



(51) International Patent Classification:

A61C 7/08 (2006.01) G06F 19/00 (2018.01)
A61C 7/00 (2006.01)

(21) International Application Number:

PCT/US2019/015639

(22) International Filing Date:

29 January 2019 (29.01.2019)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/624,281 31 January 2018 (31.01.2018) US
15/914,932 07 March 2018 (07.03.2018) US

(72) Inventors; and

(71) Applicants: **MOON, Won** [US/US]; 11917 Front Street, Norwalk, California 90650 (US). **ABDELBAR, Ehab** [EG/US]; 11917 Front Street, Norwalk, California 90650 (US). **KIM, Paul** [US/US]; 11917 Front Street, Norwalk, California 90650 (US).

(74) Agent: **LI, Zhaoyang**; 1600 Parkwood Circle, Suite 200, Atlanta, Georgia 30339 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,

CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(54) Title: ELASTIC ORTHODONTIC APPLIANCE

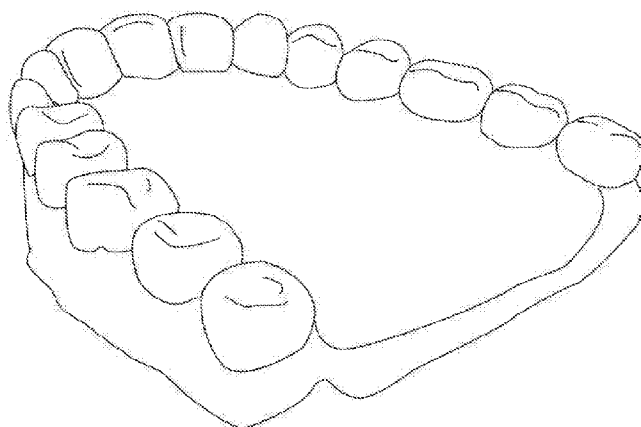


Figure 1

(57) Abstract: Provided herein is an orthodontic aligning appliance for moving tooth or teeth of a patient and methods of making and using the same. The orthodontic aligning appliance is formed of a material ("appliance forming material") having an elastic material in an amount that imparts to the aligner elastic properties such that the appliance exerts a continuous aligning force on a tooth or teeth, the elastic material is a material other than polyester, and the elastic material accounts for all or substantially all the elastic properties of the appliance.



ELASTIC ORTHODONTIC APPLIANCE

FIELD OF THE INVENTION

[0001] The present invention generally relates to an orthodontic aligning appliance and methods of making and using the same.

BACKGROUND OF THE INVENTION

[0002] Orthodontic tooth movement is accomplished by applying force to a tooth or set of teeth. This force causes a biological remodeling of the bone surrounding the teeth. This remodeling causes the tooth to shift and move inside the jaw bones. This orthodontic force can be applied by fixed and/or removable appliances. One type of appliances that is gaining popularity is orthodontic aligners or clear aligners. Clear aligners are a type of removable appliances used to move the teeth by having the patient wear the said aligner for 1-2 weeks and then switching to another sequential tray where they wear it for 1-2 weeks and so on and so forth.

[0003] Clear aligners are fabricated by thermoforming a heat sensitive clear plastic sheet onto a dental model of the teeth. In the aforementioned dental model, the teeth are shifted by a small increment in position and orientation. The concept is that when the patient wears the plastic trays they will flex and distort and apply force to the teeth forcing them into a new position similar to the dental model used to fabricate the tray. The process is repeated for the number of trays needed to place the teeth in an ideal position.

[0004] There are a few inherent problems with plastic aligners. The current plastic tooth re-alignment technologies using clear aligners exert intermittent aligning forces, and thus, requires at least several trays, and often times more than a dozen trays, and lengthy treatment time (about 2 years) to re-align the teeth to a desired position, resulting in waste of tray materials and onerous doctor visit times so as to make the technology uneconomical and sometimes cost prohibitive. Moreover, clear Aligners have a limited range of flexing before they are permanently deformed and hence they can only move the teeth by a small increment at a time. If a large incremental movement is attempted, then usually two things will occur, which are either: 1) aligners will lose track of the teeth and will not move them into the proposed position or orientation, or 2) the aligner will distort beyond plastic deformation and will be permanently deformed and might not fit into the patient's mouth all together. Additionally, the nature of the material used in the aligner dictates the

amount of force applied on the teeth and the rate at which the said force is dissipated. The plastic used in aligners applies a large amount of force initially and then it dissipates quickly. This is mainly due to the low flexibility of the material.

[0005] Further, the aforementioned force loading and dissipation is not biologically favorable in efficient tooth movement because it is considered a large intermittent force loading where teeth move faster and respond better to small continuous forces.

[0006] Therefore, there is a need for aligners that overcome the aforementioned shortcomings of the clear aligner.

[0007] Therefore, the embodiments described below address the above-identified issues and needs.

[0008] Because Aligners have a uniform thickness on the occlusal surface of the teeth. This can cause the posterior teeth to get imbedded inside the jaw bone (Intrusion movement). This is a general side effect of aligners that is usually very apparent with longer treatment times.

SUMMARY OF THE INVENTION

[0009] In one aspect of the present invention, it is provided an orthodontic appliance formed of a material (appliance forming material) comprising an elastic material in an amount that imparts to the aligner elastic properties such that the appliance exerts a continuous aligning force on a tooth or teeth, wherein the elastic material is a material other than polyester, and wherein the elastic material accounts for all or substantially all the elastic properties of the appliance.

[0010] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 10 wt% of the appliance forming material.

[0011] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 20 wt% of the appliance forming material.

[0012] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 30 wt% of the appliance forming material.

[0013] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 40 wt% of the appliance forming material.

[0014] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 50 wt% of the appliance forming material.

[0015] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 60 wt% of the appliance forming material.

[0016] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 70 wt% of the appliance forming material.

[0017] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 80 wt% of the appliance forming material.

[0018] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 90 wt% of the appliance forming material.

[0019] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 95 wt% of the appliance forming material.

[0020] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises between 0-100 %. e.g. $0 < x < 100$, where x is the elasticity.

[0021] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material has an elasticity that it is capable of being stretched at least 300% of its original length.

[0022] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material is selected from the group consisting of silicone or orthodontic power chain material, and orthodontic rubber bands.

[0023] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the appliance forming material further comprises a reinforcing material to enhance stability and anchorage of the appliance.

[0024] In a second aspect of the present invention, it is provided a method of forming an orthodontic appliance, comprising:

- creating a dental model of a patient tooth and bite,
- constructing individual teeth from the dental model,
- moving a tooth or teeth of target of alignment according to a prescription by a treating doctor to create an aligned dental model of the patient,
- forming at least one appliance from the aligned dental model of the patient, and
- wherein the appliance comprises an appliance forming material comprising an elastic material in an amount that imparts to the appliance elastic properties such that the appliance exerts a continuous aligning force on a tooth or teeth, and
- wherein the elastic material is a material other than polyester, and wherein the elastic material accounts for all or substantially all the elastic properties of the appliance.

[0025] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, moving a tooth or teeth of target comprises moving the tooth or teeth of target manually or using computer software.

[0026] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, forming an appliance comprises forming the appliance by direct 3D printing (Additive manufacturing), CNC Machining (Subtractive manufacturing) or by casting.

[0027] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, forming the appliance by casting comprises:

- 3D printing a cast-able appliance using a cast-able material,
- fabricating a mold from the cast-able appliance, and
- injecting into the mold the appliance forming material to form the appliance.

[0028] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the appliance forming material comprises a reinforcing material to enhance appliance stability, anchorage, and force loading.

[0029] In a third aspect of the present invention, it is provided a method of aligning a tooth or teeth of target of a patient, comprising:

- forming an appliance, and
- applying the appliance to the patient to move the tooth or teeth of target from an original position(s) to a prescribed position(s) according to a prescription by a treating doctor,

- wherein forming the appliance comprises:

- creating a dental model of a patient tooth and bite,
 - constructing individual teeth from the dental model,
 - moving a tooth or teeth of target of alignment according to a prescription by a treating doctor to create an aligned dental model of the patient,
 - forming at least one appliance from the aligned dental model of the patient,
- wherein the appliance comprises an appliance forming material comprising an elastic material in an amount that imparts to the appliance elastic properties such that the appliance exerts a continuous aligning force on a tooth or teeth, and
- wherein the elastic material is a material other than polyester, and wherein the elastic material accounts for all or substantially all the elastic properties of the appliance.

[0030] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the appliance is according to any of the various embodiments disclosed herein.

[0031] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the prescribed position is an intermediate position toward a final prescribed alignment of the tooth or teeth of target of alignment prescribed by a treating doctor.

[0032] In a further aspect of the present invention, it is provided an orthodontic aligner kit, comprising at least one appliance according to the various embodiments disclosed herein.

[0033] In some embodiments of the invention aligner kit, optionally in combination with any or all the various embodiments disclosed herein, the aligner comprises a plurality of appliances, wherein each appliance is formed by a method according to the various embodiments of method of invention.

DESCRIPTION OF THE DRAWINGS

[0034] Figure I is an image of an embodiment of the invention appliance showing a view of the top side (non-tooth contacting side) of the invention appliance.

[0035] Figure 2 is an image of an embodiment of the invention appliance showing a view of the bottom side (tooth/teeth contacting side) of the invention appliance.

[0036] Figure 3 shows an image of an embodiment of the invention appliance (top) being applied to teeth (bottom).

[0037] Figures 4A-4D show one aspect of the invention appliance over traditional aligner appliances.

DETAILED DESCRIPTION OF THE INVENTION

Definitions

[0038] As used herein, the term "original position" of tooth or teeth refers to the position of the tooth or teeth of the target of treatment prior to the treatment using the appliance of invention; and the term "final position" refers to position of such tooth or teeth at the conclusion time point of an orthodontic treatment course prescribed by a treating doctor; and the term "intermediate position" refers to any position between the original position and the final position of the tooth or teeth of the target of treatment prescribed by a treating doctor.

[0039] As used herein, the term "appliance" or "aligner", which is used interchangeably herein, refers to an orthodontic device for moving a tooth or teeth according to a prescription by a treating doctor. Clear orthodontic appliances refer to those made from a plastic material, which is generally a polyester material. Such clear appliances are exemplified by

Invisalign™ aligners. The Invisalign™ aligners, and methods of making and using the same, are described in general in U.S. Patent Nos. Pat. Nos. 6,450,807, and 5,975,893, the teaching of which is incorporated herein by reference in its entirety.

[0040] As used herein, the term "elastic appliance" refers to an orthodontic appliance capable of being stretched to a substantially higher degree than traditional polymer based clear aligners, such as the Invisalign™ aligners.

[0041] As used herein, the term "intermittent aligning force" refers to an aligning force generated by an aligner that substantially or entirely loses its strength due to characteristics of the material forming the aligner, e.g., due to fatigue, aging, degradation, erosion, or

breaking down of the material. In contrast, "continuous aligning force" refers to an aligning force that is not intermittent, an example of "intermittent aligning force" being the aligning force generated by conventional plastic orthodontic aligners such as the Invisalign™ aligners.

Orthodontic Appliances

[0042] In one aspect of the present invention, it is provided an orthodontic appliance formed of a material (appliance forming material) comprising an elastic material in an amount that imparts to the aligner elastic properties such that the appliance exerts a continuous aligning force on a tooth or teeth, wherein the elastic material is a material other than polyester, and wherein the elastic material accounts for all or substantially all the elastic properties of the appliance.

[0043] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 10 wt% of the appliance forming material.

[0044] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 20 wt% of the appliance forming material.

[0045] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 30 wt% of the appliance forming material.

[0046] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 40 wt% of the appliance forming material.

[0047] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 50 wt% of the appliance forming material.

[0048] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 60 wt% of the appliance forming material.

[0049] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 70 wt% of the appliance forming material.

[0050] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 80 wt% of the appliance forming material.

[0051] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 90 wt% of the appliance forming material.

[0052] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 95 wt% of the appliance forming material.

[0053] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises between 0-100 %. e.g. $0 < x < 100$, where x is the elasticity.

[0054] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material has an elasticity that it is capable of being stretched at least 300% of its original length.

[0055] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the elastic material is selected from the group consisting of silicone or orthodontic power chain material, and orthodontic rubber bands.

[0056] In some embodiments of the invention appliance, optionally in combination with any or all the various embodiments disclosed herein, the appliance forming material further comprises a reinforcing material to enhance stability and anchorage of the appliance.

Appliance Forming Materials

[0057] Appliance forming materials usable for forming the elastic appliance of invention can be any biocompatible elastic materials. As used herein, the term "elastic material" generally refers to materials which possess high elasticity (i.e.) which can be stretched

several times its original length (at least 300%) and upon releasing of the stress (stretching force), it returns back to its original shape and dimensions.

[0058] Examples of elastic materials useful in the present invention include elastomers, which are the class of polymer materials with high elastic nature. Elastomers show entropy-dependent elasticity. The polymer chains return back to the original state because it prefers to be in the lowest state of entropy. Elastomers are the class of polymer materials with high elastic nature and they include natural rubber, synthetic rubber, nitrile rubber, silicone rubber, urethane rubbers, chloroprene rubber, Ethylene Vinyl Acetate (EVA rubber), ethylene propylene diene monomer (M-class) rubber (EPDM), styrene-butadiene rubber (SBR), etc.

[0059] The appliance forming materials can be substantially all elastic materials or, in some embodiments, can include other materials, such as a reinforcing material. In some embodiments, the appliance forming material specifically exclude a polyester material.

[0060] As used herein, the term "reinforcing material" refers to any material capable of enhancing appliance stability, anchorage, and force loading. To enhance stability of an orthodontic appliance, such reinforcing material imparts attributes to the appliance that inhibits or prevents degradation or erosion of the appliance such that the appliance retains its elasticity and aligning force over the entire course of treatment or, alternatively, over a period of 2 weeks, 4 weeks, 6 weeks, 8 weeks, 12 weeks, 16 weeks, 20 weeks, 24 weeks, 26 weeks or 28 weeks, retaining at least 80% (e.g., about 85%, 90%, 95%, 98%, or about 99%) of its elasticity and/or aligning force.

[0061] To enhance anchorage of an orthodontic appliance, such reinforcing material imparts, for example, attributes that allows the appliance to be anchored at a point or an area in the oral cavity. Such attributes can be, for example, adhesion, and thus, a reinforcing material that enhances adhesion of the appliance would be useful.

[0062] Examples of such reinforcing materials can include a fiber material, which fiber material can be, for example, polyester fibers, or polyethylene fibers.

[0063] Another example of such reinforcing material is metallic alloys used in orthodontics or dentistry in general (ST. steel, Ni Ti, TMA, Cu-Ni Ti).

[0064] The physical properties of the elastic material (modulus of elasticity, stiffness, etc.) can be readily modified according to the type of orthodontic movement needed with any specific case.

[0065] The appliance of invention of elastic material will have the shape of individual teeth so that it fits around individual teeth. Using the analogy of glover-fingers, the appliance of invention fits around individual teeth like a glove fits individual fingers, and using the same analogy, previous art plastic aligners cover teeth like a mitten covers the fingers where all the fingers are wrapped around with no internal boundary. The invention appliance covers individual teeth and wrap around them to eliminate the tracking error problem of prior art.

[0066] In some embodiments, the internal dimensions of the elastic appliance can have the same size of the teeth to provide perfect fit or they can be designed to be slightly smaller, which is made possible due to the elasticity of the elastic appliance forming material. The combination of smaller size and elastic material will entail that the aligner will be slightly stretched and hence provide a better grip on individual teeth.

[0067] In some embodiments, the appliance of invention can have very thin or no coverage in areas where upper and lower teeth interact or touch. This will eliminate the intrusion side effect mentioned earlier in the prior art.

[0068] In some further embodiments, the elastic appliance of invention can have variable thickness either before fitting into the patient mouth or due to variable stretching that will happen after fitting into the patient mouth.

[0069] An advantage of the invention appliance is that it can be made to exert a relatively lighter force that will span for a longer time period before dissipating and another activation is needed. This provided a more biologically compatible and favorable force loading leading to more efficient and comfortable tooth movement.

Aligner Kit

[0070] Figure 1 shows an image of an embodiment of the invention appliance showing a view of the top side (non-tooth contacting side) of the invention appliance. Figure 2 is an image of an embodiment of the invention appliance showing a view of the bottom side (tooth/teeth contacting side) of the invention appliance.

[0071] In a further aspect of the present invention, it is provided an orthodontic aligner kit, comprising at least one appliance according to the various embodiments disclosed herein.

[0072] In some embodiments of the invention aligner kit, optionally in combination with any or all the various embodiments disclosed herein, the aligner comprises a plurality of

appliances, wherein each appliance is formed by a method according to the various embodiments of method of invention.

[0073] In some embodiments of the invention aligner kit, optionally in combination with any or all the various embodiments disclosed herein, the plurality of appliances have up to three appliances.

Method of Fabrication

[0074] In a second aspect of the present invention, it is provided a method of forming an orthodontic appliance, comprising:

- creating a dental model of a patient tooth and bite,
- constructing individual teeth from the dental model,
- moving a tooth or teeth of target of alignment according to a prescription by a treating doctor to create an aligned dental model of the patient,
- forming at least one appliance from the aligned dental model of the patient,
- wherein the appliance comprises an appliance forming material comprising an elastic material in an amount that imparts to the appliance elastic properties such that the appliance exerts a continuous aligning force on a tooth or teeth, and
- wherein the elastic material is a material other than polyester, and wherein the elastic material accounts for all or substantially all the elastic properties of the appliance.

[0075] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, moving a tooth or teeth of target comprises moving the tooth or teeth of target manually or using computer software.

[0076] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, forming an appliance comprises forming the appliance by direct 3D printing or by casting.

[0077] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, forming the appliance by casting comprises:

- 3D printing a cast-able appliance using a cast-able material,
- fabricating a mold from the cast-able appliance, and
- injecting into the mold the appliance forming material to form the appliance.

[0078] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the appliance forming material comprises a reinforcing material to enhance appliance stability and anchorage.

[0079] 3D-printing and casting are well documented methods of fabricating a 3D object.

[0080] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 10 wt% of the appliance forming material.

[0081] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 20 wt% of the appliance forming material.

[0082] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 50 wt% of the appliance forming material.

[0083] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 80 wt% of the appliance forming material.

[0084] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 90 wt% of the appliance forming material.

[0085] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 95 wt% of the appliance forming material.

[0086] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the elastic material has an elasticity that it is capable of being stretched at least 300% of its original length.

[0087] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the elastic material is selected from the group consisting of silicone or power chain material, and orthodontic rubber bands.

[0088] Methods of computer aided fabrication of orthodontic appliances are well documented in the art. Examples of such methods are described in U.S. Patent Nos.

6,450,807 and 5,975,893, the teaching of which is incorporated herein by reference in its entirety.

Method of Use

[0089] In a third aspect of the present invention, it is provided a method of aligning a tooth or teeth of target of a patient, comprising:

- forming an appliance, and
- applying the appliance to the patient to move the tooth or teeth of target from an original position(s) to a prescribed position(s) according to a prescription by a treating doctor,
- wherein forming the appliance comprises:
 - creating a dental model of a patient tooth and bite,
 - constructing individual teeth from the dental model,
 - moving a tooth or teeth of target of alignment according to a prescription by a treating doctor to create an aligned dental model of the patient,
 - forming at least one appliance from the aligned dental model of the patient,
 - wherein the appliance comprises an appliance forming material comprising an elastic material in an amount that imparts to the appliance elastic properties such that the appliance exerts a continuous aligning force on a tooth or teeth, and
 - wherein the elastic material is a material other than polyester, and wherein the elastic material accounts for all or substantially all the elastic properties of the appliance.

[0090] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the appliance is according to any of the various embodiments disclosed herein.

[0091] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the prescribed position is an intermediate position toward a final prescribed alignment of the tooth or teeth of target of alignment prescribed by a treating doctor.

[0092] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 10 wt% of the appliance forming material.

[0093] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 20 wt% of the appliance forming material.

[0094] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 50 wt% of the appliance forming material.

[0095] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 80 wt% of the appliance forming material.

[0096] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 90 wt% of the appliance forming material.

[0097] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the elastic material comprises at least 95 wt% of the appliance forming material.

[0098] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the elastic material has an elasticity that it is capable of being stretched at least 300% of its original length.

[0099] In some embodiments of the invention method, optionally in combination with any or all the various embodiments disclosed herein, the elastic material is selected from the group consisting of silicone or power chain material, and orthodontic rubber bands.

[0100] Figure 3 shows an image of an embodiment of the invention appliance (top) being applied to teeth (bottom).

[0101] The following examples illustrate rather than limit the embodiments of the present invention.

Examples

Example 1. 3D-printing fabrication of orthodontic appliance

[0102] An elastic orthodontic appliance of invention was fabricated by 3D-printing using an appliance forming material using the method disclosed herein. Figure 1 shows an image

of the appliance viewed from the non-tooth contacting side, and Figure 2 shows an image of the appliance viewed from the tooth contacting side.

[0103] Figure 3 shows an image of an embodiment of the invention appliance (top) being applied to teeth (bottom).

[0104] Figures 4A-4D show one aspect of the invention appliance over traditional aligner appliances in that the invention appliance significantly reduces the aligning steps in orthodontic treatment.

[0105] While various embodiments of the present invention have been shown and described herein, it will be obvious that such embodiments are provided by way of example only. Numerous variations, changes and substitutions may be made without departing from the invention herein. Accordingly, it is intended that the invention be limited only by the spirit and scope of the appended claims.

[0106] The teachings of the references, including patents and patent related documents, cited herein are incorporated herein in their entirety to the extent not inconsistent with the teachings herein.

We Claim:

1. An orthodontic appliance formed of a material (“appliance forming material”) comprising an elastic material in an amount that imparts to the aligner elastic properties such that the appliance exerts a continuous aligning force on a tooth or teeth along a dental arch, wherein the elastic material is a material other than polyester,
 - wherein the elastic material accounts for all or substantially all the elastic properties of the appliance,
 - wherein the elastic material comprises at least 10 wt% of the appliance forming material, and
 - wherein the orthodontic appliance comprises tooth sockets that correspond to each tooth on the dental arch.
2. The orthodontic appliance according to claim 1, wherein the elastic material comprises at least 20 wt% of the appliance forming material.
3. The orthodontic appliance according to claim 1, wherein the elastic material comprises at least 50 wt% of the appliance forming material.
4. The orthodontic appliance according to claim 1, wherein the elastic material comprises at least 80 wt% of the appliance forming material.
5. The orthodontic appliance according to claim 1, wherein the elastic material comprises at least 90 wt% of the appliance forming material.
6. The orthodontic appliance according to claim 1, wherein the elastic material comprises at least 95 wt% of the appliance forming material.
7. The orthodontic appliance according to claim 1, wherein the elastic material has an elasticity that it is capable of being stretched at least 300% of its original length.
8. The orthodontic appliance according to claim 1, wherein the elastic material is selected from the group consisting of silicone rubber or power chains, and orthodontic rubber bands.
9. The orthodontic appliance according to claim 1, wherein the appliance forming material further comprises a reinforcing material to enhance stability and anchorage of the appliance.

10. A method of forming an orthodontic appliance, comprising:
 - creating a dental model of a patient tooth and bite, constructing individual teeth from the dental model,
 - moving a tooth or teeth of target of alignment according to a prescription by a treating doctor to create an aligned dental model of the patient,
 - forming at least one appliance from the aligned dental model of the patient;
 - wherein the appliance comprises an appliance forming material comprising an elastic material in an amount that imparts to the appliance elastic properties such that the appliance exerts a continuous aligning force on a tooth or teeth, and
 - wherein the elastic material is a material other than polyester, and wherein the elastic material accounts for all or substantially all the elastic properties of the appliance.
11. The method according to claim 10, wherein moving a tooth or teeth of target comprises moving the tooth or teeth of target manually or using computer software.
12. The method according to claim 10, wherein forming an appliance comprises forming the appliance by direct 3D printing or by casting.
13. The method according to claim 12, wherein forming the appliance by casting comprises:
 - 3D printing a cast-able appliance using a cast-able material, fabricating a mold from the cast-able appliance, and
 - injecting into the mold the appliance forming material to form the appliance.
14. The method according to claim 12, wherein the appliance forming material comprises a reinforcing material to enhance appliance stability and anchorage.
15. A method of aligning a tooth or teeth of target of a patient, comprising:
 - forming an appliance, and
 - applying the appliance to the patient to move the tooth or teeth of target from an original position(s) to a prescribed position(s) according to a prescription by a treating doctor,
 - wherein forming the appliance comprises:
 - creating a dental model of a patient tooth and bite, constructing individual teeth from the dental model,
 - moving a tooth or teeth of target of alignment according to a

prescription by a treating doctor to create an aligned dental model of the patient, and forming at least one appliance from the aligned dental model of the patient,

wherein the appliance comprises an appliance forming material comprising an elastic material in an amount that imparts to the appliance elastic properties such that the appliance exerts a continuous aligning force on a tooth or teeth, and

wherein the elastic material is a material other than polyester, and wherein the elastic material accounts for all or substantially all the elastic properties of the appliance.

16. The method of claim 15, wherein the elastic material is selected from the group consisting of silicone or power chain material, and orthodontic rubber bands.

17. The method of claim 15, wherein the elastic material comprises at least 10 wt% of the appliance forming material.

18. The method of claim 15, wherein the elastic material comprises at least 50 wt% of the appliance forming material.

19. The method of claim 15, wherein the elastic material comprises at least 80 wt% of the appliance forming material.

20. The method of claim 15, wherein the appliance forming material further comprises a reinforcing material to enhance stability and anchorage of the appliance.

21. The method of claim 15, wherein the prescribed position is an intermediate position toward a final prescribed alignment of the tooth or teeth of target of alignment prescribed by a treating doctor.

22. An orthodontic aligner kit, comprising at least one appliance formed of a material ("appliance forming material") comprising an elastic material in an amount that imparts to the aligner elastic properties such that the appliance exerts a continuous aligning force on a tooth or teeth along a dental arch, wherein the elastic material is a material other than polyester,

wherein the elastic material accounts for all or substantially all the elastic properties of the appliance,

wherein the elastic material comprises at least 10 wt% of the appliance forming material, and

wherein the orthodontic appliance comprises tooth sockets that correspond

to each tooth on the dental arch.

23. The orthodontic aligner kit of claim 22, comprising a plurality of appliances, wherein each appliance is formed according to a method comprising:

creating a dental model of a patient tooth and bite, constructing individual teeth from the dental model,

moving a tooth or teeth of target of alignment according to a prescription by a treating doctor to create an aligned dental model of the patient, and

forming at least one appliance from the aligned dental model of the patient[[]],

wherein the elastic material is selected from the group consisting of silicone rubber or power chains, and orthodontic rubber bands.

24. The orthodontic aligner kit of claim 22, wherein the elastic material comprises at least 20 wt% of the appliance forming material.

25. The orthodontic aligner kit of claim 22, wherein the elastic material comprises at least 50 wt% of the appliance forming material.

26. The orthodontic aligner kit of claim 22, wherein the elastic material comprises at least 80 wt% of the appliance forming material.

27. The orthodontic aligner kit of claim 22, wherein the appliance forming material further comprises a reinforcing material to enhance stability and anchorage of the appliance.

28. The orthodontic aligner kit of claim 23, wherein the plurality of appliances have up to three appliances.

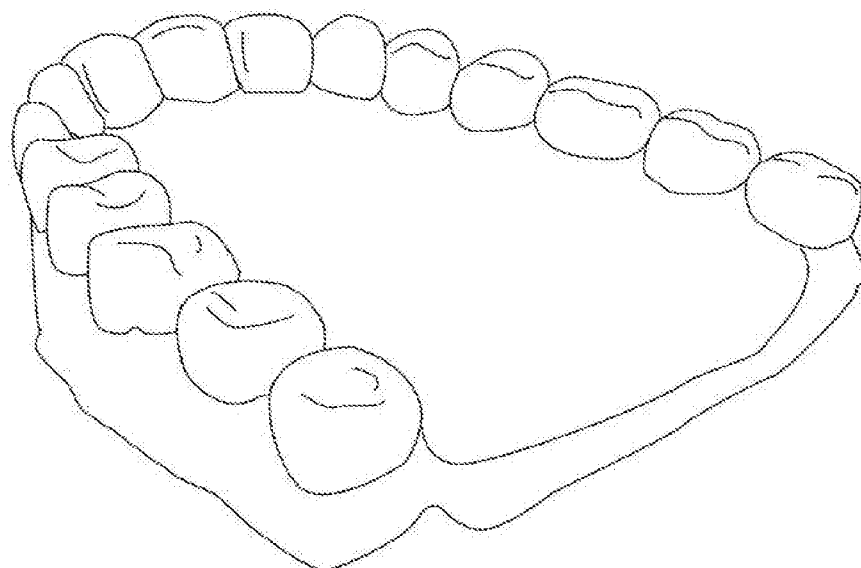


Figure 1

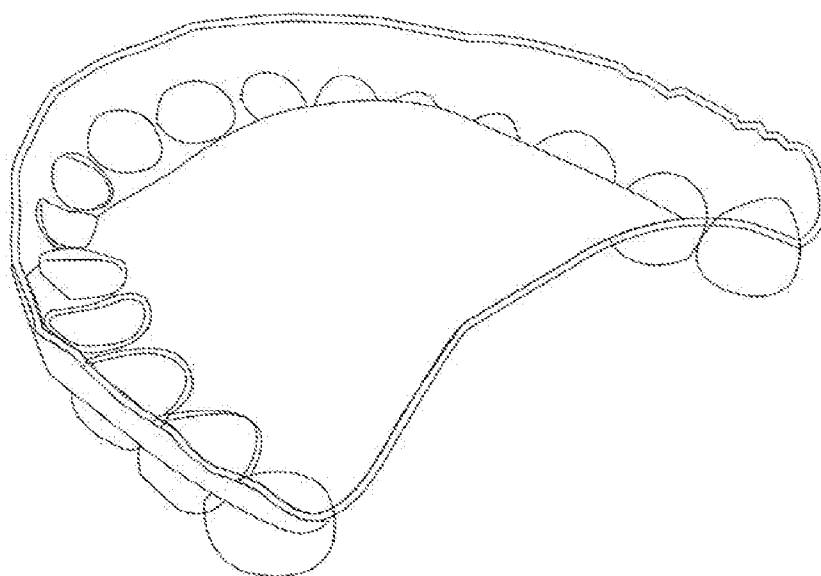


Figure 2

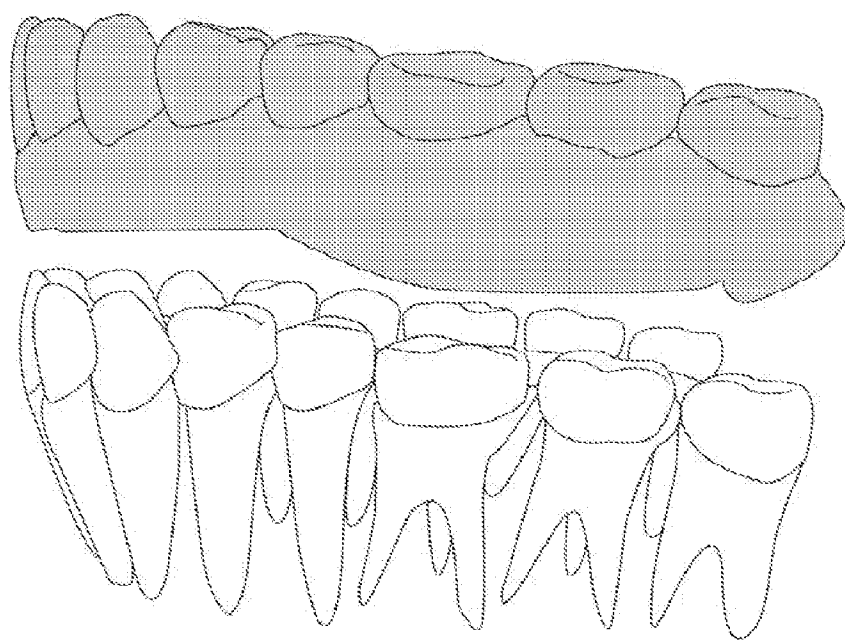


Figure 3

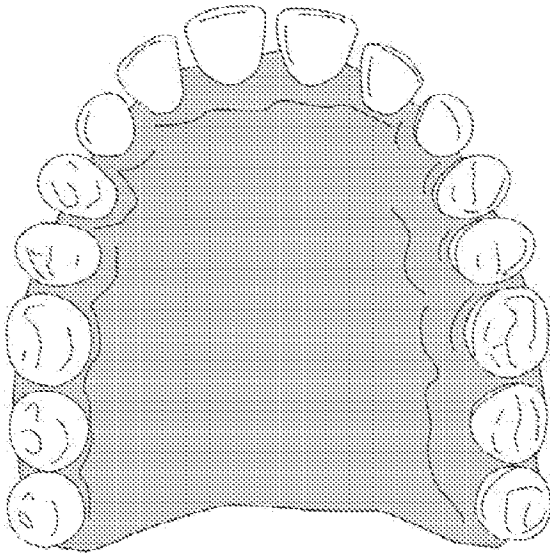


Figure 4A

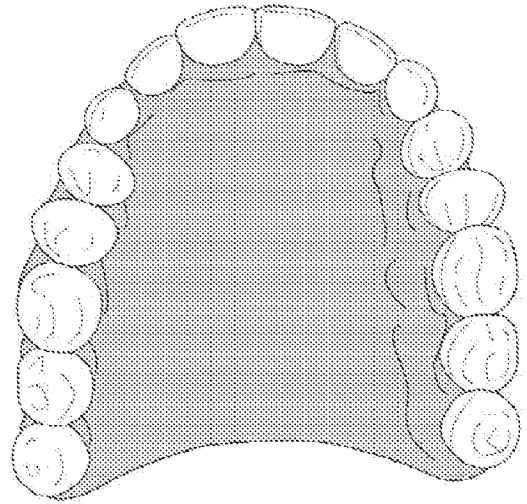


Figure 4B

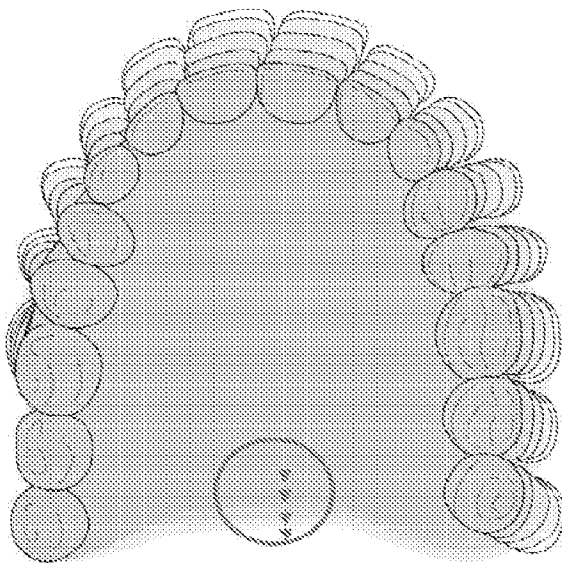


Figure 4C

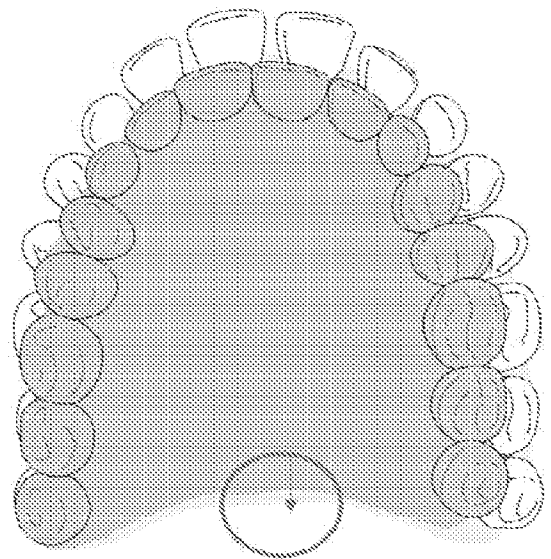


Figure 4D

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 19/15639

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
-see extra sheet-

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-9, 22-28

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 19/15639

A. CLASSIFICATION OF SUBJECT MATTER
 IPC(8) - A61C 7/08, A61C 7/00, G06F 19/00 (2019/01)
 CPC - A61C 7/08, A61C 7/002, A61C 2201/007, B33Y 80/00

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

See Search History Document

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

See Search History Document

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

See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ---	US 2005/0003318 A1 (Choi et al.) 6 January 2005 (06.01.2005), entire document	1-7, 22, 24-26
Y		8-9, 23, 27-28
Y	US 2016/0310236 A1 (Align Technology, Inc.) 27 October 2016 (27.10.2016), entire document	8, 23, 28
Y	US 2017/0367792 A1 (3M Innovative Properties Company) 28 December 2017 (28.12.2017), entire document	9, 27

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

☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

1 APRIL 2019

Date of mailing of the international search report

07 JUN 2019

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
 P.O. Box 1450, Alexandria, Virginia 22313-1450
 Facsimile No. 571-273-8300

Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300
 PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 19/15639

BOX III: Observations where unity of invention is lacking

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-9, 22-28 directed to an orthodontic appliance and kit.

Group II: Claims 10-21 directed to a method of forming an orthodontic appliance and a method of aligning teeth.

The inventions listed as Groups I and II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

The invention of Group II includes the special technical feature of a method of forming an orthodontic appliance, comprising: creating a dental model of a patient tooth and bite, constructing individual teeth from the dental model, moving a tooth or teeth of target of alignment according to a prescription by a treating doctor to create an aligned dental model of the patient, and forming at least one appliance from the aligned dental model of the patient; and a method of aligning a tooth or teeth of target of a patient, comprising: applying the appliance to the patient to move the tooth or teeth of target from an original position(s) to a prescribed position(s) according to a prescription by a treating doctor, not required in Group I.

The inventions of Groups I-II share the technical features of an orthodontic appliance formed of a material ("appliance forming material") comprising an elastic material in an amount that imparts to the aligner elastic properties such that the appliance exerts a continuous aligning force on a tooth or teeth along a dental arch, wherein the elastic material is a material other than polyester, wherein the elastic material accounts for all or substantially all the elastic properties of the appliance. Specifically, Groups I and II are related as an apparatus (Group I) and methods for using the apparatus (Group II). The apparatus is known in prior art as shown in US 2005/0003318 A1 to Choi et al. (hereinafter Choi). Therefore, Groups I and II lack unity since the shared technical features do not represent a contribution over Choi:

Choi discloses an orthodontic appliance (see fig. 5; para [0063]) formed of a material ("appliance forming material") comprising an elastic material (para [0039]; para [0063]; para [0109]) in an amount that imparts to the aligner elastic properties such that the appliance exerts a continuous aligning force on a tooth or teeth along a dental arch (para [0109]), wherein the elastic material is a material other than polyester (para [0097] material may be a polyether), wherein the elastic material accounts for all or substantially all the elastic properties of the appliance (para [0109]).

As the common features were known in the art at the time of the invention, they cannot be considered special technical features that would otherwise unify the groups.

Therefore, Groups I-II lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.