

MAGNET-BASED ORTHODONTIC APPLIANCE

[0001] The present application is based on and claims priority to U.S. Provisional Application Serial No. 63/201,816 filed May 14, 2021, which is incorporated herein by reference in its entirety.

FIELD

[0002] The present exemplary embodiments relate to orthodontic appliances. Embodiments include appliances for installation and operation on the lingual and palatal side of teeth of a patient.

BACKGROUND

[0003] Traditionally metallic or non-metallic brackets are attached to the labial and/or lingual surfaces of the teeth and serve as handles or points of attachment. The brackets transfer force applied by various force elements such as an elastic recoil of the metallic or non-metallic arch wires, elastics made of natural rubber, elastomeric chains made of synthetic polymers, magnets or a combination of any of these. Also, removable appliances that use metallic wires and elastics or clear aligners based on the flexible properties of vacuum formed thermoplastic materials can be used in a sequential manner for orthodontic tooth movement.

[0004] For example, U.S. Patent No. 9,775,687 to Hoyberg shows a secondary magnet 22 positioned below a tooth that has primary magnets attached on both a buccal and lingual side of the tooth allegedly arranged to be attracted to secondary magnet 22. It is suggested that the resulting attractive force will draw the tooth downward. Other arrangements where one or both of the primary magnets are repelled by the secondary magnet are also discussed (e.g., see column 6, lines 27 – 58). Fig. 12 shows an arrangement alleged to apply rotational torque to a tooth. Fig. 7 shows a magnetizable element 25 mounted on a mesial side of a tooth (covered by an aligner tray 34) and a secondary magnet 40 (see also Figs. 8 and 9) mounted on a labial side of a secondary magnet holder 38. Fig. 14 also shows primary magnets 26 mounted on the lingual (or palatal) sides of respective molars with secondary magnets 40 apparently mounted on

lingual sides of a secondary magnet holder. An aligner and magnet holder tray are not illustrated in Fig. 14 so that the magnets 26 and 40 can be more clearly seen (column 14, lines 37 – 39).

[0005] U.S. Patent No. 9,498,302 to Patel discusses an orthodontic appliance for moving selected teeth of a patient. The appliance includes a hollow aligner shell that fits over a set of selected teeth and supports a series of tooth moving elements, such as magnets or metal engagement plates. Figs. 10 and 12 of Patel show aligner shells 1020 (made of thermoplastic or suitable resin (see column 12, lines 55 – 56)) supporting metal engagement plates 1050 and magnets 1040 in positions relative to magnets or engagement plates mounted on selected teeth. For example, one metal engagement plate and magnet pair are illustrated on a lingual or palatal side of a tooth.

[0006] U.S. Patent Application Publication No. 2018/0071054 A1 by Ha discusses an apparatus and method for correcting orthodontic malocclusions. The Orthodontic appliance includes a body and one or more first magnets disposed on the body and arranged to provide either repulsive or attractive force between one or more second magnets disposed on a surface of a tooth. The appliances are attached to the subject's dental arch using one or more temporary anchor devices (TADs). Surgical guides are created using a computer model of the subject and are used to assist in placement and attachment of the TADs. The appliance 12 includes a body 18 having a general loop form configured to generally follow the contour and shape of the subject's teeth. The body 18 is formed to contact vertical surfaces of the teeth that are not being moved and provide a space or gap between the body and the front and/or back surfaces of the teeth that are being repositioned. The front wall of the body 18 that overlaps teeth not being repositioned extends from about the middle of the front vertical surfaces of the teeth to the gum line. The body 18 is formed so that it does not cover any bite surfaces of the subject's teeth, thereby allowing the bite surfaces of the top and bottom teeth to engage when the subject closes his or her jaw. Each appliance 12 is allegedly precision fabricated as a single piece by computer-controlled manufacturing using a 3D printer based upon a 3D scanned image of the subject's dentition.

[0007] U.S. Patent No. 3,984,915 (to Noble, et al.) discusses magnets placed on the teeth in such a manner to employ the attraction and repulsion characteristics of a

magnetic field. These forces are used to align teeth, tilt teeth, move root positions and angulations, torque teeth, and erupt impacted or partially impacted teeth into the correct position in the mouth. In the movement of a single tooth, normally a magnet will be attached to the single tooth with the other magnet which creates the repulsion or attraction force being attached to several teeth in combination. In Fig. 7 of Noble, a magnet is attached to a bridge supported by two spaced teeth. A third tooth, between the spaced teeth, is only partially erupted and a second magnet is attached thereto. An attractive force between the two magnets is said to encourage the further eruption of the third tooth. In addition to various arrangements for applying forces between teeth, Noble suggests a magnet-based retainer (Fig. 15) to hold teeth in position after they have been moved.

[0008] U.S. Patent Application Publication No. 2010/0183997 A1 by Darendeliler discusses a sequential orthodontic appliance comprising a body for engaging a plurality of teeth, and at least one magnetic attachment positioned so as to be in attractive or repulsive configuration with a magnet bonded to a surface of a tooth in need of repositioning. The body defines a space for allowing movement of the tooth in need of repositioning caused by attraction or repulsion. While a number of variations of the appliance are addressed (e.g., see 17, 22, 34, 39, 64, 84, 90, 100, 103, 187, 191, 203 and 208), very few construction details of physical characteristics are provided. However, the dotted outline of the appliances in the figures make it clear that the appliances cover the front of the teeth of the patient.

[0009] While these proposals, and others, have been made, it appears the proposals have deficiencies and have not been widely adapted. For instance, in the system of Hoyberg, the aligner tray and/or secondary magnet holder cover the front of the teeth and are esthetically unattractive. Additionally, it is not understood how the described appliances can be rigid enough to stop tooth movement as indicated at column 5, lines 30 – 36, and flexible enough to allow placement over teeth and magnets or magnetizable elements as illustrated, for example, in Fig. 6 of Hoyberg. The magnet-based aligner of Patel seems to suffer from similar issues, as do the devices of Ha and Darendeliler. Noble does not propose the use of an appliance for tooth movement other than the attachments of magnets to teeth and bridges. The retainer of Noble is suggested only as a means of holding teeth in position after they have been repositioned by other means.

BRIEF DESCRIPTION

[0010] An orthodontic appliance system includes at least one first docking component configured to be attached to the lingual or palatal side of at least one respective support tooth, at least one target magnet, the at least one target magnet can be at least one of a magnet or a paramagnet. The at least one target magnet can be configured to be attached to at least one of the lingual, palatal, distal or mesial surface of at least one respective target tooth, at least one point on a bony palate and/or at least one point on a buccal bone. The orthodontic appliance system also includes a rigid support arch having respective at least one second docking component corresponding to, and for securement to, the at least one first docking component, the rigid support arch being configured to support at least one therapeutic magnet at at least one respective therapeutic position adjacent to a respective one of the at least one target magnet. At least one of the rigid support arches, at least one of the at least one target magnet or at least one of the at least one therapeutic magnet includes at least one stop configured to prevent or limit an aspect of movement of a tooth.

[0011] For example, the at least one first docking component can be at least one attachment magnet and the at least one second docking component can be at least one mounting magnet. In such embodiments, the at least one attachment magnet and the at least one mounting magnet can include at least one stop. Alternatively, in some embodiments the first and second docking components can include non-magnet and/or conventional orthodontic attachment mechanisms.

[0012] In one aspect of the presently described embodiments, an orthodontic appliance system comprises at least one first docking component configured to be attached to the lingual or palatal side of at least one respective support tooth; at least one target magnet, the at least one target magnet comprising at least one of a magnet or paramagnet, the at least one target magnet being configured to be attached to at least one of a lingual, palatal, distal or mesial surface of at least one respective target tooth, at least one point on a bony palate and/or at least one point on a buccal bone; a rigid support arch having respective at least one second docking component corresponding to, and for securement to, the at least one first docking component, the rigid support arch being

configured to support at least one therapeutic magnet at least at one respective therapeutic position adjacent a respective one of the at least one target magnet; wherein the at least one of the rigid support arch, at least one of the at least one target magnet or at least one of the at least one therapeutic magnet includes at least one stop configured to prevent or limit an aspect of movement of a tooth.

[0013] In another aspect of the presently described embodiments, the rigid support arch comprises an orthodontic wire.

[0014] In another aspect of the presently described embodiments, the rigid support arch comprises a metal band.

[0015] In another aspect of the presently described embodiments, the rigid support arch comprises a thermoplastic appliance.

[0016] In another aspect of the presently described embodiments, the rigid support arch comprises a resin-based appliance.

[0017] In another aspect of the presently described embodiments, the rigid support arch comprises a rigid thermoplastic or resin.

[0018] In another aspect of the presently described embodiments, at least one of the at least one target or at least one of the at least one therapeutic magnet has a non-planar shape.

[0019] In another aspect of the presently described embodiments, the non-planar shape comprises an L-shape.

[0020] In another aspect of the presently described embodiments, the L-shape comprises an obtuse angle between legs of the L-shape.

[0021] In another aspect of the presently described embodiments, the non-planar shape comprises one of a C-shape and a U-shape in cross section from an occlusal view.

[0022] In another aspect of the presently described embodiments, at least one target of the at least one target comprises an extended target that is larger in at least one dimension than a corresponding dimension of an exposed portion the at least one associated target tooth.

[0023] In another aspect of the presently described embodiments, the at least one stop comprises a first stop and a second stop, the first stop being configured to make an initial contact during a therapeutic movement of a tooth, thereby limiting a first aspect of

the therapeutic movement the tooth, while the second stop has not yet made a contact, thereby allowing a second aspect of therapeutic movement of the tooth.

[0024] In another aspect of the presently described embodiments, the rigid support arch includes at least one extension configured to extend into a space left by an extracted or missing tooth and the at least one therapeutic magnet includes at least one therapeutic magnet mounted on the at least one extension and the at least one target magnet includes at least one target magnet mounted on at least one mesial or distal surface of at least one target tooth adjacent the space left by the extracted or missing tooth.

[0025] In another aspect of the presently described embodiments, the at least one extension that is configured to occupy the space left by an extracted or missing tooth comprises a tooth shaped pontic.

[0026] In another aspect of the presently described embodiments, the rigid support arch supports at least one non-magnetic guide plane configured to provide a supplemental contact-based guidance to urge a tooth in a desired direction.

[0027] In another aspect of the presently described embodiments, the rigid support arch wherein at least one of the at least one target magnet and at least one of the at least one therapeutic magnet are configured to have opposite poles facing each other while at least one of the at least one target magnet and the at least one therapeutic magnet include at least one stop configured to prevent movement of the target tooth toward the therapeutic magnet.

[0028] In another aspect of the presently described embodiments, the L-Shaped magnet is configured to urge the target tooth occlusally, lingually and/or laterally.

[0029] In another aspect of the presently described embodiments, at least one of the at least one target magnet and the at least one therapeutic magnet supports at least a first stop and a second stop, the first stop being configured to contact the other of the at least one target magnet and the at least one therapeutic magnet during a therapeutic time period before the second stop contacts the other of the at least one target magnet and the at least one therapeutic magnet, thereby providing a pivot point for achieving a desired movement of an associated target tooth.

[0030] In another aspect of the presently described embodiments, the at least one target magnet and the at least one therapeutic magnet comprise complementary

triangular shapes whereby respective hypotenuses of the triangular shapes can be configured to face each other.

[0031] In another aspect of the presently described embodiments, the at least one target magnet comprises a first target magnet and a second target magnet configured to be attached to a lingual or palatal side of a same respective target tooth and wherein the rigid support arch is configured to support a first therapeutic magnet and a second therapeutic magnet adjacent the same respective target tooth, wherein the first target magnet and the first therapeutic magnet are configured to produce an attractive force therebetween and the second target magnet and the second therapeutic magnet are configured to produce a repulsive force therebetween.

[0032] In another aspect of the presently described embodiments, at least one of the at least one therapeutic magnet is configured to include a substantially horizontal lever arm longer than the width of an associated target tooth.

[0033] In another aspect of the presently described embodiments, the substantially horizontal lever arm supports a magnetic attachment at a distal end thereof.

[0034] In another aspect of the presently described embodiments, the rigid support arch includes at least one occlusal extension configured to apply intruding forces to at least one tooth.

[0035] In another aspect of the presently described embodiments, the rigid support arch includes at least one sagittal stabilization stop configured to contact a rear surface of a respective at least one attachment magnet and limit forward movement of the rigid support arch.

[0036] In another aspect of the presently described embodiments, the at least one first and the at least one second docking components comprise respective at least one attachment and at least one mounting magnet.

[0037] In another aspect of the presently described embodiments, the at least one first docking component comprises at least one set of conjoined attachment magnets.

[0038] In another aspect of the presently described embodiments, at least one of the at least one mounting magnet includes a horizontal extension configured to extend from the at least one mounting magnet to an area adjacent a second face of a respective attachment magnet.

[0039] In another aspect of the presently described embodiments, the horizontal extension includes at least one stop on the horizontal extension configured to prevent vertical movement of an associated support tooth due to attractive magnetic force between the at least one mounting magnet including the horizontal extension and the attachment magnet.

[0040] In another aspect of the presently described embodiments, at least one of the at least one therapeutic magnet includes a horizontal extension configured to extend from the at least one therapeutic magnet to an area adjacent to and approximating a second face of a respective target magnet.

[0041] In another aspect of the presently described embodiments, the horizontal extension includes a first stop and a second stop on a surface of the horizontal extension approximating the second face of the target magnet, wherein the first stop is configured to be positioned at a point that is closer to the top surface of the target magnet than the second stop, thereby limiting vertical movement of the corresponding side of the target magnet relative to a side of the target magnet corresponding to a location of the second stop.

[0042] In another aspect of the presently described embodiments, the rigid support arch comprises at least one of orthodontic rod, orthodontic wire, injection molded plastic, cast plastic and 3D printed material including ferromagnetic material.

[0043] In another aspect of the presently described embodiments, the orthodontic appliance system comprises a transpalatal arch connecting one or more attachment magnets from either side of the rigid support arch.

[0044] In another aspect of the presently described embodiments, the rigid support arch is configured to follow the contour of a palate of a patient.

[0045] In another aspect of the presently described embodiments, at least one of the at least one target is configured to be mounted on an implant configured to be implanted in the bony palate.

[0046] In another aspect of the presently described embodiments, the rigid support arch comprises occlusal extensions configured to cover and transmit therapeutic force between the at least one target magnet and at least one therapeutic magnet to at least one target tooth.

[0047] In another aspect of the presently described embodiments, at least one of the at least one target magnet is configured to be mounted on an implant configured to be implanted in the buccal bone.

[0048] In another aspect of the presently described embodiments, the rigid support arch is configured to support a horizontal extension, the horizontal extension being configured to contact an occlusal surface between teeth.

[0049] In another aspect of the presently described embodiments, the rigid support arch is configured to support a distal extension, the distal extension being configured to contact an occlusal surface of one of the at least one respective support tooth and further extend as a buccal extension to embrace a buccal surface of the one of the at least one respective support tooth and support a stabilizing magnet at a position adjacent to at least one stabilizing implant magnet mounted on a stabilizing implant implanted in the buccal bone.

[0050] In another aspect of the presently described embodiments, at least one therapeutic magnet is L-shaped and one leg of the L-shaped magnet comprises a horizontal extension of the at least one therapeutic magnet the horizontal extension comprising a stop configured to initially be spaced from a mesial surface of one of the at least one target magnet and to be contacted by the mesial surface of the one of the at least one target magnet only after a therapeutic mesial movement of the target tooth associated with the one of the at least one target magnet.

[0051] In another aspect of the presently described embodiments, at least one mounting magnet is L-shaped and one leg of the L-shaped magnet comprises a horizontal extension of the at least one therapeutic magnet the horizontal extension comprising a stop configured to initially contact a mesial surface of one of the at least one attachment magnet thereby preventing mesial movement of the support tooth associated with the one of the at least one attachment magnet.

[0052] In another aspect of the presently described embodiments, the rigid support arch comprises a horizontal extension configured to reach through a space between teeth to support at least one stabilizing implant magnet at a stabilizing position corresponding to a stabilizing implant magnet configured to be mounted on an implant implanted in a buccal bone.

[0053] In another aspect of the presently described embodiments, the horizontal extension is configured to abut a surface of a tooth, thereby providing further stabilization.

[0054] In another aspect of the presently described embodiments, at least one of the at least one attachment magnet includes a seat configured to receive a guide key extending from an associated mounting magnet.

[0055] In another aspect of the presently described embodiments, at least one of the at least one mounting magnet includes a guide key configured to be received in a seat included in an associated attachment magnet.

[0056] In another aspect of the presently described embodiments, the rigid support arch comprises at least one of a permanent magnet in the form of an arch shaped strip and an arch shaped strip including isolated magnetized regions.

[0057] In another aspect of the presently described embodiments, at least one of the at least one therapeutic magnet comprises a therapeutic magnet extension configured to face a mesial side or a distal side of at least one of the at least one target magnet.

[0058] In another aspect of the presently described embodiments, at least one of the at least one mounting magnet is L-shaped due to inclusion of a horizontal mounting extension configured to provide a mesio-distal support force.

[0059] In another aspect of the presently described embodiments, the horizontal mounting extension includes at least one stop for opposing mesio-distal movement of at least one associated support tooth.

[0060] In another aspect of the presently described embodiments, the rigid support arch is configured to be located gingival to the crowns of teeth of an associated patient and wherein the at least one mounting magnet and the at least one therapeutic magnet are attached to the rigid support arch by vertical extensions from the rigid support arch.

[0061] In another aspect of the presently described embodiments, the rigid support arch, at least one mounting magnet and the at least one therapeutic magnet are a single unitary manufacture.

[0062] In another aspect of the presently described embodiments, the rigid support arch comprises an upper rigid support arch and the at least one mounting magnet comprises at least one upper mounting magnet, at least one of the at least one upper mounting magnet comprising a downward extension, the orthodontic appliance system

further comprising a lower rigid support arch having at least one lower mounting magnet, at least one of the at least one lower mounting magnet comprising an upward extension wherein extensions of respective at least one pair of the downward extension of the at least one upper mounting magnet and the upward extension of the at least one lower mounting magnet are configured to magnetically attract one another when installed in an associated patient, thereby urging an upper dental arch and a lower dental arch of the associated patient toward one another in an antero-posterior direction.

[0063] In another aspect of the presently described embodiments, at least one of the at least one attachment magnet and at least one mounting magnet comprise a stop.

[0064] In another aspect of the presently described embodiments, the rigid support arch and at least one of the at least one therapeutic magnet and at least one mounting magnet comprise at least one set of interlocking portions.

[0065] In another aspect of the presently described embodiments, the interlocking portions comprise at least one half-blind dovetail in the rigid support arch and a dovetail pin in the at least one of the at least one therapeutic magnet and at least one mounting magnet.

[0066] In another aspect of the presently described embodiments, at least one of the attachment magnets on either side of the rigid support arch and connected by the transpalatal arch is a wide attachment magnet configured to be attached to two or more support teeth.

[0067] In another aspect of the presently described embodiments, the at least one of the at least one attachment magnet includes at least one a spring clip configured to participate in retaining the guide key in the seat.

[0068] In another aspect of the presently described embodiments, the at least one of the at least one attachment magnet includes a door that is configured to be securable under the at least one spring clip and over the seat, thereby being configured to participate in retaining the guide key in the seat.

[0069] In another aspect of the presently described embodiments, the at least one spring clip comprises two spring clips configured to be installed on either side of the seat and wherein the guide key includes a stabilization member including a first arm and a second arm that extend out in two opposite directions perpendicular to a top surface of a

distal end of the guide key, thereby forming a T-shape, the stabilization member being configured to rest on a top surface of the attachment magnet when the guide key is in the seat, and wherein the spring clips are configured to capture the first arm and the second arm of the stabilization member respectively.

[0070] In another aspect of the presently described embodiments, at least one of the at least one therapeutic magnet includes a slot or pocket configured to accept one or more additional magnets.

[0071] In another aspect of the presently described embodiments, the orthodontic appliance system comprises at least one additional magnet.

[0072] In another aspect of the presently described embodiments, at least one of the at least one target magnet comprises the L-shape with an angle between a shorter leg and a longer leg of the L-shape wherein the shorter leg is configured to be bonded to and extend briefly lingually away from the crown of an associated target tooth of an associated patient and the longer leg is configured to extend, at an angle, away from the shorter leg, approximating a local contour of a bony palate of the associated patient until a distal end of the longer leg reaches a bit beyond a vertical location of a center of resistance in a root of the target tooth; and wherein the rigid support arch is configured to support a therapeutic magnet corresponding to and for magnetic attraction to the target magnet at the distal end of the longer leg of the target magnet at a point centered on and horizontally aligned in line with the center of resistance of the associated target tooth, whereby a force formed due the magnetic interaction between the therapeutic magnet and target magnet would act in a direction horizontally through the center of resistance.

[0073] In another aspect of the presently described embodiments, the rigid support arch includes an extension configured to grasp a front edge of the crown of the associated target tooth.

[0074] In another aspect of the presently described embodiments, the orthodontic appliance system further comprises at least one of a first and/or second additional magnet and an L-shaped extension of the rigid support arch, wherein the first additional magnet is configured to be mounted on the distal end of the long leg of the target magnet, the second additional magnet being configured to be mounted on the short leg of the target magnet, the L-shaped extension of the rigid support arch having a longer leg extending

from the rigid support arch generally parallel to the long leg of the target magnet and a short leg extending from a distal end of the long leg generally parallel to the short leg of the target magnet, the short leg of the extension of the rigid support arch supporting an auxiliary therapeutic magnet.

[0075] In another aspect of the presently described embodiments, at least one of the at least one target comprises the L-shape with an angle between a shorter leg and a longer leg of the L-shape wherein the shorter leg is configured to be bonded to and extend briefly lingually away from the crown of an associated target tooth of an associated patient and wherein the longer leg is configured to extend, at an angle, away from the shorter leg and approximating a local contour of a bony palate of the associated patient until a distal end of the longer leg reaches beyond a vertical location of a center of resistance in a root of the target tooth; and wherein the rigid support arch is configured to support a therapeutic magnet corresponding to and for magnetic attraction to the target magnet at the distal end of the longer leg of the target magnet centered on and aligned horizontally in line with a point beyond the center of resistance, closer to root end of the target tooth, whereby a force formed due the magnetic interaction between the therapeutic magnet and target magnet would act in a direction horizontally through the center of resistance.

[0076] In another aspect of the presently described embodiments, the rigid support arch is configured to change the position of teeth and has extensions which hold labial veneers which are connected to each other thereby mimicking the final position of the teeth.

[0077] In another aspect of the presently described embodiments, a method for performing an orthodontic procedure comprises using the orthodontic appliance system as described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0078] Figs. 1A – C illustrate a first embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system.

[0079] Figs. 2A – C illustrate a second embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system.

[0080] Figs. 3A – C illustrate a third embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system.

[0081] Figs. 4A – C illustrate a fourth embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system. The rigid support arch includes tooth shaped pontics.

[0082] Figs. 5A – C illustrate a fifth embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system.

[0083] Figs. 6A – C illustrate a sixth embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system. The illustrated embodiment includes non-planar magnets.

[0084] Figs. 7A – C illustrate a seventh embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system.

[0085] Figs. 8A – C illustrate an eighth embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system. The illustrated embodiment includes non-planar magnets.

[0086] Fig 9A – C illustrate a ninth embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system. The embodiment illustrates examples of target magnets attached to implants.

[0087] Figs. 10A – C illustrate a tenth embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system. The embodiment illustrates an example of a rigid support arch with sagittal stabilization arms.

[0088] Figs. 11A – B illustrate an eleventh embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system. The embodiment illustrates an example of a trans-palatal arch.

[0089] Figs. 12A – D illustrate a twelfth embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system.

[0090] Figs. 13A – D illustrate a thirteenth embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system. The embodiment illustrates examples of stabilization magnets attached to arch extensions adjacent to stabilization implant magnets attached to implants and used for arch stabilization.

[0091] Figs. 14A – C illustrate a fourteenth embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system.

[0092] Figs. 15A – C illustrate a fifteenth embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system.

[0093] Figs. 16A – C illustrate a sixteenth embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system.

[0094] Figs. 17A – C illustrate a seventeenth embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system. The embodiment illustrates an example of a rigid support arch configured to be situated apical to the level of the crown of the teeth.

[0095] Figs. 18A – C illustrate an eighteenth embodiment of a magnet-based orthodontic appliance system. The illustrated embodiment includes an upper and a lower rigid support arch.

[0096] Figs. 19A – B illustrate aspects of an embodiment of a magnet and aspects of a compatible embodiment of a rigid support arch.

[0097] Figs. 20A – C illustrate aspects of an embodiment of an attachment magnet including a slot or seat and a mounting magnet including a guide key for reception in the slot or seat.

[0098] Figs. 21A – B illustrate aspects of an embodiment of an attachment magnet including a slot or seat and a mounting magnet including a guide key for reception in the slot or seat.

[0099] Figs. 22 illustrate aspect of an embodiment a magnet base orthodontic appliance system including an embodiment of a target magnet and an embodiment of a modifiable therapeutic magnet.

[00100] Fig. 23 illustrates a cross-sectional view of an embodiment of a target magnet mounted to a palatal or lingual side of a tooth and an embodiment of a rigid support arch supporting an embodiment of a therapeutic magnet behind the tooth.

[00101] Fig. 24 illustrates a cross-sectional view of an embodiment of an L-shaped target magnet mounted to a palatal or lingual side of a tooth and an embodiment of a rigid support arch supporting an embodiment of a therapeutic magnet behind the tooth for providing a force in a line through a center of resistance of the tooth.

[00102] Fig. 25 illustrates a cross-sectional view of an embodiment of an L-shaped target magnet mounted to a palatal or lingual side of a tooth and an embodiment of a rigid support arch supporting an embodiment of a therapeutic magnet behind the tooth for providing a force in a line through a point closer to a root end of the tooth, apical to the center of resistance of the tooth.

[00103] Fig. 26 illustrates a cross-sectional view of an embodiment of an L-shaped target magnet mounted to a palatal or lingual side of a tooth and an embodiment of a rigid support arch supporting an embodiment of a therapeutic magnet behind the tooth for providing a force in a line through a point closer to a root end of the tooth, apical to the center of resistance of the tooth wherein the rigid support arch includes an extension to restrict outward movement of an incisal edge of the tooth.

[00104] Fig. 27 illustrates a cross-sectional view of an embodiment of an L-shaped target magnet mounted to a palatal or lingual side of a tooth and an embodiment of a rigid support arch supporting an embodiment of a therapeutic magnet behind the tooth for providing a force in a line through a point closer to a root end of the tooth, apical to the center of resistance of the tooth wherein the rigid support arch includes an extension to support an additional therapeutic magnet at a second position to obtain the desired force vector.

[00105] Figs. 28A – C illustrate an embodiment of a rigid support arch and other components of a magnet-based orthodontic appliance system including only a single attachment magnet and only a single mounting magnet.

[00106] Figs. 29A – D illustrate another embodiment of a magnet based orthodontic appliance.

[00107] Fig. 30 illustrates another embodiment of a magnet based orthodontic appliance with veneers attached.

[00108] Figs. 31A – B illustrate components of magnet based orthodontic appliance which are attached to the teeth.

DETAILED DESCRIPTION

[00109] In order to overcome the above-mentioned shortcomings, a hidden removable magnet-based appliance system is proposed, wherein the appliance will not flex

significantly in response to the magnetic forces involved and wherein, when desired, the appliance is easily removed and installed by the patient. Easy patient installation and removal has important health consequences as it means the appliance is less likely to interfere with eating and makes it much easier to floss and brush the teeth of the patient. Still further, easy installation and removal makes it much easier to maintain the hygiene of the appliance. A rigid appliance prevents the reduction of the force delivered due to the flexion of the appliance while magnetic forces are being used to move teeth. While ease of removal is preferable, in some scenarios, patients are not likely to be compliant and if able, might not reinstall an appliance as promptly after eating or cleaning as they should. Accordingly, some embodiments allow scenarios wherein the appliance is installed in a manner that would be more difficult for the patient to remove on his or her own.

[00110] The present disclosure may be understood more readily by reference to the following detailed description of desired embodiments and the examples included therein. In the following specification and the claims which follow, reference will be made to a number of terms which shall be defined to have the following meanings.

[00111] Although specific terms are used in the following description for the sake of clarity, these terms are intended to refer only to the particular structure of the embodiments selected for illustration in the drawings, and are not intended to define or limit the scope of the disclosure. In the drawings and the following description below, it is to be understood that like numeric designations refer to components of like function.

[00112] The singular forms "a," "an," and "the" include plural referents unless the context clearly dictates otherwise.

[00113] The term "comprising" is used herein as requiring the presence of the named components/steps and allowing the presence of other components/steps. The term "comprising" should be construed to include the term "consisting of", which allows the presence of only the named components/steps.

[00114] Numerical values should be understood to include numerical values which are the same when reduced to the same number of significant figures and numerical values which differ from the stated value by less than the experimental error of conventional

measurement technique of the type described in the present application to determine the value.

[00115] All ranges disclosed herein are inclusive of the recited endpoint and independently combinable (for example, the range of “from 2 grams to 10 grams” is inclusive of the endpoints, 2 grams and 10 grams, and all the intermediate values). The endpoints of the ranges and any values disclosed herein are not limited to the precise range or value; they are sufficiently imprecise to include values approximating these ranges and/or values.

[00116] The modifier “about” used in connection with a quantity is inclusive of the stated value and has the meaning dictated by the context. When used in the context of a range, the modifier “about” should also be considered as disclosing the range defined by the absolute values of the two endpoints. For example, the range of “from about 2 to about 10” also discloses the range “from 2 to 10.” The term “about” may refer to plus or minus 10% of the indicated number. For example, “about 10%” may indicate a range of 9% to 11%, and “about 1” may mean from 0.9-1.1.

[00117] In an embodiment illustrated in Figs. 1A – C, a magnet-based orthodontic appliance system **101** includes at least one first docking component such as at least one attachment magnet **118** configured to be attached to the lingual or palatal side of at least one respective support tooth (e.g., **112**, **114**). For instance, four support teeth **112** and **114** might be used. The magnet based orthodontic appliance system **101** includes a rigid support arch **100** having respective at least one second docking component such as at least one mounting magnet **116**. The appliance system can include stops. For example, the support arch **100** includes one or more stops in the form of stop arch extensions **103**. The rigid support arch **100** is secured in position by the docking components, for example, by attractive magnetic forces between the mounting magnets **116** and attachment magnets **118**. Though there is an attractive force between the mounting magnets **116** and attachment magnets **118**, which might otherwise be carried through to the support teeth **112**, **114**, the support teeth **112**, **114** are protected from those forces and are prevented from significant movement toward the rigid support arch **100** by stops (e.g., **103**), which oppose the attractive force by physically preventing tooth movement. In the illustrated embodiment, stops or arch extensions **103** are configured to contact the lingual

or palatal side of the support teeth **112**, **114** and maintain a separation between the first docking component(s), in this case attachment magnets **118** and the second docking component(s), in this case the mounting magnets **116**. The rigid support arch **100** is configured to be held in place by magnetic forces between the attachment magnets **118** and mounting magnets **116**. Stop arch extensions **103** prevent direct contact of the approximating surfaces. Close approximation **133** of the rigid support arch **100** to the palatal or lingual surface of other teeth of the illustrated set of teeth **150** can be used to provide a guide for the fit of the appliance in the mouth when the patient is inserting it.

[00118] The rigid support arch **100** supports at least one therapeutic magnet **106** at therapeutic positions corresponding to at least one target magnet **104** attached to the palatal or lingual side of at least one target tooth **108 – 111**. For instance, in the illustrated scenario, four target teeth **108 – 111** are mispositioned. For example, the teeth **108 – 111** have gaps or undesired space on either side. Respective pairs of the therapeutic magnets **106** and target magnets **104** would provide respective magnetic forces for urging (e.g. pulling) the target teeth **108 – 111** toward a preferred position. The appliance system **101** includes further stops in the form stop arch extensions **102** which extend from the rigid support arch **100** toward the target teeth **108 – 111**. Initially the stops (extensions **102**) do not make contact with the target teeth **108 – 111**. The attractive force between the therapeutic magnets **106** and target magnets **104** pulls the target teeth **108 – 111** toward the rigid support arch **100** in order to urge the target teeth backward and reduce the size of the gaps or spaces between the target teeth and the teeth adjacent thereto. A space **105** between the therapeutic magnets **106** and the target magnets **104** is more than a space **151** between the extensions **102** from the support arch **100** and the palatal or lingual side of the target teeth **108 – 111**. Accordingly, as the teeth are pulled back toward the desired position by the therapeutic forces between the therapeutic magnets **106** and the target magnets **104**, the stops or extensions **102** would prevent direct contact between the therapeutic magnets **106** and the target magnets **104** and prevent the target teeth from being repositioned back further than desired. While direct contact may, in some scenarios be necessary or desirable, direct contact between the magnets on the teeth and those on the support arch would makes it difficult for the patient to insert and remove the appliance due to, for example, the very strong magnetic forces produced

under those circumstances. Accordingly, another reason this embodiment includes the stops or extensions **102** is to prevent such direct approximation.

[00119] It is noted that while the word “magnet” is used herein throughout for clarity, it is to be understood that as used herein, the word “magnet” does not necessarily refer to a permanent magnet. In some embodiments or scenarios, it may be acceptable or beneficial for only one magnet of a magnet pair (e.g., a therapeutic and target magnet or an attachment and mounting magnet) to be a permanent magnet. The other magnet of a magnet pair may be a paramagnet or element made of material that becomes magnetized in the presence of a magnetic field. For example, one element of a pair might be made of stainless steel or other ferromagnetic material that becomes magnetized and drawn to its mate in the presence of the magnetic field from that mate. For simplicity and clarity, it is to be understood that in any description where attractive magnetic forces are discussed or implied, one of the magnets of the pair may be a paramagnetic element. In applications where repulsive forces are employed, both magnets must be permanent magnets so that like magnetic poles of the pair can be configured to face one another, thereby providing the repulsive force. Biocompatibility can be achieved by making the magnets of a bio-compatible material or by coating or encapsulating the magnets in a bio-compatible material. For example, the bio-compatible material that could be used to coat the magnet could be a varnish, plastic, gold, silver, steel, metal alloy, or other appropriate metal or metal alloy. In addition, a coating such as a gold coating could then be coated with a second coating such as steel or other appropriate bio-compatible material. The second coating such as steel could serve multiple purposes such as protecting the underlying coating and of enhancing the magnetic forces.

[00120] It should also be appreciated that the respective magnets for teeth may be attached to or incorporated into the teeth in a variety of manners including, for example, with use of cement or adhesives. Likewise, the respective magnets for the appliance may be unitary with the appliance (e.g., by stamping, casting, or additive manufacturing) or attached using any of a variety of manners including, for example, using screws, brackets, cement, adhesives, etc.

[00121] Figs. 2A – C illustrate a magnet-based orthodontic appliance system **201** relative to a set of teeth **250**. The magnet-based appliance system **201** includes at least one first docking component such as attachment magnets **218** configured to be attached to the lingual or palatal side of at least one respective support tooth **212**, **214**. In the illustrated embodiment, four support teeth **212**, **214** are used. The magnet-based orthodontic appliance system **201** includes a rigid support arch **200** having respective at least one second docking component such as mounting magnet **216** corresponding to and for magnetic attraction to at least one attachment magnet **218**. The support arch **200** is secured in position by the attractive magnetic forces between the mounting magnets **216** and attachment magnets **218**.

[00122] The rigid support arch **200** supports at least one therapeutic magnet **206** at therapeutic positions corresponding to target magnets **204** attached to the palatal or lingual side of the four target teeth **208 – 211**. As with the target teeth **108 – 111** in Figs. 1A – C, target teeth **208 – 211** are associated with gaps or spaces on either side. Additionally, tooth **208** is initially rotated out of proper alignment. Attractive forces between the therapeutic magnets **206** and target magnets **204** urge the target teeth **208 – 211** toward the rigid support arch **200**. As noted above, the rigid support arch is held in place by the magnetic interaction between the mounting magnets **216** on the support arch **200** and the attachments magnets **218** on the support teeth **212**, **214**. The appliance system **201** includes stops. For instance, the therapeutic magnets **206** and target magnets **204** have one or more extensions or protrusions which form stops **202**, **203**, **205**, **207**. The stops **202**, **203**, **205**, **207** prevent a direct approximation of therapeutic magnets **206** and target magnets **204** as the target teeth **208 – 211** are urged towards the support arch **200**. In the illustrated embodiment, the stops **202** and **203** are present on the target magnet **204** on the target tooth **208**, stop **207** is present on the target magnet **204** on the target tooth **209**, and one stop **205** each are illustrated on the therapeutic magnets **206** present in positions corresponding to the target magnets **204** on the target teeth **210** and **211**. In the case of the tooth **208**, it is anticipated that the stop **202** on the target magnet **204** would make an initial contact with the therapeutic magnet **206** preventing further retraction on the distal side of the tooth while the mesial side would continue retraction until the stop **203** on the target magnet **204** contacted the therapeutic

magnet **206**. This differential movement would provide a de-rotation and alignment of the tooth **208** during the planned retraction.

[00123] Stops on magnets might be made unitary with the magnet. For instance, a cast, molded, machined, or additively manufactured (e.g., 3D printed) magnet might be made as a single piece including one or more protrusions to act as stops, such as those discussed above (e.g., **202 – 207**). While such embodiments might lead to direct approximation of one magnet to another at the point of the stop, the small surface area of direct approximation or contact between the magnets would limit the force between the magnets relative to the force that might otherwise occur if the full faces of the magnets came in contact. Accordingly, even embodiments wherein the stops are unitary with the magnets would improve the ease with which the rigid support arch can be removed. In other embodiments, the stops of non-magnetic material (e.g., plastic or rubber) might be adhesively attached or molded into the magnet or the magnet might be threaded and stops might be screwed into the magnet. It is noted that the rigid support arch **200** also includes stop arch extensions (unnumbered) that are similar to the stop arch extensions **103** of Figs. 1A – C.

[00124] As implied above, stops on rigid support arches might also be unitary with the arch. For example, a cast, molded, machined, or additively manufactured rigid support arch might be made as a single piece including one or more extensions to act as stops, such as those discussed above (e.g., **102, 103**). In some embodiments the target and/or mounting magnets might also be unitary with the rigid support arch. For example, a rigid support arch might be cast, molded, machined, or additively manufactured from a ferromagnetic material or from plastics or epoxies with ferromagnetic suspensions. Alternatively, embodiments might be assembled from component parts that are screwed, glued, welded, soldered, and/or snapped or mated together. Some embodiments, such as plastic or epoxy-based embodiments, might be reinforced with orthodontic wire or metal strips or rods for added rigidity. Rod or wire with a diameter of about 0.045 to about 0.06 inches or more may be appropriate. In some applications, thinner material may suffice. In some embodiments (e.g., see Figs. 10 – 15) the rigid support arch might be substantially made of orthodontic wire or metal rod.

[00125] In the embodiment illustrated in Figs. 3A – C, a magnet-based orthodontic appliance system **301** includes at least one first docking component such as, for example, at least one attachment magnet **323** configured to be attached to the lingual or palatal side of at least one respective support tooth **322**, **324** and **326** of a set of teeth **350**. In the illustrated embodiment, six support teeth **322**, **324** and **326** are used. The magnet based orthodontic appliance system **301** includes a rigid support arch **300** having respective at least one second docking element such as, for example, mounting magnets **325** corresponding to and for magnetic attraction to attachment magnets **323**. The support arch **300** is secured in position by attractive magnetic forces between the mounting magnets **325** and attachment magnets **323**. The stops or extensions **328** are configured to contact the lingual or palatal surface of the support teeth **322**, **324** and **326** and act as guides for positioning of the support arch in the mouth by the patient. Additionally, the stops, guides or extensions **328** prevent movement of the support teeth **322**, **324** and **326** which might otherwise occur due to the attractive magnetic forces between the mounting magnets **325** and the attachment magnets **323** by physically opposing the magnetic force by contacting, for example, the support teeth **322**, **324**, **326**.

[00126] The rigid support arch **300** supports at least one therapeutic magnet **314** at at least one therapeutic position corresponding to at least one target magnet **313** attached to the palatal or lingual side of at least one target tooth **308 – 311**. The support arch **300** also has at least one therapeutic magnet **316** attached to arms or extensions **317** which project into extraction space **351** in front of teeth **326**. The therapeutic magnets **316** are mounted at the therapeutic positions corresponding to target magnets **315** attached on respective distal surfaces of the target teeth **307** and **312**. Stops or small projections **335** are provided on the target magnets **313** and **315**. Attractive forces between the therapeutic magnets **314** and **316** and the respective target magnets **313** and **315** urges (e.g., pulls) the target teeth **307 – 312** backward toward the rigid support arch **300**. The stops **335** on the target magnets **313** and **315** prevent a flush contact or approximation between the target magnets **313** and **315** with the respective therapeutic magnets **314** and **316** as the teeth **307 – 312** move backward towards the rigid support arch **300** and/or the arms or extensions **317** thereof. While the target magnet **315** is on a distal surface of the tooth **307** in the illustrated embodiment, other configurations are contemplated. For

example, a target magnet could instead be placed on a mesial surface of, for example, tooth **326** and a rigid support arch could be configured to support a therapeutic magnet so as to urge (e.g. pull) the tooth **326** forward.

[00127] Figs. 4A – C illustrate an embodiment of a magnet based orthodontic appliance system **401** that might be used, for example, for retraction of six anterior teeth **407 – 412** into a space in front of teeth **426**. The system **401** includes a rigid support arch **400** that is secured in position by the attractive magnetic forces between at least one mounting magnet **425** and at least one attachment magnet **423** bonded to the palatal or lingual side of the one or more support teeth **422**, **424** and **426** of a set of teeth **450**. First and second docking components comprise the attachment magnets **423** and mounting magnets **425**. The rigid support arch **400** includes tooth shaped extensions which form pontics **420** configured to be located in spaces or gaps in the set of teeth **450** located in front of the teeth **426**. The rigid support arch also supports guide planes **417** for guiding movement of target teeth **407** and **412**. It is noted that the rigid support arch **400** also includes stop arch extensions (unnumbered) that are similar to the stop arch extensions **103** of Figs. 1A – C.

[00128] The rigid support arch **400** supports at least one therapeutic magnet **414** at at least one therapeutic position corresponding to at least one target magnet **413** attached to the palatal or lingual side of target teeth **408 – 411**. As indicated above, the support arch **400** also supports at least one therapeutic magnet **416**, attached to extensions **420** which project from the support arch **400** into extraction spaces in front of the teeth **426**. For instance, the illustrated therapeutic magnets **416** are mounted at therapeutic positions corresponding to the target magnets **415** attached to target the teeth **407** and **412**. The extensions **420** from the support arch **400** are configured to resemble natural teeth. For example, the extensions **420** are also configured to occupy most of the extraction space seen in front of teeth **426** except for the space needed for the retraction of the teeth **407** and **412** during several stages of tooth movement. At subsequent stages, the appliance system **401** would be replaced or modified to continue retraction of the teeth **407 – 412**. In each subsequent replacement appliance system **401**, the width of the extension **420** would be reduced. The reduction in the width of extensions or pontics **420** would be in response to a reduction in the size of the space or gap due to a rearward movement of

the associated target teeth **407** and **412** and would allow the one or more therapeutic magnets **416** to be moved further back, closer to the teeth **426** allowing movement of the teeth **407** and **412** backward.

[00129] As indicated above, the rigid support arch **400** also supports one or more non-magnetic guide planes **417** in a position corresponding to the surface of one or more target magnets that face the support arch **400**. The one or more non-magnetic guide planes **417** would provide a supplemental contact-based force to urge a tooth in a desired direction. For example, as therapeutic magnets **416** urge target teeth **407** and **412** rearward, guide planes prevent the target teeth **407**, **412** from straying inward and may even be configured to, at least initially, provide an outward force vector. That is, if the target teeth **407**, **412** wander inward toward the rigid support arch **400**, the target teeth **407**, **412**, or magnets **415** thereon, would contact the non-magnetic guide planes **417** and through that contact be urged (e.g., pushed) outward toward the desired path. The one or more non-magnetic guide planes might carry one or more stops **418** in order to reduce the friction which might occur if the whole inner surface of the one or more target magnet **415** is in contact with the corresponding surface of one or more guide planes **417**. Alternatively, a stop (not shown) might be formed directly on the rigid support arch **400**.

[00130] In the embodiment of Figs. 5A-C a magnet-based orthodontic appliance system **501** includes at least one attachment magnet **523** configured to be attached to the lingual or palatal side of at least one respective support tooth **522**, **524**, **526** and **528** of a set of teeth **550**. The magnet based orthodontic appliance system **501** includes a rigid support arch **500** having at least one respective mounting magnet **525** corresponding to and for magnetic attraction to at least one respective attachment magnet **523**. The support arch **500** is secured in position by the attractive magnetic forces between the mounting magnets **525** and attachment magnets **523**. First and second docking components comprise the attachment magnets **523** and mounting magnets **525**.

[00131] The rigid support arch **500** supports at least one therapeutic magnet **514** at a respective at least one therapeutic position corresponding to at least one respective target magnet **513** attached to the palatal or lingual side of the at a respective at least one target tooth **507 – 509**, **511** and **512**. The therapeutic magnets **514** and target magnets **513** are configured to have similar magnetic poles facing each other so that a repulsive force

pushes the teeth **507** and **512** laterally and teeth **508**, **509** and **511** labially and/or forward to expand the dental arch and create space for the one or more crowded or blocked out tooth **510**. In the illustrated embodiment a space is created for tooth **510** by labial or lateral movement of multiple teeth **507 – 509**, **511** and **512**. The support arch **500** also supports a therapeutic magnet **517** at a therapeutic position corresponding to the target magnet **518** attached to the lingual surface of target tooth **510**. The therapeutic magnet **517** and target magnet **518** are configured to have opposite poles facing each other so that the therapeutic magnet **517** and target magnet **518** tend to attract each other. However, one or more stops **537** located, for example, on the therapeutic magnet **517**, would prevent the lingual movement of target tooth **510**. Accordingly, the tooth **510** would be held in its position while the teeth **507 – 509**, **511** and **512** are urged forward and/or laterally by the interaction between their respective target and therapeutic magnets. It is noted that the rigid support arch **500** also includes stop arch extensions (unnumbered) that are similar to the stop arch extensions **103** of Figs. 1A – C.

[00132] In the embodiment of Figs. 6A – C twelve teeth **622**, **624**, **626**, **628**, **630** and **632** of a set of teeth **650** are used for supporting a rigid support arch **600** of a magnet based orthodontic appliance system **601**. The magnet based orthodontic appliance system **601** includes at least one mounting magnet **625** supported by the rigid support arch **600**. For instance, twelve mounting magnets **625** attached to the rigid support arch, correspond to, and are for magnetic attraction to twelve attachment magnets **623** mounted on the support teeth. First and second docking components comprise the attachment magnets **623** and mounting magnets **625**. The support arch **600** is secured in position by the attractive magnetic forces between the mounting magnets **625** and attachment magnets **623**. As discussed with regard to Figs. 1A – C (see **103**), and illustrated in the figures discussed above and many of the figures to be discussed below, those same attractive magnetic forces can be opposed by extensions **603** extending from the rigid support arch **601** and configured to contact the lingual surfaces of the support teeth **622**, **622**, **624**, **626**, **628**, **630** and **632**, thereby preventing the attractive forces between the mounting magnets and the attachment magnets from causing movement of the support teeth **622**, **624**, **626**, **628**, **630** and **632** towards the support arch.

[00133] The rigid support arch **600** is configured to support a therapeutic magnet **614** at a therapeutic position corresponding to target magnets **613** attached to a palatal side of a target tooth **609**. The therapeutic magnet **614** is non-planar. That is, therapeutic magnet **614** is L-shaped in cross section when viewed from the top and is configured to have a larger leg attached to the rigid support arch while a smaller leg is configured to face a lateral edge of the target magnet. The shape and dimensions of the legs are determined by the amount and direction of the force required. The therapeutic magnet **614** and target magnet **613** are configured to have opposite poles face each other so that attractive forces between the target and the smaller leg of the therapeutic magnet might urge (e.g., pull) the target tooth **609** laterally to create space for adjacent target tooth **610**. The therapeutic magnet **614** has stop **641** on the larger leg and stop **645** on the smaller leg which prevent the direct approximation of the facing surfaces of the therapeutic magnet **614** and target magnet **613**. For example, as illustrated, the stop **641** contacts the target magnet, thereby preventing movement of the target tooth backward toward the longer leg of the therapeutic magnet **614**. However, initially, the stop **645** is spaced from the lateral edge of the target magnet, thereby allowing for lateral movement toward the smaller leg of the L-shaped therapeutic magnet **614**.

[00134] The support arch **600** also supports a therapeutic magnet **616** at a therapeutic position corresponding to a target magnet **617** attached to the lingual surface of target tooth **610**. The therapeutic magnet **616** is non-planar. The therapeutic magnet **616** is L-shaped in cross section when viewed from the side and is configured to have a larger leg attached to the rigid support arch while a smaller leg is configured to face a bottom edge (as viewed in Fig. 6) of the target magnet **617**. The shape and dimensions of the legs are determined by the amount and direction of the force required. The therapeutic magnet **616** and target magnet **617** are configured to have opposite poles face each other so that attractive forces between the target and the smaller leg of the therapeutic magnet might urge the target tooth downward so that the target tooth **610** will extrude and the larger leg might urge the target tooth backward into the space created by the lateral movement of the target tooth **609**. The therapeutic magnet **616** also has one or more stops **642** which prevents the direct approximation of the facing surfaces of the therapeutic magnet **616** and target magnet **617** as the target tooth **610** moves down and back. It is noted that the

rigid support arch **600** of the illustrated embodiment would be removed by the patient by pulling it downward, away from the upper teeth.

[00135] In some embodiments, similar magnetic forces may be beneficially generated using L-shaped target magnets and generally planar therapeutic magnets.

[00136] In the embodiment of Figs. 7A – C, a magnet-based orthodontic appliance system **701** includes at least one attachment magnet **723** configured to be attached to the lingual or palatal side of at least one support tooth **724**, **707 – 709**, **711** and **712** of a set of teeth **750**. In the illustrated embodiment, seven support teeth **724**, **707 – 709**, **711** and **712** are used. The magnet based orthodontic appliance system **701** includes a rigid support arch **700** having respective at least one mounting magnet **725** corresponding to and for magnetic attraction to at least one attachment magnet **723** secured to the at least one support tooth **724**, **707 – 709**, **711** and **712**. The at least one mounting magnet **725** has at least one stop **726** included thereon. In the illustrated embodiment, the stops **726** are configured to prevent the direct approximation of facing surfaces of the mounting magnets **725** and attachment magnets **723**. The support arch **700** is secured in position by the attractive magnetic forces between the mounting magnets **725** and attachment magnets **723**.

[00137] The rigid support arch **700** supports a therapeutic magnet **720** at a therapeutic position corresponding to a target magnet **733** attached to the palatal or lingual side of a target tooth **710**. The target magnet **733**, which is attached along and aligned with the long axis of the target tooth **710**, is at an angle relative to the therapeutic magnet **720** which is held substantially perpendicular to the occlusal plane. The therapeutic magnet **720** has two stops **735** and **737**. Lower (as shown in the figure) stop **735** is closer to the incisal edge of the tooth **710** near the bottom of the face of the therapeutic magnet facing the target magnet. Due to the angle of the target tooth **710** and target magnet, the lower stop **735**, which is closer to the incisal edge of the tooth **710**, is closer to target magnet **733** than is upper stop **737**. In the illustrated scenario, the lower stop **735** is in contact with the target magnet **733** so that the lower aspect of the tooth will not move toward the therapeutic magnet **720** due to the magnetic interaction between therapeutic magnet **720** and target magnet **733**. During the treatment period, the lower stop **735** would act as a pivot point. There is a space between the upper stop **737** and the target magnet.

Accordingly, the upper portion of the target magnet **733** is free to move toward the therapeutic magnet **720** until the target magnet **733** contacts the upper stop **737**. As the inclination of the target tooth **710** becomes normal, the stops **735** and **737** would prevent the direct approximation of the facing surfaces of the therapeutic magnet **720** and target magnet **733**.

[00138] In the embodiment of Figs. 8A – C a magnet-based orthodontic appliance system **801** includes at least one attachment magnet **823** configured to be attached, in the illustrated example, to the palatal side of at least one respective support tooth **822** and **824** of a set of teeth **850**. The magnet based orthodontic appliance system **801** includes a rigid support arch **800** having respective at least one mounting magnet **825** corresponding to and for magnetic attraction to at least one attachment magnet **823**. The support arch **800** is secured in position by the attractive magnetic forces between the mounting magnets **825** and attachment magnets **823**. The at least one mounting magnet **825** carry at least one stop **860** which contact the at least one attachment magnet **823**, thereby preventing the direct approximation of the facing surfaces of the mounting magnets **825** and attachment magnets **823**.

[00139] The rigid support arch **800** is configured to support multiple therapeutic magnets in varying shapes at therapeutic positions corresponding to different target magnets attached to the palatal side of the various target teeth for specific tooth movement. For example, an L-shaped therapeutic magnet **838** that is attached at therapeutic position corresponding to a bar shaped target magnet **837** on the palatal surface of a tooth **811** in an attraction mode would urge the tooth **811** occlusally and mesially.

[00140] A triangular therapeutic magnet **836** that is attached at therapeutic position corresponding to a complementary triangular shaped target magnet **835** on the palatal surface of a target tooth **810**. The complementary triangular shapes allow respective hypotenuses of the triangular shapes to be configured to face each other in, for example, an attraction mode to allow, for example, the tooth **810** to be urged both occlusally and mesially.

[00141] Non-planar therapeutic magnet **834**, which might be described as C or U-shaped in cross section, is attached at a therapeutic position corresponding a bar shaped

target magnet **833** attached to the palatal surface of a target tooth **809** in an attraction mode and would urge the target tooth **809** palatally. A planar or bar shaped therapeutic magnet **832** which is attached at therapeutic position corresponding to a U or C shaped target magnet **831** on the palatal surface of target tooth **808** in an attraction mode, would urge the target tooth **808** palatally. The three walls of the C or U-shaped magnet **834** may generate forces that urge the target magnet toward the center of the C or U in a left and right sense, thereby providing a multi-dimensional control on the position of the target magnet **833** and hence the target tooth **809**. Modifying the C or U-shaped magnet to include a fourth and fifth wall (not shown) as a top and bottom to the therapeutic magnet (as viewed in the figure) to arrive at a box-shape might be used to additionally provide centering forces in the vertical direction. A similar effect might be achieved with a non-planar therapeutic magnet that is bowl-shaped. Alternatively, the target might be configured to be C, U, box or bowl-shaped and the therapeutic magnet might be bar shaped to achieve similar and corresponding forces and therapy. Similar centering effects might be achieved if the therapeutic and target magnets were configured to produce repulsive force vectors.

[00142] A therapeutic magnet **852** is attached at a therapeutic position corresponding to a first target magnet **853** on target tooth **826**. The therapeutic magnet **852** and the first target magnet **853** are arranged in a repulsion mode so that the magnetic interaction between the first target magnet **853** and the first therapeutic magnet **852** urge the palatal side of target tooth **826** distally, thereby urging a derotation of the target tooth **826**. In regard to the same target tooth **826**, a second therapeutic magnet **855** is arranged at a therapeutic position corresponding to a second target magnet **854**, which is also mounted on the palatal side of target tooth **826**, in an attraction mode so that magnetic interaction between the therapeutic magnet **855** and the target magnet **854** would urge the palatal side of the target tooth **826** distally, augmenting the derotation force provided by the repulsive interaction between the first therapeutic magnet **852** and target magnet **853**.

[00143] A therapeutic magnet **842** is also arranged at a therapeutic position corresponding to target magnet **841** on target tooth **827** in an attractive mode. The target magnet **841** includes a portion mounted to the target tooth **827** and a second portion or generally horizontal lever arm **865** that extends away from the mounted portion of the

target magnet **841** back in the general direction of support teeth **824** and **822**, yet angled a bit palatally due to a posture of the target tooth **827**. A second therapeutic magnet **844** for the target tooth **827** is arranged at a therapeutic position corresponding to an additional magnetic attachment **843** near a distal end of the generally horizontal lever arm **865** of the target magnet **841**. The second therapeutic magnet **844** is arranged in a repulsive configuration relative to the target magnet **841** and additional magnetic attachment **843** so that the combined effect of the magnetic interactions would derotate the tooth **827**. The generally horizontal lever arm **865** of the target magnet **841** allows positioning of the additional attachment **843** far from the center of the tooth so that mechanical advantage of a resulting moment arm can be taken advantage of to bring about the derotation of the target tooth **827**.

[00144] Therapeutic magnets shown in the Figs. 8A – C (e.g., **825**, **855**, **832**, **838**, **842**) have stops **880** which prevent direct approximation between the approximating surfaces of the therapeutic magnets and the target magnets.

[00145] In the embodiment of Figs. 9A – C, a magnet-based orthodontic appliance system **901** includes at least one attachment magnet **923** configured to be attached to the palatal side of at least one respective support tooth **922**, **924**, **926** and **928** from a set of teeth **950**. In the illustrated embodiment, the support teeth **922**, **924**, **926** and **928** are also target teeth **922**, **924**, **926** and **928**. The magnet-based appliance system also includes at least one or more target magnets **917** attached occlusal to the one or more mounting magnets **923**. The magnet based orthodontic appliance system **901** includes a rigid support arch **900** having respective at least one mounting magnet **925** corresponding to and for magnetic attraction to the at least one attachment magnets **923**. The rigid support arch **900** is configured to follow the contour of the palate of the patient rather than, or in addition to, the contour of a portion of the set of teeth **950**. The support arch includes occlusal extension **903** which cover the occlusal surfaces of the one or more support/target teeth **922**, **924**, **926** and **928**. The support arch **900** is secured in position by attractive magnetic forces between the mounting magnets **923** and attachment magnets **925**. The one or more stops **929** on the one or more mounting magnets prevent the direct approximation of the facing surfaces of the one or more mounting magnets **925** and the corresponding attachment magnets **923**. The occlusal extension **903** of the

support arch **900** also has one or more therapeutic magnets **927** in therapeutic positions corresponding to the occlusal surface of the target magnets **917** attached to the palatal side of the target teeth **922, 924, 926** and **928**.

[00146] The rigid support arch **900** is also configured to support at least one therapeutic magnet **935** and **938** at therapeutic positions corresponding to at least one implant magnet **936** and **939** attached to at least one orthodontic mini implant **937** and **940** implanted in the bony palate **902**. The attractive force between the therapeutic magnets **935** and **938** and implant magnets **936** and **939** is carried by the rigid support arch to the occlusal extensions and thereby urges the support/target teeth **922, 924, 926** and **928** toward the bony palate **902**. Though the at least one therapeutic magnets **935** and **938** are urged toward the implant magnets **936** and **939**, the facing surfaces of these magnets will not directly approximate due to one or more stops **970** present on, for example, the one or more implant magnets **936** and **939**. The therapeutic magnets **927** and the target magnets **937** are arranged in a repulsive configuration so that the support teeth/ target teeth **922, 924, 926** and **928** are pushed towards the bone **902**. The repulsive force between the one or more therapeutic magnets **927** and target magnets **937** will not move the support arch **900** away as it is kept in position by the attractive forces between the therapeutic magnets **935** and **938** and the respective target magnets **936** and **939**. Also, the attractive forces between the mounting magnets **925** and attachment magnets **923** will ensure that the target teeth **922, 924, 926** and **928** will move gingivally into the bone along a plane guided by the vertical orientation of the mounting magnets **925**.

[00147] It is noted that a similar assembly of therapeutic magnets and target magnets could be used to intrude the whole set of teeth **950**, front teeth, posterior teeth in either and/or both dental arches with the help of orthodontic mini implants and implant magnets at the appropriate sites in upper jaw, lower jaw or both.

[00148] In the embodiment of Figs. 10A – C, a magnet-based orthodontic appliance system **1001** includes at least one attachment magnet **1023** configured to be attached to the lingual or palatal side of at least one respective support tooth **1024** and **1032**. The magnet based orthodontic appliance system **1001** includes a rigid support arch **1000**. For example, the rigid support arch is made of orthodontic wire or metallic rod of appropriate size and rigidity. For instance, in some applications, the wire or rod commonly used in

orthodontic headgear may provide sufficient rigidity. Rod or wire with a diameter of about 0.045 to about 0.06 inches or more may be appropriate. In some applications, thinner wire may suffice. Other embodiments might be injection molded or cast plastic or 3D printed (made through additive manufacturing). Machined embodiments are also possible. The rigid support arch **1000** is configured to support at least one mounting magnet **1025** corresponding to and for magnetic attraction to at least one attachment magnet **1023**. The support arch **1000** is secured in position by the attractive magnetic forces between the mounting magnets **1025** and attachment magnets **1023**. At least one stop **1036** on the attachment magnets **1023** prevent the direct approximation of the facing surfaces of the mounting magnets **1025** and the attachment magnets **1023**, thereby preventing any movement of the support teeth **1024** and **1032** due to the magnetic interaction between the mounting magnets **1025** and attachment magnets **1023**. The rigid support arch **1000** is also configured to include at least one extension which forms a sagittal stabilization stop **1065** that is configured to contact the distal surface of one or more attachment magnets **1023** on the one or more support teeth **1024**.

[00149] The rigid support arch **1000** supports at least one therapeutic magnet **1014** at at least one therapeutic position corresponding to at least one target magnet **1013** attached to the palatal or lingual side of at least one target tooth **1008 – 1011**. In the illustrated embodiment, four target teeth **1008 – 1011**, which are front teeth, are addressed. An attractive force between the therapeutic magnets **1014** and target magnets **1013** tends to retract the target teeth **1008 – 1011** backward toward the rigid support arch **1000** which, as indicated above, is stabilized by the magnetic interaction between the mounting magnets **1025** and the attachments magnets **1023** on the support teeth **1024** and **1032** and is prevented from moving forward by the sagittal stabilization stops **1065** which embrace a rear most surfaces of attachment magnets **1023**. For instance, the sagittal stabilization stops **1065** prevent the rigid support arch **1000** from moving forward due to the magnetic interaction between the therapeutic magnets **1014** and target magnets **1013**. The stops **1046** on the target magnets **1013** would prevent a flush contact, or direct approximation, between the target magnets **1013** and the therapeutic magnets **1014** due to the teeth **1008 – 1011** being urged backward.

[00150] Figs. 11A – B illustrate a set of teeth on one section of an upper dental arch **1150** in relation to a partial embodiment of a magnet-based orthodontic appliance system **1101** which uses cross arch stabilization using a trans-palatal arch **1180** and conjoined attachment magnets **1123**. The phrase -partial embodiment- is used here to note that only part of the magnet-based orthodontic appliance system **1101** is illustrated. In the illustrated partial embodiment, a magnet based orthodontic appliance system **1101** includes at least one attachment magnet **1123** configured to be attached to the lingual or palatal side of at least two respective support teeth **1122** and **1124**. The at least one attachment magnets **1123** in the illustrated embodiment are larger in dimension than attachment magnets of previously described embodiments and can be described as conjoined attachment magnets to be attached to two or more teeth **1122** and **1124** on each side of the arch. Alternatively, attachments magnets **1123** can be considered to be attachment magnets that are larger than those described above and configured to be attached to a plurality of support teeth. The attachment magnets **1123**, on either side of the arch, are connected by a rigid trans-palatal arch **1180** in order to provide cross arch stabilization. The appliance system **1101** also includes a rigid support arch **1100** (only partially illustrated) configured to support respective at least one mounting magnet **1125** corresponding to, and for magnetic attraction to, the at least one attachment magnet **1123**. At least one stop **1136** present on the at least one mounting magnet **1125** are configured to prevent the direct approximation of the facing surfaces of the mounting magnets **1125** and attachment magnets **1123**. The cross-arch stabilization provided by the rigid transpalatal arch **1180**, which is attached to two or more supporting teeth on either side of the arch would augment posterior anchorage when the rigid support arch is used for tooth movement with the help of therapeutic and target magnets. A similar cross arch stabilization can be provided in the lower dental arch as well.

[00151] For example, the trans-palatal arch **1180** might be made of orthodontic rod or wire. For example, in some applications, the wire or rod commonly used in orthodontic headgear may provide sufficient rigidity. Rod or wire with a diameter of about 0.045 to about 0.06 inches or more may be appropriate. In some applications, thinner wire may suffice. Other embodiments might be injection molded or cast plastic or 3D printed (made through additive manufacturing). Machined embodiments are also possible.

[00152] In the embodiment of Figs. 12A – D a magnet-based orthodontic appliance system **1201** includes at least one first docking component, such as an attachment magnet **1223** configured to be attached to the lingual side of at least one respective support tooth **1222**, **1226** and **1228**. The magnet based orthodontic appliance system **1201** includes a rigid support arch **1200** having a respective at least one second docking component, such as mounting magnet **1225** corresponding to and for magnetic attraction to the at least one attachment magnets **1223**. The rigid support arch **1200** is secured in position by the attractive magnetic forces between the mounting magnets **1225** and attachment magnets **1223**. For example, the rigid support arch is made of orthodontic wire or metallic rod of appropriate size and rigidity. For example, in some applications, the wire or rod commonly used in orthodontic headgear may provide sufficient rigidity. Rod or wire with a diameter of about 0.045 to about 0.06 inches or more may be appropriate. In some applications, thinner wire may suffice. Other embodiments might be injection molded or cast plastic or 3D printed (made through additive manufacturing). Machined embodiments are also possible. The mounting magnets **1225** include horizontal extensions **1215** that are configured to extend from the mounting magnets **1225** over a second or top face (as viewed in the figures) of their respective attachment magnet **1223**. At least one stop **1236** on the at least one mounting magnet **1225** contacts the lingual surface of the at least one attachment magnets **1223** and prevents lingual movement of the support teeth **1222**, **1226** and **1228**, whereas at least one stop **1256** (see Fig. 12D) on the horizontal extensions **1215** from the mounting magnets **1225** prevents vertical movement of the support teeth **1222**, **1226** and **1228** due to the attractive magnetic forces between the mounting magnets **1225** and the attachment magnets **1223**.

[00153] The rigid support arch **1200** is configured to support a therapeutic magnet **1235** at a therapeutic position corresponding to a target magnet **1233** attached to the lingual side of a target tooth **1224**. The therapeutic magnet **1235** has a horizontal extension **1255** that extends over a second or top surface of the target magnet **1233**, which results in, for example, and attractive force in a vertical plane to correct, for example, an angulation of the target tooth **1224**. The therapeutic magnet **1235** also includes at least one stop **1246** configured to be in contact with the lingual surface of target magnet **1233** to prevent lingual movement of the target tooth **1224**. It is noted that since lingual tooth

movement is not desired in the illustrated scenario, the vertical portion of the therapeutic magnet **1235** need not actually be magnetic and may instead be a non-magnetic support for the horizontal extension **1255**. However, due to manufacturing and inventory practicalities, the vertical portion of the therapeutic magnet **1235** may be magnetic and include stops **1246** to counteract the related magnetic force, as described above. The horizontal extension **1255** of the therapeutic magnet **1235** has two stops **1245** and **1247** on the surface approximating the top surface (as viewed in the figures) of target magnet **1233**. The target magnet is substantially rectangular and is mounted with a long side substantially parallel to the occlusal surface of the crown of the target tooth **1224**. However, the target tooth **1224** is tipped mesially at an angle relative to the direction of other teeth (e.g., **1222**, **1226**). Accordingly, the target magnet **1233** is at an angle relative to the orientation of the horizontal extension **1255**. Therefore, the stop **1247** is positioned at a point that is closer to the top surface of the target magnet **1233** due to the angled nature of the target magnet **1223** and may even be configured to be in contact with the target magnet **1233**, even initially, thereby preventing upward (as viewed in the figure) vertical movement of the corresponding side of the target tooth **1224**. The stop **1245** is positioned above (as viewed in the figures) the lower side of the target magnet **1223**. A resulting space between the stop **1245** and the top surface of the target magnet **1223** allows an extrusive movement of that side of the tooth **1224**, due to attractive forces between the horizontal extension **1255** and the target magnet **1223**, until there is a contact between the target magnet **1233** and the stop **1245**, at which point the angulation of the tooth **1224** would be corrected.

[00154] In the embodiment of Figs. 13A – D, a magnet-based orthodontic appliance system **1301** includes at least one first docking component, such as an attachment magnet **1323** configured to be attached to the lingual side of at least one respective support tooth **1322**, **1326** and **1328**. The magnet based orthodontic appliance system **1301** includes a rigid support arch **1300** having respective at least one second docking component, such as mounting magnet **1325** corresponding to and for magnetic attraction to the at least one attachment magnet **1323**. The rigid support arch may be made of, for example, orthodontic wire or a metallic rod, or any of the plastics or 3D printed materials discussed above with regard to Figs. 10 – 12. The rigid support arch **1300** is secured in

position by the attractive magnetic forces between the mounting magnets **1325** and attachment magnets **1323**. At least one stop **1336** on the at least one mounting magnet **1325** contacts the lingual surface of the at least one attachment magnets **1323**. The stops **1336** prevent movement of the support teeth **1322**, **1326** and **1328** due to the attractive magnetic forces between the mounting magnets **1325** and the attachment magnets **1323**.

[00155] The rigid support arch **1300** is configured to support a therapeutic magnet **1335** at a therapeutic position adjacent a target magnet **1333** attached to the lingual side of a target tooth **1324**. The therapeutic magnet **1335** includes a horizontal extension **1355** configured to produce a force component in a vertical plane to correct, for example an angulation of the target tooth **1324** by magnetic interaction between the therapeutic magnet **1335** and target magnet **1333**. The rigid support arch **1300** is configured to support a horizontal extension **1340** that is configured to contact an occlusal surface between, for example, the support teeth **1326** and **1328**. The rigid support arch **1300** is also configured to include a distal extension **1342** configured to contact an occlusal surface of the support tooth **1322** and further extend as buccal extension **1352** to embrace a buccal surface of the support tooth **1322**. The buccal extension **1352** of the support arch supports one or more stabilizing magnets **1365** which is placed at a stabilizing position approximating a stabilizing implant magnet **1363** mounted on a mini-implant **1380** mounted in a buccal bone **1350** of the patient. At least one stop **1364** on the stabilizing magnet **1365** prevents direct approximation of the stabilizing magnet **1365** and the stabilizing implant magnet **1363**. The extensions **1340** and **1342** of the support arch **1300** provide vertical stabilization for the support arch while the magnetic interaction between the horizontal extension **1355** of the therapeutic magnet **1335** and target magnet **1333** corrects the angulation of the tooth **1324**.

[00156] In the embodiment of Figs. 14A – C, a magnet-based orthodontic appliance system **1401** includes at least one first docking component, such as attachment magnets **1423** configured to be attached to the lingual side of at least one respective support tooth **1422**, **1426** and **1428** of a set of teeth **1450**. The magnet based orthodontic appliance system **1401** includes a rigid support arch **1400** having respective at least one second docking component, such as mounting magnets **1425** corresponding to and for magnetic attraction to at the east one attachment magnets **1423**. The rigid support arch **1400** is

secured in position by attractive magnetic forces between the mounting magnets **1425** and the attachment magnets **1423**. The rigid support arch may be made of, for example, orthodontic rod or wire, or any of the plastics or 3D printed materials discussed above with regard to Figs. 10 – 12. The mounting magnets **1425** associated with the support teeth **1422** and **1426** have horizontal extensions **1415** facing distal and the mesial surfaces of the attachment magnets **1423** on the respective teeth **1422** and **1426**, respectively. The extensions **1415** give the mounting magnets an L-shaped cross-sectional appearance. Stops **1436** on the at least one mounting magnet **1425** are configured to contact the approximating surface of the one or more attachment magnets **1423** thereby preventing lingual or mesiodistal movement of the support teeth **1422**, **1426** and **1428** due to the attractive magnetic forces between the mounting magnets **1425** and the attachment magnets **1423**.

[00157] The rigid support arch **1400** is configured to support a therapeutic magnet **1435** at a therapeutic position corresponding to a target magnet **1433** attached to the lingual side of a target tooth **1424**. The therapeutic magnet **1435** includes an extension **1455** on a mesial side facing a mesial surface of the target magnet **1433**. At least one stop **1445** on the therapeutic magnet **1435** is configured to be in contact with a lingual surface of target magnet **1433** acts as a stop to prevent lingual movement of the target tooth **1424**. Stops **1447** on the extension **1455** of the therapeutic magnet **1435** are initially spaced from an approximating mesial surface of the target magnet **1433**, initially allowing the target tooth **1424** to be urged mesially in response to a magnetic attraction between the extension **1455** of the therapeutic magnet **1435** and the target magnet **1433**.

[00158] In the embodiment of Figs. 15A – C a magnet-based orthodontic appliance system **1501** includes at least one attachment magnet **1523** configured to be attached to the lingual side of at least one respective support tooth **1526** and **1528** of a set of teeth **1550**. The magnet based orthodontic appliance system **1501** includes a rigid support arch **1500** having respective at least one mounting magnet **1525** corresponding to and for magnetic attraction to the at least one attachment magnet **1523**. The rigid support arch is, for example, made orthodontic wire or a metallic rod of appropriate size and rigidity. For example, in some applications, the wire or rod commonly used in orthodontic headgear may provide sufficient rigidity. Rod or wire with a diameter of about 0.045 to

about 0.06 inches or more may be appropriate. In some applications, thinner wire may suffice. Other embodiments might be injection molded or cast plastic or 3D printed (made through additive manufacturing). Machined embodiments are also possible. The support arch **1500** is secured in position by attractive magnetic forces between the mounting magnets **1525** and attachment magnets **1523**. The mounting magnets **1525** associated with support teeth **1526** and **1528** include at least one stop **1536** that is configured to contact a lingual surface of the one or more attachment magnets **1523** and prevent lingual movement of the support teeth **1526** and **1528** due to the attractive magnetic forces between the mounting magnets **1525** and the attachment magnets **1523**.

[00159] The rigid support arch **1500** is configured to support one or more therapeutic magnets **1535** at at least one therapeutic position corresponding to at least one target magnet **1533** attached to the lingual side of at least one target tooth **1522** and **1524**. The therapeutic magnets **1535** may include extensions **1555**, for example, on a mesial side approximating a mesial surface of the at least one target magnets **1533** attached to the lingual surface of the target teeth **1522** and **1524**. The extensions **1555** may give the therapeutic magnets **1535** an L-shaped appearance or cross-section. One or more stops **1545** on the one or more therapeutic magnets **1535** may be configured to contact the lingual surface of the at least one target magnets **1533**, thereby preventing or limiting lingual movement of the support teeth **1522** and **1524**. The extensions **1555** on the therapeutic magnets **1535** may also carry one or more stops **1547**. The one or more stops **1547** may be configured to be initially spaced from an approximating surface of the target magnets **1533**, thereby allowing the target teeth **1522** and **1524** to be urged mesially by a magnetic attraction between the one or more therapeutic magnet extensions **1555** and the target magnets **1533**. The support arch **1500** may be further configured to include a horizontal extension **1505**, for example, configured to abut a disto-occlusal surface of, for example, support tooth **1526**, thereby providing further stabilization. For instance, the horizontal extension **1505** of the rigid support arch **1500** may be configured to reach through a space or gap between teeth to support at least one stabilizing magnet **1510** at a stabilizing position corresponding to a stabilizing implant magnet **1515** mounted on a mini-implant **1560** implanted in buccal bone **1580** of the patient. A stop **1513** on the

stabilizing magnet **1510** may be configured to prevent direct approximation of the stabilizing magnet **1510** and the stabilizing implant magnet **1515**.

[00160] In the embodiment of Figs. 16A – C, a magnet-based orthodontic appliance system **1601** includes at least one attachment magnet **1623** configured to be attached to the lingual side of at least one respective support tooth **1622**, **1626** and **1628** of a set of teeth **1650**. The attachment magnets **1623** have slots or seats **1665** that are configured to accept guide arms **1667** extending from mounting magnets **1625**. The magnet based orthodontic appliance system **1601** includes a rigid support arch **1600** which can itself be a permanent magnet in the form of an arch shaped strip. Alternatively, the rigid support arch **1600** strip may be configured to have isolated magnetized regions. For instance, the rigid support arch might be made through additive manufacturing or 3D printing wherein all or only portions of the rigid support arch are formed from a ferromagnetic material or a suspension including ferromagnetic material. In either case, regions configured to be adjacent the attachment magnets **1623** act as or correspond to at least one mounting magnet **1625**. Similar orientations can be made from orthodontic rod or wire. For example, in some applications, the wire or rod commonly used in orthodontic headgear may provide sufficient rigidity. Rod or wire with a diameter of about 0.045 to about 0.06 inches or more may be appropriate. In some applications, thinner wire may suffice. Other embodiments might be injection molded or cast plastic or 3D printed (made through additive manufacturing). Machined embodiments are also possible.

[00161] The rigid support arch **1600** is secured in position by attractive magnetic forces between the at least one mounting magnet **1625** and the corresponding at least one attachment magnet **1623**. The rigid support arch **1600** and/or the one or more mounting magnets **1625**, is configured to include at least one guide arms **1667** extending therefrom and configured to be received in the at least one respective slot or seat **1665** in the at least one attachment magnet **1623**. The inclusion and use of guide arms **1667** and seats **1665** are a way for a patient to ensure the rigid support arch **1600** is properly positioned and installed. Proper seating can be felt during installation. At least one mounting magnet **1625**, or at least one corresponding magnetized region of the support arch **1600** designated to be the same, can be configured to include horizontal mounting extensions **1615** for providing a mesio-distal support for the support teeth preventing their movement

in the mesiodistal plane. For example, horizontal mounting extensions **1615** are illustrated in relation to the attachment magnets **1623** on support teeth **1622** and **1626**. For instance, the horizontal mounting extensions **1615** can be configured to have stops **1636** which prevent or oppose mesio-distal movement of the support teeth **1622** and **1626**. The one or more guide arms **1667** from the support arch **1600** or one or more mounting magnets **1625** can rest passively in their respective slots or seats **1665**. In some embodiments, the one or more guide arms in the slots or seats might be secured with a lock or clip (e.g., see Figs. 20A – C) so that the support arch might be removed only by a trained clinician and not by the patient. As in all embodiments, the attachment magnets and mounting magnets can instead be other first and second docking components. Using magnets as the docking components facilitates removal and installation by the patient. In instances where the support arch is secured to the support teeth with the help of a locking mechanism, ease of removal and installation by the patient is less of a concern and the convenience of magnetic first and the second docking components might be less of a consideration. The one or more guide arms **1667** provide guidance for placement of the support arch **1600** on the attachment magnets to provide appropriate orientation of the mounting magnets **1625** approximate to the attachment magnets **1623**. Stops **1636** of the one or more mounting magnets **1625** which contact the approximating surfaces of the one or more attachment magnets **1623** prevent lingual or mesiodistal movement of the support teeth **1622**, **1626** and **1628** due to the attractive magnetic forces between the mounting magnets **1625** and the attachment magnets **1623**.

[00162] The rigid support arch **1600** which, as indicated above, can itself be an arch-shaped strip magnet, or have magnetic regions, can have regions corresponding to, for example, a therapeutic magnet **1635** at a therapeutic position adjacent to target magnet **1633** attached to the lingual side of target tooth **1624**. The therapeutic magnet **1635** also has a therapeutic magnet extension **1655** on, for example, a mesial side facing a mesial surface of the target magnet **1633**. At least one stop **1647** on the extension **1655** is initially spaced away from an approximating surface of the target magnet **1633**, thereby allowing the target tooth **1624** to move mesially in response to the magnetic attraction between the therapeutic extension **1655** of the therapeutic magnet **1635** and the target magnet **1633**.

[00163] In the embodiment of Figs. 17A – C, a magnet-based orthodontic appliance system **1701** includes at least one attachment magnet **1723** configured to be attached to the lingual side of at least one respective support tooth **1722**, **1726** and **1728** of a set of teeth **1750**. The magnet based orthodontic appliance system **1701** includes a rigid support arch **1700** having respective at least one mounting magnet **1725** corresponding to and for magnetic attraction to the at least one attachment magnet **1723**. The rigid support arch **1700** is configured to be located gingival to the crown of the one or more teeth **1722**, **1724**, **1726** and **1728**. For instance, the one or more mounting magnets **1725** are attached to the rigid support arch by vertical extensions **1785** in order to reach toward their respective attachment magnets **1723** from the gingival rigid support arch **1700**. The rigid support arch **1700** also supports at least one therapeutic magnet **1735** at at least one therapeutic position corresponding to at least one target magnet (not shown) attached to the lingual side of a target tooth **1724**. The at least one therapeutic magnet **1735** is attached to the rigid support arch **1700** by vertical extension **1775**. For example, the rigid support arch **1700** and vertical extensions **1785**, **1775** might be made from a stamping, such as a stamping or milling of a sheet of stainless steel or ferromagnetic material. Some embodiments might be cast, injection molded or made by additive manufacturing or 3D printing using thermoplastics and/or ferromagnetic suspensions in plastics or epoxies. Alternatively, embodiments might be assembled from sections of orthodontic wire or sheet metal welded or soldered together. Some embodiments may be unitary in that the magnets and rigid support arch **1700** are manufactured (e.g., by stamping, casting or additive manufacturing) as a single unit. Alternatively, the mounting and therapeutic magnets are attached as described previously (e.g., screws, brackets, cement, adhesives, etc.). Configuring the rigid support arch to be located gingival to the level of the teeth, as illustrated in Figs. 17A – C reduces an in-out thickness of the appliance, thereby, for example, improving the tongue space and/or facilitates flossing of the teeth with the appliance in place.

[00164] In the embodiment of Figs. 18A – C a magnet-based orthodontic appliance system **1801** includes at least one attachment magnet **1823** configured to be attached to the lingual or palatal side of at least one respective upper support tooth **1812** of an upper arch of a patient. The magnet based orthodontic appliance system **1801** includes an

upper rigid support arch **1800** having respective at least one upper mounting magnet **1824** and **1844** corresponding to and for magnetic attraction to the at least one upper attachment magnet **1823**. The at least one upper mounting magnet **1844** include downward extensions **1817** that are configured to extend downward towards the lower arch of the patient. The upper rigid support arch **1800** is secured in position by attractive forces between the upper mounting magnets **1824** and **1844** and upper attachment magnets **1823**. Stops **1854** of the upper mounting magnets **1824**, **1844** prevent movement of the upper support teeth **1812** towards the upper mounting magnets **1824**.

[00165] The magnet-based orthodontic appliance system **1801** also includes at least one lower attachment magnet **1825** configured to be attached to the lingual side of at least one respective lower support tooth **1832** of the lower arch. The magnet based orthodontic appliance system **1801** includes a lower rigid support arch **1802** having respective at least one lower mounting magnet **1826**, **1846** corresponding to and for magnetic attraction to the at least one lower attachment magnet **1825**. The lower mounting magnets **1846** have upward extensions **1818** extending towards the upper arch. The lower rigid support arch **1802** is secured in position by attractive forces between the lower mounting magnets **1826**, **1846** and the lower attachment magnets **1825**. Stops **1856** of the mounting magnets **1826**, **1846** are configured to prevent the movement of the at least one lower support teeth **1832** toward the lower mounting magnets **1826**.

[00166] The downward extensions **1817** of the upper mounting magnets **1844** of the upper arch and the upward extensions **1818** of the lower mounting magnets **1846** of the lower arch are configured to magnetically attract each other, thereby urging the upper arch and lower arch toward each other in an antero-posterior direction, thereby urging an improved inter-arch relationship.

[00167] Both mounting and therapeutic magnets may be supported or affixed to embodiments of the rigid support arch in a variety of ways. For example, embodiments of the rigid support arch may include a pocket or groove for accepting and supporting a magnet. For instance, embodiments, including embodiments described herein above, may include an interlocking arrangement such as that described relative to Figs. 19A – B wherein a magnet **1925** carries a dovetail or pin **1995** configured to be interlocked or mated with a corresponding recess, slot or half blind dovetail as illustrated in rigid support

arch **1900** (see Fig. 19B). Other configurations for interlocking are contemplated. Such embodiments might allow clinicians to use a same rigid support arch for multiple stages of treatment as early treatment stage magnets could be replaced with later treatment stage magnets of various size, strength and/or dimensions as appropriate for a next stage of treatment or therapy.

[00168] As indicated above, for example, with regard to Figs. 16A – C, there are scenarios where removal of an appliance by the patient needs to be prevented. In those instances, it can be beneficial to lock, secure or fix the orthodontic appliance in place, or at least discourage the patient from attempting removal. In this regard, it will be appreciated that the docking components may take a variety of forms, including, for example, magnetic or non-magnetic forms, and/or forms that include securing or fixing components.

[00169] Figs. 20 A – C illustrate an embodiment of a variation of docking components such as securing or fixing components **2001** of embodiments of the magnet-based orthodontic appliance system. The securing or fixing components **2001** include, for example, a mounting magnet **2025** illustrated on a portion of a rigid support arch **2000** fixed in place with the help of a door or latch **2024** and a spring clip **2035**. For instance, an attachment magnet **2023** includes a slot or recess **2010** configured to receive a guide key **2012** extending from the mounting magnet **2025**. For instance, the slot or recess **2010** is in a top portion of the attachment magnet **2023** and the guide key **2012** extends from a corresponding portion of the mounting magnet **2025**. A door or latch **2024** is shown attached to the top portion of the attachment magnet with a screw **2021**. With the screw **2021** loosely secured, the door **2024** is configured to be pivotable about the screw. The door **2024** is long enough to extend over a top of the slot or recess **2010**. The guide key **2012** is configured to be placed in the slot or recess **2010**. The door **2024** is configured to have a portion of the door positioned over the slot or recess **2010** and secured in place. For instance, the screw can be tightened to hold the door in place. In that state, a guide key installed in the slot or recess **2010** is prevented from being lifted out of the slot, thereby tending to secure or fix the mounting magnet **2025** and attached rigid support arch **2000** in place. Similar securing or fixing components included on one or more additional tooth and one or more corresponding additional portions of the rigid support

arch **2000** might enhance the level of security or fixation. In addition to, or as an alternative to securing the door **2024** in place by the tightness of the screw **2021**, in some embodiments, the door **2024** can be pivoted around the screw **2021** after insertion of the guide key **2012** and locked in place with a spring clip **2035**, thereby fixing the guide key **2012**, the mounting magnet **2025** and hence the rigid support arch **2000** in position.

[00170] With reference to Figs. 21A – B, another embodiment of docking components such as securing or fixing components **2101** of magnetic based orthodontic appliance system includes at least one attachment magnet **2123** which is configured to be attached to the lingual or palatal side of one or more support tooth **2105**. The attachment magnet **2123** can include a recess or seat **2110** and one or more spring clips **2135** on the occlusal surface of the attachment magnet **2123**. The illustrated magnetic based orthodontic appliance system **2101** includes a rigid support arch **2100** configured to support at least one mounting magnet **2125** corresponding to and for magnetic attraction to at least one attachment magnet **2123**. The mounting magnet **2125** includes a fixing extension in the form a guide key **2112** with a stabilization member **2133**. For instance, the recess, slot or seat **2110** has a shape such as the illustrated V-shape. The guide key **2112** has a corresponding shape, such as a solid V-shape that extends outward from and normal to the mounting magnet and is configured to be received in the seat **2110**. The V-shape of the seat **2110** and the corresponding V-shape of the guide key are illustrative. The use of alternate mating shapes is contemplated. When viewed from the top, the stabilization member **2133** extends a first arm and a second arm out in opposite directions perpendicular to a top surface of a distal end of the V of the guide key, thereby forming a T-shape. The stabilization member **2133** is configured to rest on the occlusal surface of the attachment magnet **2123** when the guide key **2112** is inserted in the recess, slot or seat **2110**. Once seated, the guide key can be captured and held in place by installation of at least one spring clip **2135** installed over a portion of the stabilization arm **2133**. For instance, the attachment magnet **2123** is configured to accept the at least one spring clip **2135**. In the illustrated embodiment, two spring clips are used. One spring clip **2135** captures the first arm of the stabilization member **2133** and the other spring clip captures the second arm of the stabilization member **2133**. In this way, the spring clips **2135** hold the stabilization member **2133** of the guide key **2112** in place after the guide key **2112** is

inserted into the recess or seat **2110** on the attachment magnet **2123**, thereby securing the mounting magnet **2125** and hence the rigid support arch **2100** against the attachment magnet **2123** on the support tooth **2105**. The T-shape and spring clips are illustrative. Other locking mechanisms are contemplated. Similar securing or fixing components included on one or more additional tooth and one or more corresponding additional portions of the rigid support arch **2100** might enhance the level of security or fixation.

[00171] As indicated above, the various component magnets of embodiments of the magnet based orthodontic appliance system can be configured to have a wide variety of beneficial shapes and features. In addition to those features, embodiments of the magnets discussed herein can be configured to provide an adjustable level of force. For example, and with reference to Fig. 22, an embodiment of one or more component magnet of embodiments of the magnet based orthodontic appliance system comprises, for example, a modifiable therapeutic magnet **2225**. In the illustrated embodiment, a target magnet **2223** is configured to be attached to the lingual or palatal surface of a tooth **2205**. The target magnet **2223** carries a stop **2245**. A rigid support arch **2200** supports a corresponding modifiable therapeutic magnet **2225**. The therapeutic magnet **2225** includes a recess, slot or pocket **2207** configured to accept one or more additional magnets **2229**. Such embodiments allow a range of force to be adjusted or customized reducing a need for custom manufacturing of magnets on a per patient and/or per treatment stage basis. Additionally, such embodiments allow a clinician to adjust applied forces for a particular patient over the course of treatment.

[00172] For example, if the target magnet **2223** and therapeutic magnet **2225** are configured to be in the attractive mode, the presence of additional magnet **2229** in the recess **2207** will allow the initial movement of the tooth **2205** towards the rigid support arch **2200**. As the stop **2245** of the target magnet **2223** contacts the approximating surface of the additional magnet **2229**, the movement of the tooth **2205** would stop. At this point, it may be beneficial for the clinician to reduce the therapeutic force, for example, in order to compensate for the reduced distance between the target magnet **2223** and the therapeutic magnet **2225**. Accordingly, the clinician might remove the additional magnet **2229**. With the additional magnet **2229** removed, the target magnet **2223** and hence the

tooth **2205** can be urged to move at a therapeutically appropriate rate, further into the slot or pocket **2207** of the therapeutic magnet **2225**.

[00173] In another scenario, if the target magnet **2223** and therapeutic magnet **2225** are configured to be placed in the repulsive mode, the additional magnet **2229** could be added later, after the repulsive force formed by the interactions between the therapeutic magnet **2225** and target magnet **2223** subside due to the increase in distance between the therapeutic magnet **2225** and the target magnet **2223** resulting from target tooth movement.

[00174] As with other features of magnets discussed herein throughout, while in the illustrated embodiment it is a therapeutic magnet that is modifiable, target magnets can be configured to be modifiable as well. Furthermore, scenarios wherein both therapeutic and target magnets are modifiable are contemplated.

[00175] Fig. 23 provides a cross-sectional view of a tooth **2304** along with a bony palate **2307** of a patient in relation to a cross-sectional view of a magnet based orthodontic appliance system **2301** used for retraction of the tooth **2304**. A target magnet **2323** is configured to be attached to the lingual or palatal side of the crown **2303** of the target tooth **2304**. The magnet based orthodontic appliance system **2301** includes a rigid support arch **2300** (only partially shown in cross-section) having a therapeutic magnet **2325** corresponding to and for magnetic attraction to the target magnet **2323**. In the illustrated embodiment, the support arch **2300**, therapeutic magnet **2325** and the target magnet **2323** are configured to be horizontally aligned with the crown **2303** of the target tooth **2304**, so that the force **2350** of the magnetic interaction between the therapeutic magnet **2325** and target magnet **2323** are occlusal to a center of resistance **2306** to movement located on the root **2305** of the tooth **2304**. A stop **2336** on the therapeutic magnet **2325** would eventually prevent direct approximation of the therapeutic magnet **2325** and the target magnet **2323**.

[00176] Embodiments including extended target magnets will now be described. For instance, Fig. 24 provides a cross-sectional view of a target tooth **2404** along with a bony palate **2407** of a patient in relation to a cross-sectional view of a magnet based orthodontic appliance system **2401** that might be used for retraction of the target tooth **2404** using an extended target magnet **2423**. The target magnet **2423** is configured to be attached to

the lingual or palatal side of a crown **2403** of the target tooth **2404**. However, unlike the embodiment of Fig. 23, the target magnet **2423** is L-shaped and includes a first portion or shorter leg configured to extend briefly lingually away from the crown of the tooth **2404** and a second portion or longer leg that extends upward (as viewed in the figure) at an obtuse angle from the first portion and approximating a local contour of the bony palate **2407** until a distal end of the second portion reaches a bit beyond a vertical location of a center of resistance **2406**, located in the root **2405** of the target tooth **2404**. Fig. 23 is illustrative, as are all the Figs. In some applications a target magnet corresponding to target magnet **2423** might have a different shape. For instance, an angle between the first and second leg might not be obtuse. In some situations, there may not be a definite distinction between the first and the second leg, the target magnet might be substantially linear and a region corresponding to the second leg might extend from a first region which is attached to the lingual or palatal surface of the tooth. The magnet based orthodontic appliance system **2401** includes a rigid support arch **2400** (only partially shown in cross-section) having a therapeutic magnet **2425** corresponding to and for magnetic attraction to the target magnet **2423**. In the illustrated embodiment, the rigid support arch **2400**, therapeutic magnet **2425** and the distal end of the second portion or longer leg of the target magnet **2423** are aligned in line horizontally with the center of resistance **2406** of the target tooth **2404**, so that the force formed due the magnetic interaction between the therapeutic magnet **2425** and target magnet **2423** acts along a horizontal line **2450** through the center of resistance **2406** allowing translation of the tooth **2404**, rather than applying a tipping or pivoting torque. One or more stops **2436** on the therapeutic magnet **2425** would prevent eventual direct approximation of the therapeutic magnet **2425** and the target magnet **2423** during the course of treatment.

[00177] Fig. 25 provides a cross-sectional view of a target tooth **2504** along with a bony palate **2507** of a patient in relation to a cross-sectional view of a magnet based orthodontic appliance system **2501** that might be used for torqueing or lingual root movement of the target tooth **2504** using an extended target magnet **2523**. The target magnet **2523** is L-shaped and includes a first portion configured to extend briefly lingually away from the crown **2503** of the target tooth **2504** and a longer portion that extends upward at an obtuse angle from the first portion and approximating a local contour of the bony palate **2507**

until a distal end of the second portion reaches a beyond a vertical location of a center of resistance **2506** of the target tooth **2504**, located in a root **2505** of the target tooth **2504**. In some applications a target magnet corresponding to target magnet **2523** might have a different shape. For instance, an angle between the first and second leg might not be obtuse. In some situations, there may not be a definite distinction between the first and the second leg, the target magnet might be substantially linear and a region corresponding to the second leg might extend from a first region which is attached to the lingual or palatal surface of the tooth. The magnet based orthodontic appliance system **2501** includes a rigid support arch **2500** (only partially shown in cross-section) having a therapeutic magnet **2525** corresponding to and for magnetic attraction to the target magnet **2523**. In the illustrated embodiment, the support arch **2500**, therapeutic magnet **2525** and the longer portion of the target magnet **2523** are aligned horizontally at a point above (as viewed in the figure), or closer to, the root end of the target tooth **2504** that the center of resistance **2506** of the target tooth **2504**, so that a force formed due the magnetic interaction between the therapeutic magnet **2525** and target magnet **2523** acts along a horizontal line **2550** above or beyond the center of resistance **2506** at the point that is closer to the root end of the target tooth **2504** allowing more retraction of the root **2505** than the crown **2503** of the tooth **2504**. Stops **2536** on the therapeutic magnet **2525** would prevent direct approximation of the therapeutic magnet **2525** and the target magnet **2523** during the course of treatment.

[00178] Fig. 26 provides a cross-sectional view of a target tooth **2604** along with a bony palate **2607** of a patient in relation to a magnet based orthodontic appliance system **2601** that might be used for torqueing or lingual root movement of the target tooth **2604** using an extended target magnet **2623**. The extended target magnet **2623** is configured to be attached to the lingual or palatal side of the crown **2603** of the target tooth **2604**. In the illustrated embodiment, the target magnet **2623** is L-shaped and includes a first or shorter portion configured to extend briefly lingually away from the crown **2603** of the target tooth **2604** and a longer or second portion that extends upward at an obtuse angle from the first or shorter portion while approximating a local contour of the bony palate **2607** until a distal end of the longer portion reaches a point beyond a vertical location of a center of resistance **2606** of the target tooth **2604** located in the root **2605** of the target tooth **2604**.

The magnet based orthodontic appliance system **2601** includes a rigid support arch **2600** (only partially shown in cross-section) having a therapeutic magnet **2625** corresponding to and for magnetic attraction to the target magnet **2623**. The rigid support arch **2600** could be extended to all front teeth or only teeth that need the extension. In the illustrated embodiment, the therapeutic magnet **2625** and an additional magnet **2643** located at the distal end of the second portion of the extension **2633** of the target magnet **2623** are horizontally aligned at a point above (as viewed in the figure) the center of resistance **2606**, at a point closer to the root end of the target tooth **2604**, so that a therapeutic magnetic force **2650** formed due a magnetic interaction between the therapeutic magnet **2625**, the target magnet **2623** and the additional magnet **2643** would act at a point above the center of resistance **2606**, which is closer to the root end of the tooth **2604**, thereby, for example, urging more retraction of the root **2605** than the crown **2603** of the target tooth **2604**. The additional magnet **2643** can be included to modulate the strength of the therapeutic magnetic force **2650**. At least one stop **2636** on the therapeutic magnet **2625** would prevent direct approximation of the therapeutic magnet **2625** and the additional magnet **2643** during the course of treatment. The rigid support arch **2600** includes a labial stop **2602** that is configured to grasp a front edge of the crown **2603** of the target tooth **2604** so that the forward movement of the crown **2603** is prevented.

[00179] Fig. 27 provides a cross-sectional view of a tooth **2704** along with a bony palate **2707** of a patient in relation to a cross-sectional view of a magnet based orthodontic appliance system **2701** that might be used for intrusion of a target tooth **2704** along a long axis of the target tooth **2704** using an extended target magnet **2723**. In the illustrated embodiment, the target magnet **2723** is configured to be attached to the lingual or palatal side of a crown **2703** of the target tooth **2704**. The illustrated target magnet **2723** is L-shaped and includes a first or shorter portion configured to extend briefly lingually away from an attachment point on the crown **2703** of the target tooth **2704**, and a second or longer portion that extends upward at an obtuse angle from the first portion while approximating a local contour of a bony palate **2707** of the patient until a distal end of the second portion reaches a bit beyond a vertical location of a center of resistance **2706** of the target tooth **2704**, located in the root **2705** of the target tooth **2704**. The target magnet **2723** is configured to support a first additional magnet **2743** and a second additional

magnet **2753**. The first additional magnet **2743** is supported at a distal end of the second portion of the target magnet, a portion of which is intersected by a horizontal line through the center of resistance **2706** of the target tooth **2704**. Accordingly, a portion of the first additional magnet is also intersected by the horizontal line (e.g., see **2750**). In the illustrated embodiment, the second additional magnet **2753** is supported by the target magnet **2723** at a point on the first extension wherein portions of the target magnet **2723** and the second additional magnet **2753** are intersected by a vertical line (e.g., see **2760**) that also goes through the center of resistance **2706** of the target tooth **2704**.

[00180] The magnet based orthodontic appliance system **2701** includes a rigid support arch **2700** (only partially shown in cross-section) configured to support a therapeutic magnet **2725** corresponding to and for magnetic attraction to the first additional magnet **2743** on the target magnet **2723**. The rigid support arch **2700** could be extended to all front teeth or only teeth that need the extension. In the illustrated embodiment, the therapeutic magnet **2725** and the first additional magnet **2743** are configured to produce an attractive magnetic force and are horizontally aligned with the center of resistance **2706** of the target tooth **2704**, so that an attractive force **2750** formed due the magnetic attraction between the therapeutic magnet **2725** and additional magnet **2723** acts horizontally through the center of resistance **2706** of the tooth **2704** to urge/pull the tooth backward. At least one stop **2736** on the therapeutic magnet **2725** is shown in direct contact with the first additional magnet **2743** on the target magnet **2723** to prevent lingual retraction of the target tooth **2704** beyond the stop **2736**.

[00181] The rigid support arch **2700** includes an L-shaped extension **2702**, a first or longer portion of which extends downward (in the illustration) in a direction generally parallel to the second portion of the extended target magnet **2723** to a point below (in the illustration) a level of the second additional magnet **2753** on the target magnet **2723**. At the point below the level of the second additional magnet **2753**, a second and shorter portion of the L-shaped extension **2702** extends away from the first portion of the support arch extension **2702** at an obtuse angle and generally parallel to the second additional magnet **2753** and first or shorter portion of the target magnet **2723** to a point behind the crown **2703** of the target tooth **2704** and approximately aligned with the attachment end of the first portion of the target magnet **2723** where the target magnet **2723** is bonded to

the crown **2703** of the target tooth **2704**. The second or shorter portion of the L-shaped extension **2702** of the rigid support arch **2700** supports an additional therapeutic magnet **2755** which is configured to produce a repulsive force with the second additional magnet **2753** on the target magnet **2723**. The additional therapeutic magnet **2755** and the second additional target magnet **2753** are aligned with the center of resistance **2706** in the vertical plane (see **2760**) so that the associated generated repulsive force **2760** would urge the target tooth **2704** in an upward (relative to the figure) vertical direction along the center of resistance **2706**. For instance, the magnets are configured (e.g., by selection of size, strength, location and spacing) so that the two force vectors **2750** and **2760** form a resultant **2780** force vector which is directed along the long axis of the tooth **2704** resulting in true intrusion along the long axis of the tooth. As the tooth is urged into the bone along vector **2780** the space between the magnets **2753** and **2755** increases, in order to maintain the same repulsive force levels, a new support arch and associated attachments could be inserted or one of the magnets could be modified as explained in Fig. 22.

[00182] Embodiments discussed thus far have included multiple support teeth, multiple first docking components (e.g., attachment magnets) and multiple second docking components (e.g., mounting magnets). However, it is to be understood, that in some scenarios, only a single support tooth is needed or available. For instance, Figs. 28A – C illustrate a magnet-based orthodontic appliance system **2801** that includes one attachment magnet **2833** configured to be attached to the lingual or palatal side of a support tooth **2822** of a set of teeth **2850**. The magnet based orthodontic appliance system **2801** includes a rigid support arch **2800** which is configured to support or include one mounting magnet **2835** corresponding to and for magnetic attraction to the attachment magnet **2833**. The rigid support arch **2800** is secured in position by attractive magnetic forces between the mounting magnet **2835** and the attachment magnet **2833**. The mounting magnet **2835** includes stops **2836** which are configured to prevent direct approximation of the mounting magnet **2835** and the attachment magnet **2833**.

[00183] The rigid support arch **2800** is also configured to support a therapeutic magnet **2825** at a therapeutic position corresponding to a target magnet **2823** attached to the lingual or palatal side of a target tooth **2826**. The therapeutic magnet **2825** also has at least one or more stop **2816** which will prevent direct contact (direct approximation)

between the facing surfaces of the therapeutic magnet **2825** and target magnet **2823** as the target tooth **2826** moves towards the rigid support arch **2800** due to the attractive forces between the therapeutic magnet **2825** and target magnet **2823**.

[00184] In the embodiment of Figs. 29A – D a magnet-based orthodontic appliance system **2901** includes at least one first docking component, such as an attachment magnet **2923** configured to be attached to the lingual side of at least one respective support tooth **2924**, **2926** and **2928**. The magnet based orthodontic appliance system **2901** includes a rigid support arch **2900** having a respective at least one second docking component, such as mounting magnet **2925** corresponding to and for magnetic attraction to the at least one attachment magnets **2923**. The rigid support arch **2900** is secured in position by the attractive magnetic forces between the mounting magnets **2925** and attachment magnets **2923**. For example, the rigid support arch is made of orthodontic wire or metallic rod of appropriate size and rigidity. For example, in some applications, the wire or rod commonly used in orthodontic headgear may provide sufficient rigidity. Rod or wire with a diameter of about 0.045 to about 0.06 inches or more may be appropriate. In some applications, thinner wire may suffice. Other embodiments might be injection molded or cast plastic or 3D printed (made through additive manufacturing). Machined embodiments are also possible. The mounting magnets **2925** include horizontal extensions **2915** that are configured to extend from the mounting magnets **2925** over a second or top face (as viewed in the figures) of their respective attachment magnet **2923**. At least one stop **2936** on the at least one mounting magnet **2925** contacts the lingual and occlusal surface of the at least one of the attachment magnets **2923** and prevents lingual and occlusal movement of the support teeth **2924**, **2926** and **2928**, due to the attractive magnetic forces between the mounting magnets **2925** and the attachment magnets **2923**.

[00185] The rigid support arch **2900** is configured to support a therapeutic magnet **2935** at a therapeutic position corresponding to a target magnet **2933** attached to the occlusal surface of a target tooth **2922**. The therapeutic magnet **2935** has a horizontal extension **2955** that extends over top surface of the target magnet **2933**, which results in, for example, an attractive force in a vertical plane to urge the tooth **2922** away from the bone so that the tooth **2922** comes in a horizontal level with the support teeth **2924**, **2926** and

2928. The therapeutic magnet **2935** also includes at least one stop **2956** on the horizontal extension **2955** in order to prevent direct approximation of the facing surfaces of the horizontal extension **2955** and the target magnet **2933**.

[00186] In the embodiment of Fig. 30, the magnet based orthodontic appliance system **3001**, has a rigid support arch **3000**, configured to change the position of teeth **3008**, **3009**, **3010** and **3011**. The support arch has extensions **3030** which hold labial veneers **3018**, **3019**, **3020** and **3021** which are connected to each other, while mimicking the final position of the teeth **3008**, **3009**, **3010** and **3011**.

[00187] In the embodiment of Figs. 31A – B, attachment **3115** on the tooth **3110** presents with one or more notches **3116** or one or more flanges, to facilitate gripping of the attachments while debonding from the tooth surface.

[00188] It should be appreciated that the presently described embodiments include methods for use, operation, and/or implementation of the appliances, devices and systems described herein to perform, for example, functions, such as those described in connection with the embodiments of Figures 1A – 31B and below, to implement orthodontic techniques or procedures to resolve a variety of orthodontic issues. The implementation of any one of the presently described embodiments, including use, operation, and/or implementation of the appliances, devices and systems and/or associated methods to perform desired functions, achieves a variety of functions and results which have advantages and benefits over conventional technology and/or are not achievable by conventional technology.

[00189] At least some of these are described above. In addition, as a further example, traditionally, orthodontic appliances like removable appliances, fixed appliances using a combination of brackets and arch wires, and clear aligners using thermoplastic material, apply force on the crown of the teeth to move them in the bone. Hence, the applied force is away from the center of resistance of the teeth. The center of resistance of each individual tooth is located on the root of the tooth or within the confines of the roots in case of a multirooted tooth. The applied force, which is away from the center of resistance, produces a rotational tendency, leading to rotational movement of the tooth/ teeth around a center of rotation located on the tooth root. Although various measures are employed to counter this rotational tendency, none of the appliances that have been used for

orthodontic tooth movement have been able to generate adequate counter moments in the labio-lingual plane (in-out plane). Hence, the teeth tend to tip lingually (inward) during the initial movement wherein the crown of the teeth move ahead of the root, and additional steps are required to move the roots in order to obtain optimal labio-lingual (in-out) inclination.

[00190] According to at least some forms of the presently described embodiments, the magnet based orthodontic appliance system is configured, unlike conventional technology, to cause or obtain adequate counter moments while in use or operation, while moving the teeth lingually. The counter moment generated is a function of the vertical heights of the therapeutic magnet and the target magnet or the length of the extension arm which extends towards the center of resistance of the tooth so that the applied force is in line with the center of resistance of the tooth.

[00191] Also, according to at least some forms of the presently described embodiments, the appliance system is configured, unlike conventional technology, to cause, while in use or operation, precise tooth movement without undue side effects on the adjacent teeth, as movement of each tooth is independent of the movement of the adjacent tooth. This is possible as the teeth movement is carried out by forces which are generated by magnetic interaction of magnets or ferromagnetic material held on a rigid support arch and the magnets or ferromagnetic material attached on the teeth that required to be moved. This is in contrast to the mechanics employed by traditional fixed appliances and clear aligners which are dependent on arch wires or thermoplastic material that could flex and create undesirable side effects on the adjacent teeth while a tooth is being moved.

[00192] While features, aspects, options and components have been described or illustrated in association with particular embodiments, it is to be understood that those features, aspects, options or components are not restricted to those embodiments. To the contrary, features, aspects, options or components described or illustrated in one embodiment can be included in other embodiments. Additionally, features, aspects, options or components described in association with an embodiment can be deleted from that embodiment to arrive at an embodiment including remaining and/or alternative features, aspects, options or components.

[00193] The exemplary embodiment has been described with reference to the preferred embodiments. Modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the exemplary embodiment be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

CLAIMS:

1. An orthodontic appliance system comprising:
 - at least one first docking component configured to be attached to the lingual or palatal side of at least one respective support tooth;
 - at least one target magnet, the at least one target magnet comprising at least one of a magnet or paramagnet, the at least one target magnet being configured to be attached to at least one of a lingual, palatal, distal or mesial surface of at least one respective target tooth, at least one point on a bony palate and/or at least one point on a buccal bone;
 - a rigid support arch having respective at least one second docking component corresponding to, and for securement to, the at least one first docking component, the rigid support arch being configured to support at least one therapeutic magnet at at least one respective therapeutic position adjacent a respective one of the at least one target magnet;
 - wherein the at least one of the rigid support arch, at least one of the at least one target magnet or at least one of the at least one therapeutic magnet includes at least one stop configured to prevent or limit an aspect of movement of a tooth.
2. The orthodontic appliance system of claim 1 wherein the rigid support arch comprises an orthodontic wire.
3. The orthodontic appliance system of claim 1 wherein the rigid support arch comprises a metal band.
4. The orthodontic appliance system of claim 1 wherein the rigid support arch comprises a thermoplastic appliance.
5. The orthodontic appliance system of claim 1 wherein the rigid support arch comprises a resin-based appliance.

6. The orthodontic appliance system of claim 1 wherein the rigid support arch comprises a rigid thermoplastic or resin.

7. The orthodontic appliance system of claim 1 wherein at least one of the at least one target or at least one of the at least one therapeutic magnet has a non-planar shape.

8. The orthodontic appliance system of claim 7 wherein the non-planar shape comprises an L-shape.

9. The orthodontic appliance system of claim 8 wherein the L-shape comprises an obtuse angle between legs of the L-shape.

10. The orthodontic appliance system of claim 7 wherein the non-planar shape comprises one of a C-shape and a U-shape in cross section from an occlusal view.

11. The orthodontic appliance system of claim 1 wherein at least one target of the at least one target comprises an extended target that is larger in at least one dimension than a corresponding dimension of an exposed portion the at least one associated target tooth.

12. The orthodontic appliance system of claim 1 wherein the at least one stop comprises a first stop and a second stop, the first stop being configured to make an initial contact during a therapeutic movement of a tooth, thereby limiting a first aspect of the therapeutic movement the tooth, while the second stop has not yet made a contact, thereby allowing a second aspect of therapeutic movement of the tooth.

13. The orthodontic appliance system of claim 1 wherein the rigid support arch includes at least one extension configured to extend into a space left by an extracted or missing tooth and the at least one therapeutic magnet includes at least one therapeutic magnet mounted on the at least one extension and the at least one target magnet includes

at least one target magnet mounted on at least one mesial or distal surface of at least one target tooth adjacent the space left by the extracted or missing tooth.

14. The orthodontic appliance system of claim 13 wherein the at least one extension that is configured to occupy the space left by an extracted or missing tooth comprises a tooth shaped pontic.

15. The orthodontic appliance system of claim 1 wherein the rigid support arch supports at least one non-magnetic guide plane configured to provide a supplemental contact-based guidance to urge a tooth in a desired direction.

16. The orthodontic appliance system of claim 1 wherein the rigid support arch wherein at least one of the at least one target magnet and at least one of the at least one therapeutic magnet are configured to have opposite poles facing each other while at least one of the at least one target magnet and the at least one therapeutic magnet include at least one stop configured to prevent movement of the target tooth toward the therapeutic magnet.

17. The orthodontic appliance system of claim 8 wherein the L-Shaped magnet is configured to urge the target tooth occlusally, lingually and/or laterally.

18. The orthodontic appliance system of claim 1 wherein at least one of the at least one target magnet and the at least one therapeutic magnet supports at least a first stop and a second stop, the first stop being configured to contact the other of the at least one target magnet and the at least one therapeutic magnet during a therapeutic time period before the second stop contacts the other of the at least one target magnet and the at least one therapeutic magnet, thereby providing a pivot point for achieving a desired movement of an associated target tooth.

19. The orthodontic appliance system of claim 1 wherein the at least one target magnet and the at least one therapeutic magnet comprise complementary triangular

shapes whereby respective hypotenuses of the triangular shapes can be configured to face each other.

20. The orthodontic appliance system of claim 1 wherein the at least one target magnet comprises a first target magnet and a second target magnet configured to be attached to a lingual or palatal side of a same respective target tooth and wherein the rigid support arch is configured to support a first therapeutic magnet and a second therapeutic magnet adjacent the same respective target tooth, wherein the first target magnet and the first therapeutic magnet are configured to produce an attractive force therebetween and the second target magnet and the second therapeutic magnet are configured to produce a repulsive force therebetween.

21. The orthodontic appliance system of claim 1 wherein at least one of the at least one therapeutic magnet is configured to include a substantially horizontal lever arm longer than the width of an associated target tooth.

22. The orthodontic appliance system of claim 21 wherein the substantially horizontal lever arm supports a magnetic attachment at a distal end thereof.

23. The orthodontic appliance system of claim 1 wherein the rigid support arch includes at least one occlusal extension configured to apply intruding forces to at least one tooth.

24. The orthodontic appliance system of claim 1 wherein the rigid support arch includes at least one sagittal stabilization stop configured to contact a rear surface of a respective at least one attachment magnet and limit forward movement of the rigid support arch.

25. The orthodontic appliance system of claim 1 wherein the at least one first and the at least one second docking components comprise respective at least one attachment and at least one mounting magnet.

26. The orthodontic appliance system of claim 25 wherein the at least one first docking component comprises at least one set of conjoined attachment magnets.

27. The orthodontic appliance system of claim 25 wherein at least one of the at least one mounting magnet includes a horizontal extension configured to extend from the at least one mounting magnet to an area adjacent a second face of a respective attachment magnet.

28. The orthodontic appliance system of claim 27 wherein the horizontal extension includes at least one stop on the horizontal extension configured to prevent vertical movement of an associated support tooth due to attractive magnetic force between the at least one mounting magnet including the horizontal extension and the attachment magnet.

29. The orthodontic appliance system of claim 25 wherein at least one of the at least one therapeutic magnet includes a horizontal extension configured to extend from the at least one therapeutic magnet to an area adjacent to and approximating a second face of a respective target magnet.

30. The orthodontic appliance system of claim 29 wherein the horizontal extension includes a first stop and a second stop on a surface of the horizontal extension approximating the second face of the target magnet, wherein the first stop is configured to be positioned at a point that is closer to the top surface of the target magnet than the second stop, thereby limiting vertical movement of the corresponding side of the target magnet relative to a side of the target magnet corresponding to a location of the second stop.

31. The orthodontic appliance system of claim 1 wherein the rigid support arch comprises at least one of orthodontic rod, orthodontic wire, injection molded plastic, cast plastic and 3D printed material including ferromagnetic material.

32. The orthodontic appliance system of claim 1 comprising a transpalatal arch connecting one or more attachment magnets from either side of the rigid support arch.

33. The orthodontic appliance system of claim 1 wherein the rigid support arch is configured to follow the contour of a palate of a patient.

34. The orthodontic appliance system of claim 33 wherein at least one of the at least one target is configured to be mounted on an implant configured to be implanted in the bony palate.

35. The orthodontic appliance system of claim 34 wherein the rigid support arch comprises occlusal extensions configured to cover and transmit therapeutic force between the at least one target magnet and at least one therapeutic magnet to at least one target tooth.

36. The orthodontic appliance system of claim 1 wherein at least one of the at least one target magnet is configured to be mounted on an implant configured to be implanted in the buccal bone.

37. The orthodontic appliance system of claim 36 wherein the rigid support arch is configured to support a horizontal extension, the horizontal extension being configured to contact an occlusal surface between teeth.

38. The orthodontic appliance system of claim 36 wherein the rigid support arch is configured to support a distal extension, the distal extension being configured to contact an occlusal surface of one of the at least one respective support tooth and further extend as a buccal extension to embrace a buccal surface of the one of the at least one respective support tooth and support a stabilizing magnet at a position adjacent to at least one stabilizing implant magnet mounted on a stabilizing implant implanted in the buccal bone.

39. The orthodontic appliance system of claim 8 wherein at least one therapeutic magnet is L-shaped and one leg of the L-shaped magnet comprises a horizontal extension of the at least one therapeutic magnet the horizontal extension comprising a stop configured to initially be spaced from a mesial surface of one of the at least one target magnet and to be contacted by the mesial surface of the one of the at least one target magnet only after a therapeutic mesial movement of the target tooth associated with the one of the at least one target magnet.

40. The orthodontic appliance system of claim 39 wherein at least one mounting magnet is L-shaped and one leg of the L-shaped magnet comprises a horizontal extension of the at least one therapeutic magnet the horizontal extension comprising a stop configured to initially contact a mesial surface of one of the at least one attachment magnet thereby preventing mesial movement of the support tooth associated with the one of the at least one attachment magnet.

41. The orthodontic appliance system of claim 36 wherein the rigid support arch comprises a horizontal extension configured to reach through a space between teeth to support at least one stabilizing implant magnet at a stabilizing position corresponding to a stabilizing implant magnet configured to be mounted on an implant implanted in a buccal bone.

42. The orthodontic appliance system of claim 41 wherein the horizontal extension is configured to abut a surface of a tooth, thereby providing further stabilization.

43. The orthodontic appliance system of claim 1 wherein at least one of the at least one attachment magnet includes a seat configured to receive a guide key extending from an associated mounting magnet.

44. The orthodontic appliance system of claim 1 wherein at least one of the at least one mounting magnet includes a guide key configured to be received in a seat included in an associated attachment magnet.

45. The orthodontic appliance system of claim 1 wherein the rigid support arch comprises at least one of a permanent magnet in the form of an arch shaped strip and an arch shaped strip including isolated magnetized regions.

46. The orthodontic appliance system of claim 45 wherein at least one of the at least one therapeutic magnet comprises a therapeutic magnet extension configured to face a mesial side or a distal side of at least one of the at least one target magnet.

47. The orthodontic appliance system of claim 1 wherein at least one of the at least one mounting magnet is L-shaped due to inclusion of a horizontal mounting extension configured to provide a mesio-distal support force.

48. The orthodontic appliance system of claim 1 wherein the horizontal mounting extension includes at least one stop for opposing mesio-distal movement of at least one associated support tooth.

49. The orthodontic appliance system of claim 1 wherein the rigid support arch is configured to be located gingival to the crowns of teeth of an associated patient and wherein the at least one mounting magnet and the at least one therapeutic magnet are attached to the rigid support arch by vertical extensions from the rigid support arch.

50. The orthodontic appliance system of claim 1 wherein the rigid support arch, at least one mounting magnet and the at least one therapeutic magnet are a single unitary manufacture.

51. The orthodontic appliance system of claim 25 wherein the rigid support arch comprises an upper rigid support arch and the at least one mounting magnet comprises at least one upper mounting magnet, at least one of the at least one upper mounting magnet comprising a downward extension, the orthodontic appliance system further comprising:

a lower rigid support arch having at least one lower mounting magnet, at least one of the at least one lower mounting magnet comprising an upward extension;

wherein extensions of respective at least one pair of the downward extension of the at least one upper mounting magnet and the upward extension of the at least one lower mounting magnet are configured to magnetically attract one another when installed in an associated patient, thereby urging an upper dental arch and a lower dental arch of the associated patient toward one another in an antero-posterior direction.

52. The orthodontic appliance system of claim 25 wherein at least one of the at least one attachment magnet and at least one mounting magnet comprise a stop.

53. The orthodontic appliance system of claim 25 wherein the rigid support arch and at least one of the at least one therapeutic magnet and at least one mounting magnet comprise at least one set of interlocking portions.

54. The orthodontic appliance system of claim 53 wherein the interlocking portions comprise at least one half-blind dovetail in the rigid support arch and a dovetail pin in the at least one of the at least one therapeutic magnet and at least one mounting magnet.

55. The orthodontic appliance system of claim 32 wherein at least one of the attachment magnets on either side of the rigid support arch and connected by the transpalatal arch is a wide attachment magnet configured to be attached to two or more support teeth.

56. The orthodontic appliance system of claim 43 wherein the at least one of the at least one attachment magnet includes at least one a spring clip configured to participate in retaining the guide key in the seat.

57. The orthodontic appliance system of claim 56 wherein the at least one of the at least one attachment magnet includes a door that is configured to be securable under

the at least one spring clip and over the seat, thereby being configured to participate in retaining the guide key in the seat.

58. The orthodontic appliance system of claim 56 wherein the at least one spring clip comprises two spring clips configured to be installed on either side of the seat and wherein the guide key includes a stabilization member including a first arm and a second arm that extend out in two opposite directions perpendicular to a top surface of a distal end of the guide key, thereby forming a T-shape, the stabilization member being configured to rest on a top surface of the attachment magnet when the guide key is in the seat, and wherein the spring clips are configured to capture the first arm and the second arm of the stabilization member respectively.

59. The orthodontic appliance system of claim 1 wherein at least one of the at least one therapeutic magnet includes a slot or pocket configured to accept one or more additional magnets.

60. The orthodontic appliance system of claim 1 comprising at least one additional magnet.

61. The orthodontic appliance system of claim 8 wherein at least one of the at least one target magnet comprises the L-shape with an angle between a shorter leg and a longer leg of the L-shape wherein the shorter leg is configured to be bonded to and extend briefly lingually away from the crown of an associated target tooth of an associated patient and the longer leg is configured to extend, at an angle, away from the shorter leg, approximating a local contour of a bony palate of the associated patient until a distal end of the longer leg reaches a bit beyond a vertical location of a center of resistance in a root of the target tooth; and wherein

the rigid support arch is configured to support a therapeutic magnet corresponding to and for magnetic attraction to the target magnet at the distal end of the longer leg of the target magnet at a point centered on and horizontally aligned in line with the center of resistance of the associated target tooth, whereby a force formed due the magnetic

interaction between the therapeutic magnet and target magnet would act in a direction horizontally through the center of resistance.

62. The orthodontic appliance system of claim 61 wherein the rigid support arch includes an extension configured to grasp a front edge of the crown of the associated target tooth.

63. The orthodontic appliance system of claim 61 further comprising:

at least one of a first and/or second additional magnet and an L-shaped extension of the rigid support arch, wherein the first additional magnet is configured to be mounted on the distal end of the long leg of the target magnet, the second additional magnet being configured to be mounted on the short leg of the target magnet, the L-shaped extension of the rigid support arch having a longer leg extending from the rigid support arch generally parallel to the long leg of the target magnet and a short leg extending from a distal end of the long leg generally parallel to the short leg of the target magnet, the short leg of the extension of the rigid support arch supporting an auxiliary therapeutic magnet.

64. The orthodontic appliance system of claim 8 wherein at least one of the at least one target comprises the L-shape with an angle between a shorter leg and a longer leg of the L-shape wherein the shorter leg is configured to be bonded to and extend briefly lingually away from the crown of an associated target tooth of an associated patient and wherein the longer leg is configured to extend, at an angle, away from the shorter leg and approximating a local contour of a bony palate of the associated patient until a distal end of the longer leg reaches beyond a vertical location of a center of resistance in a root of the target tooth; and wherein

the rigid support arch is configured to support a therapeutic magnet corresponding to and for magnetic attraction to the target magnet at the distal end of the longer leg of the target magnet centered on and aligned horizontally in line with a point beyond the center of resistance, closer to root end of the target tooth, whereby a force formed due the magnetic interaction between the therapeutic magnet and target magnet would act in a direction horizontally through the center of resistance.

65. The orthodontic appliance system of claim 1, wherein the rigid support arch is configured to change the position of teeth and has extensions which hold labial veneers which are connected to each other thereby mimicking the final position of the teeth.

66. A method for performing an orthodontic procedure comprising using the orthodontic appliance system as set forth in any preceding claim.