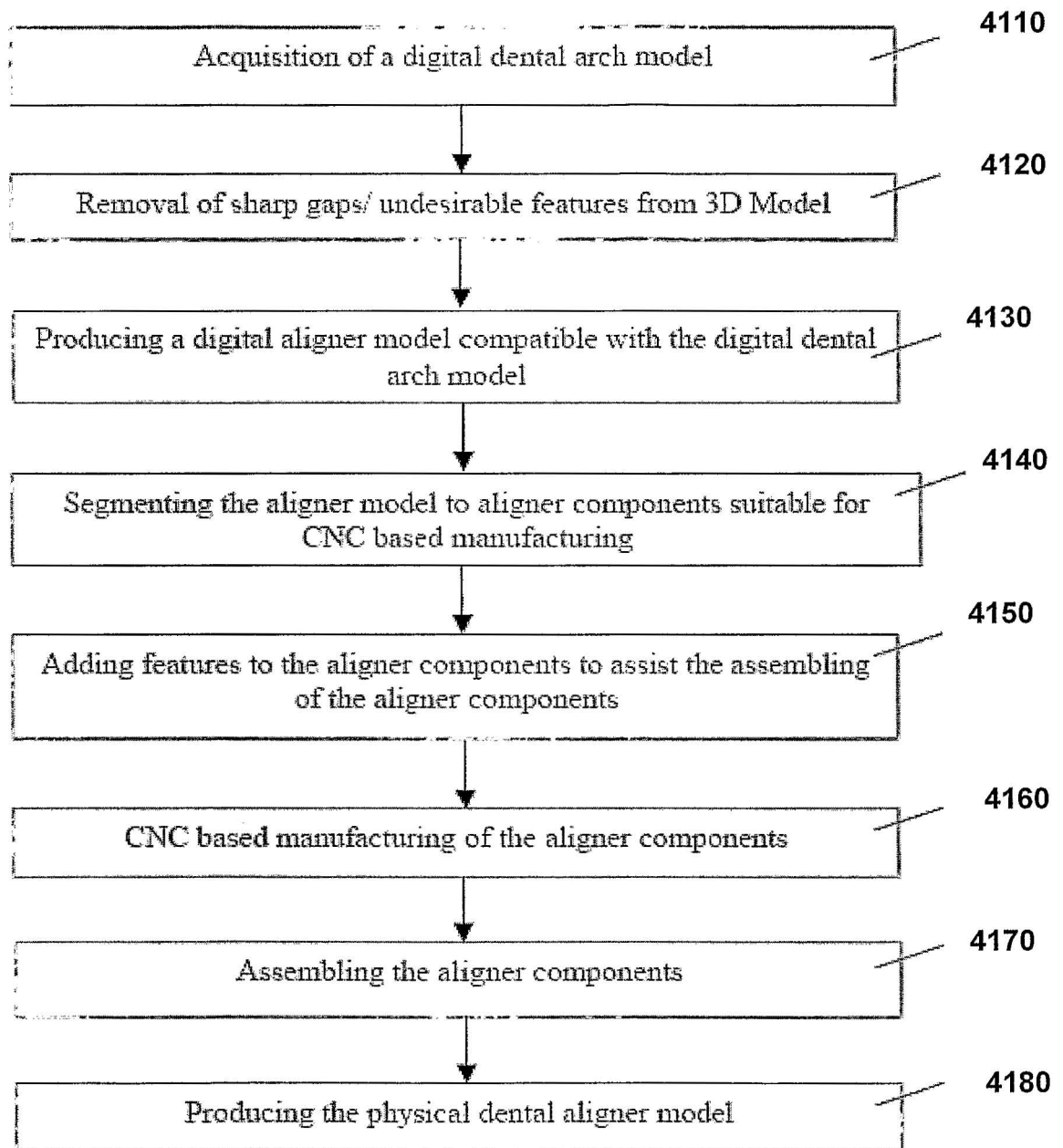


Figure 22

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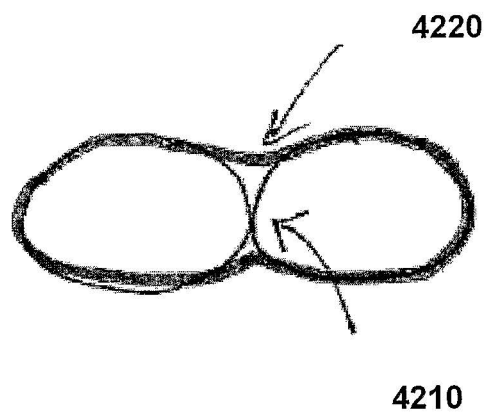


Figure 23

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4300

4310

4320

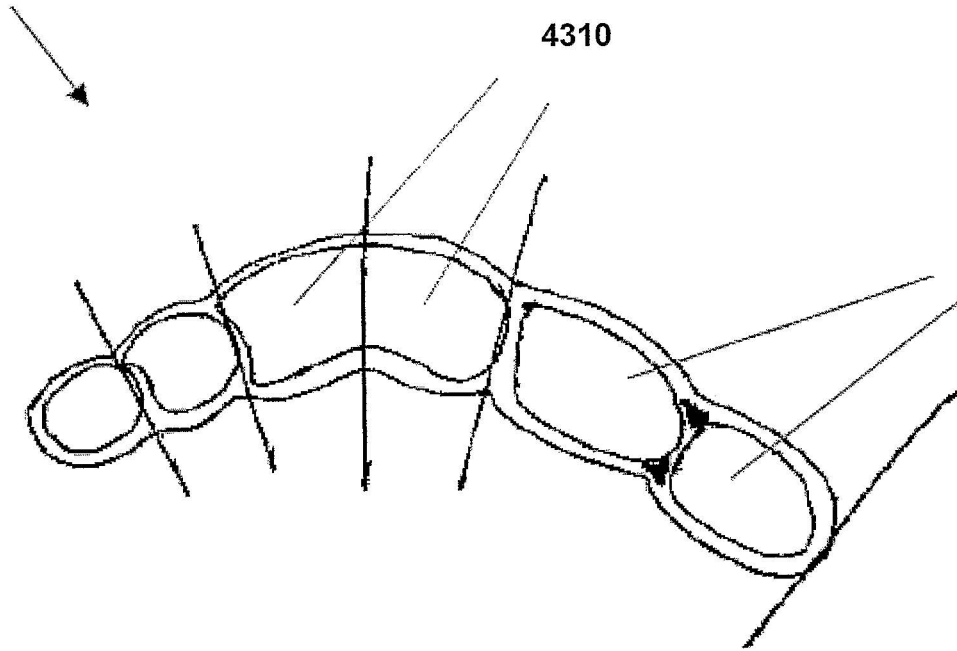


Figure 24

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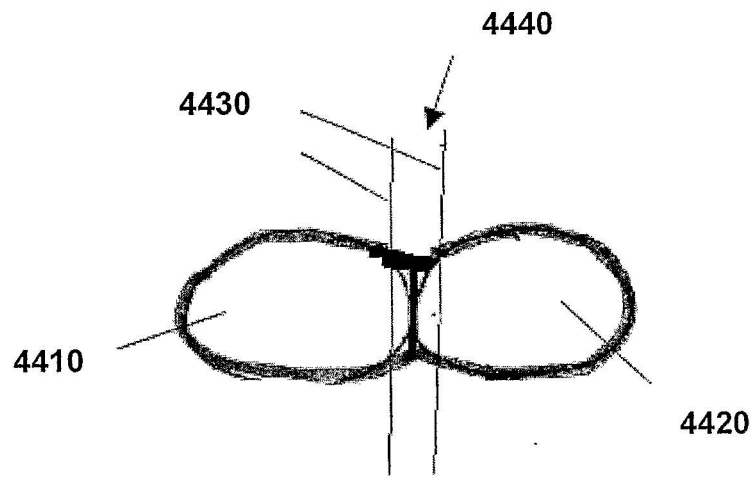


Figure 25a

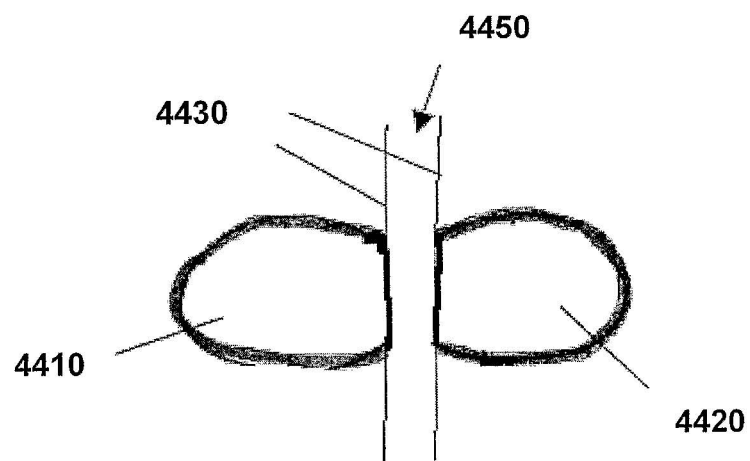


Figure 25b

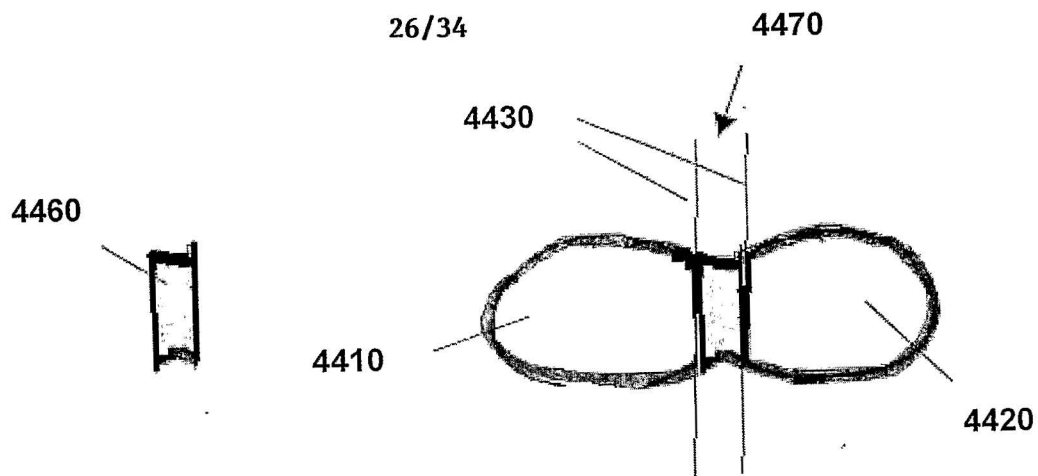


Figure 25c

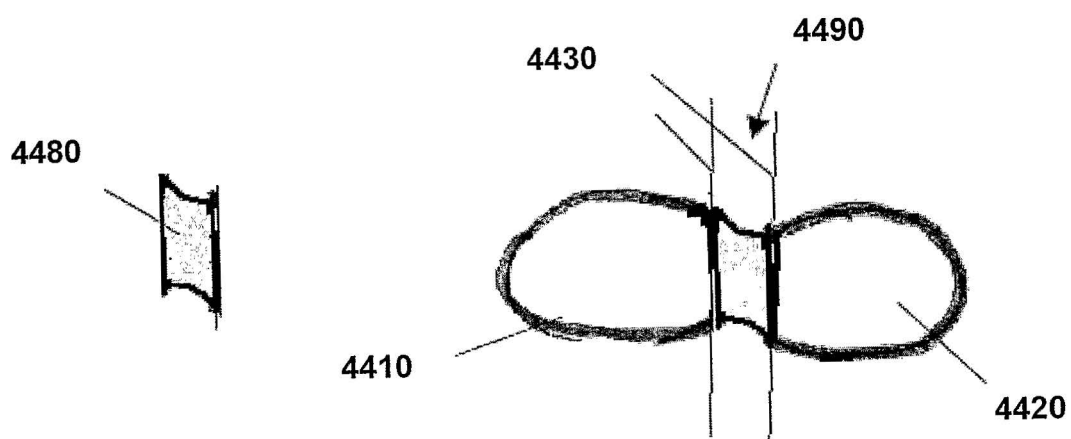


Figure 25d

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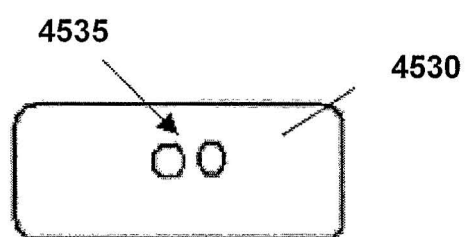
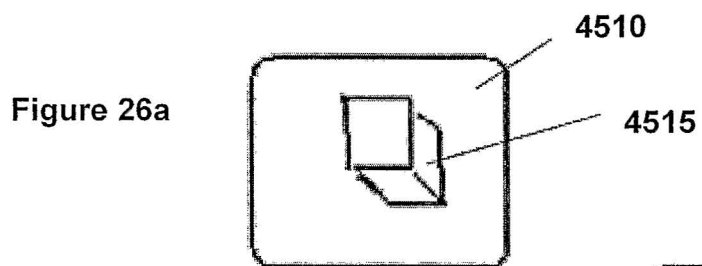


Figure 26c

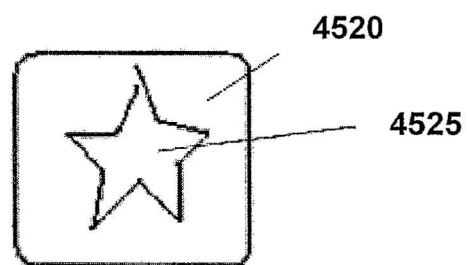


Figure 26b

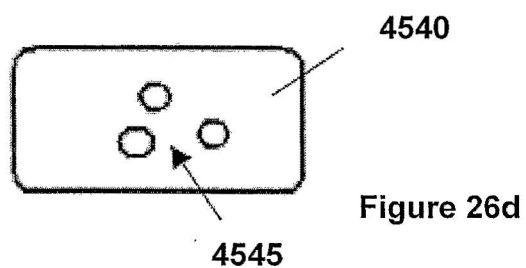


Figure 26d

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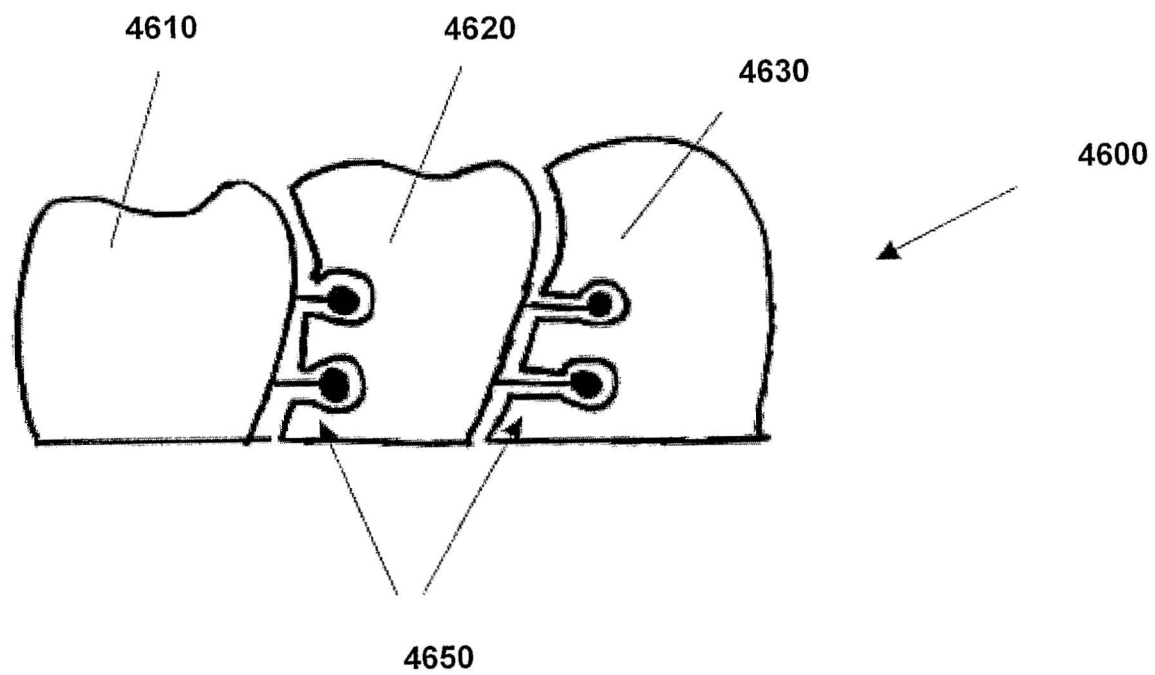


Figure 27

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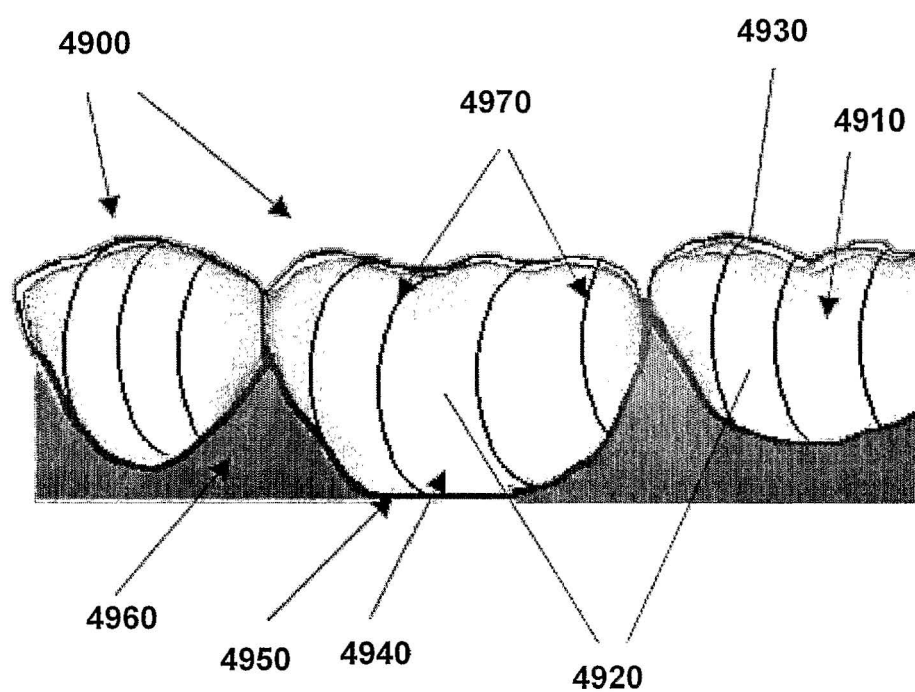


Figure 28

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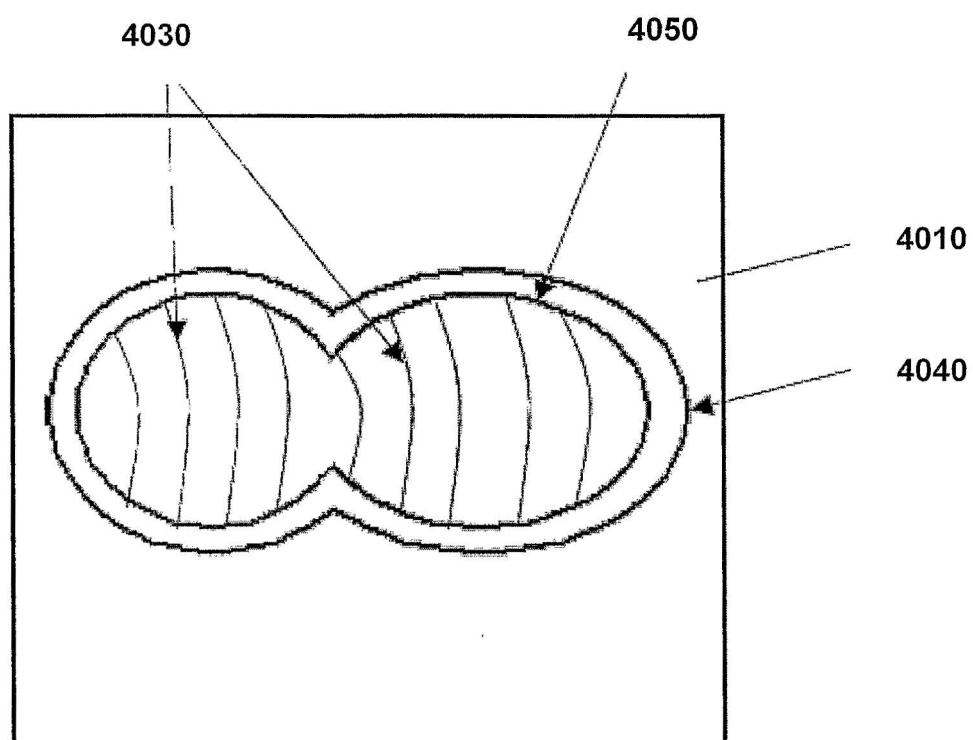


Figure 29

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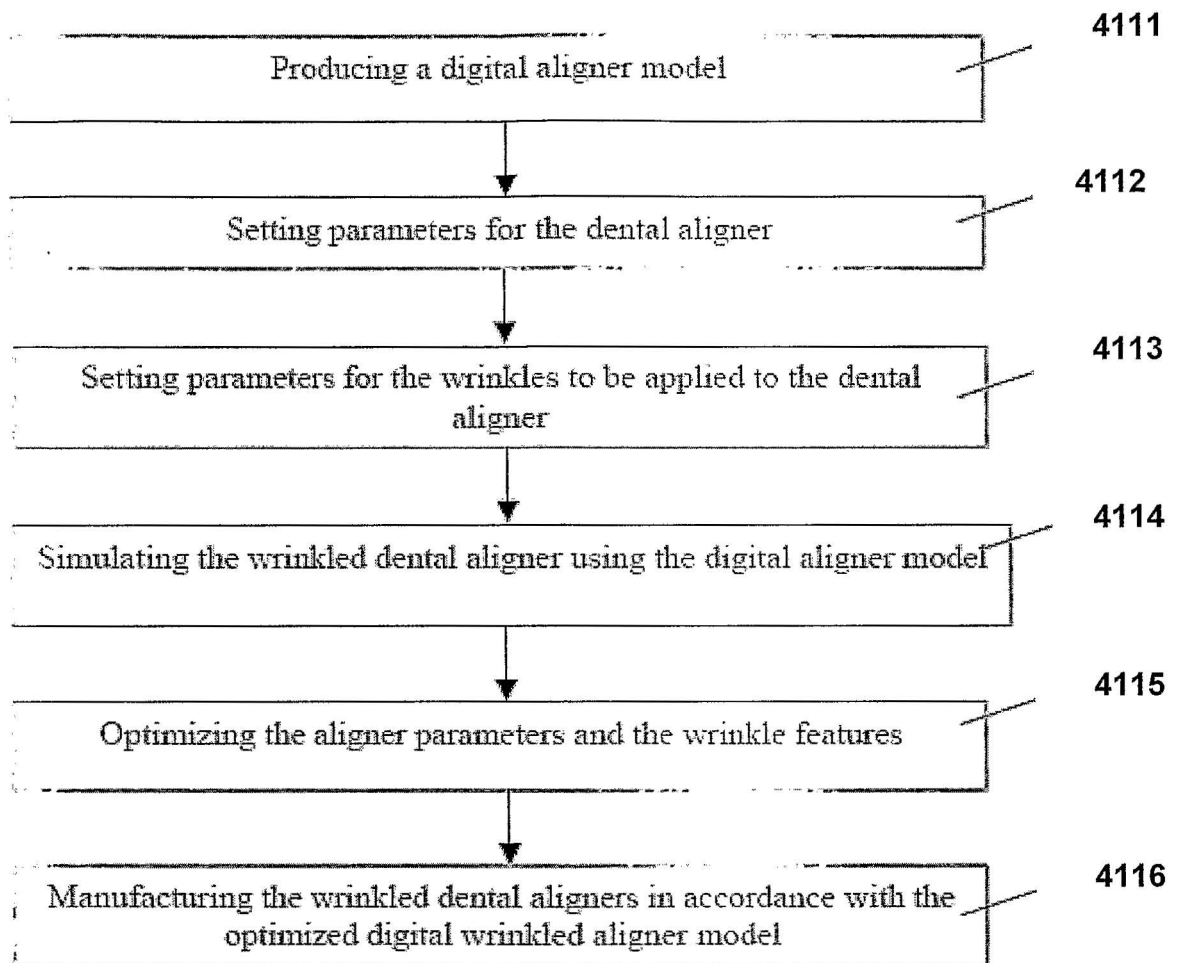


Figure 30

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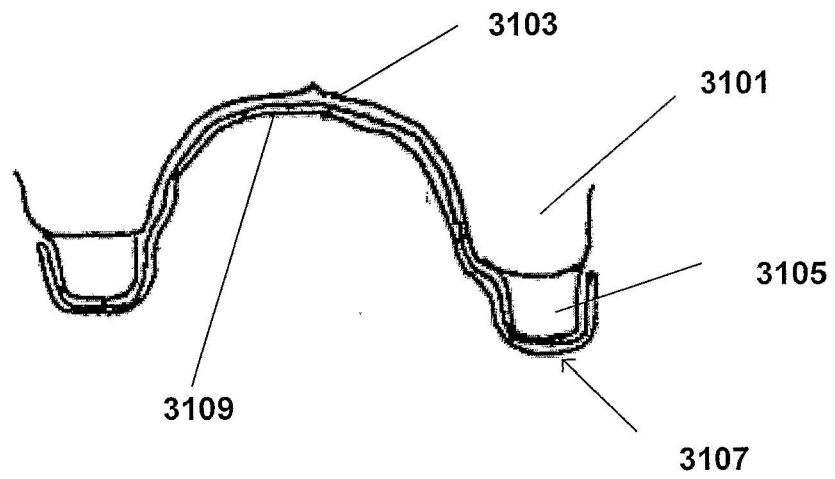


Figure 31a

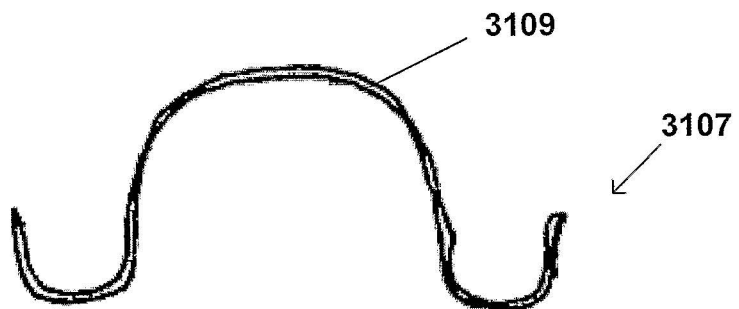


Figure 31b

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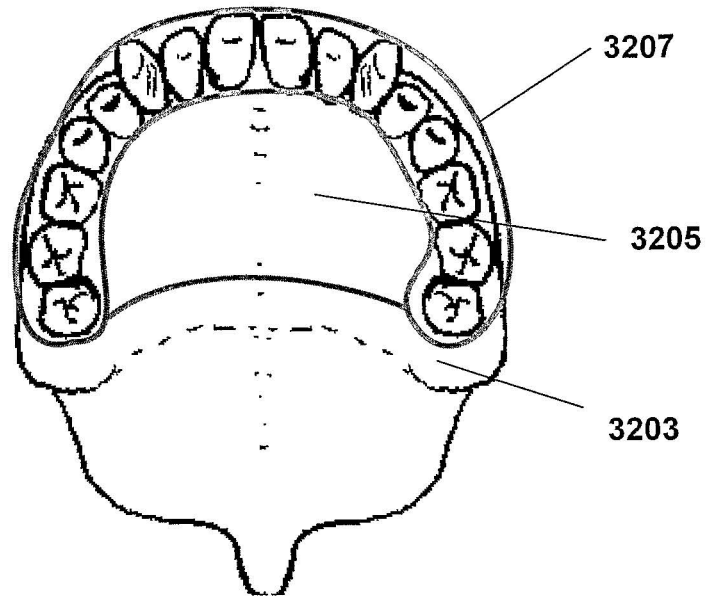


Figure 32a

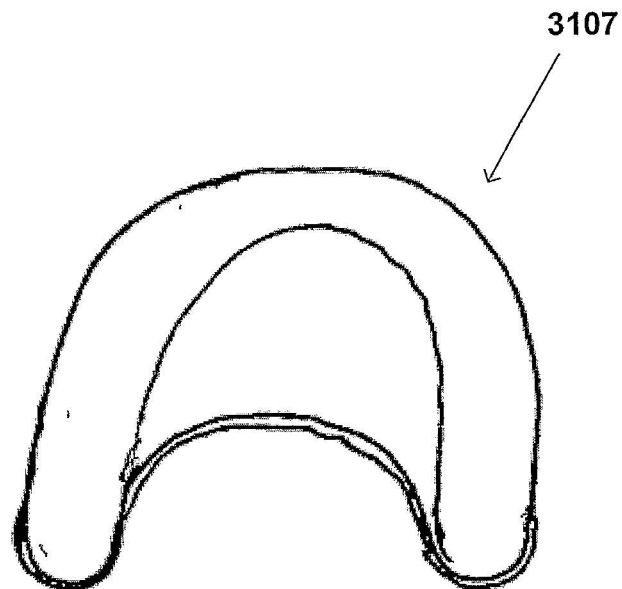


Figure 32b

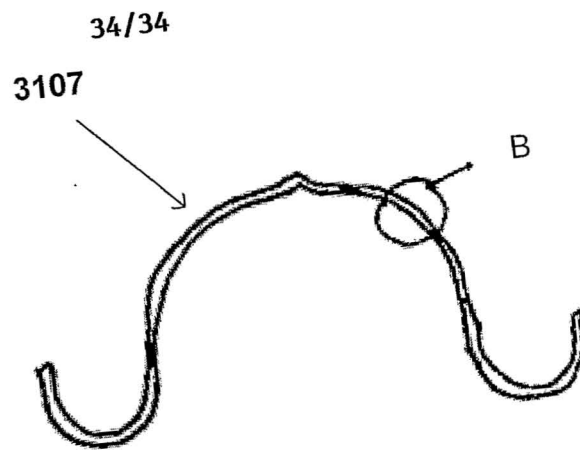


Figure 33a

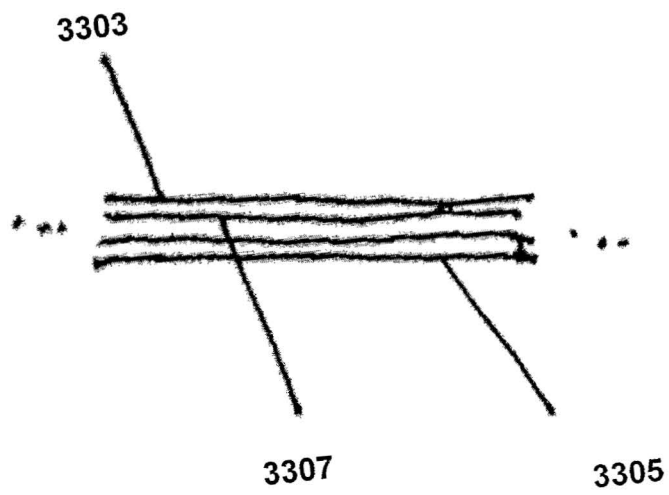


Figure 33b