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August 26, 2024

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APPLICATION NUMBER: 62/742,942

FILING DATE: *October 9, 2018*

THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS US 62/742,942

**By Authority of the
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Provisional Application for Patent Cover Sheet					
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Given Name	Middle Name	Family Name	City	State	Country ;
Charles	Albert	Rudisill	Apex	NC	US
Inventor 2					<input type="button" value="Remove"/>
Given Name	Middle Name	Family Name	City	State	Country ;
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Title of Invention		Separable Fastener Systems and Methods for Adapting Dental Prostheses and Dentures to Dental Implants			
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Signature				Date (YYYY-MM-DD)	2018-10-08
First Name	Charles	Last Name	Rudisill	Registration Number (if appropriate)	

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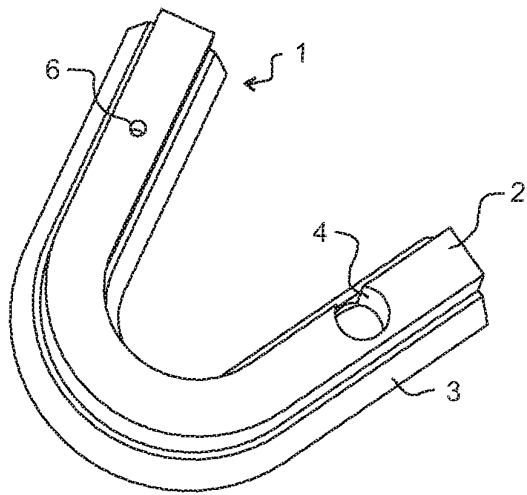


FIG. 1

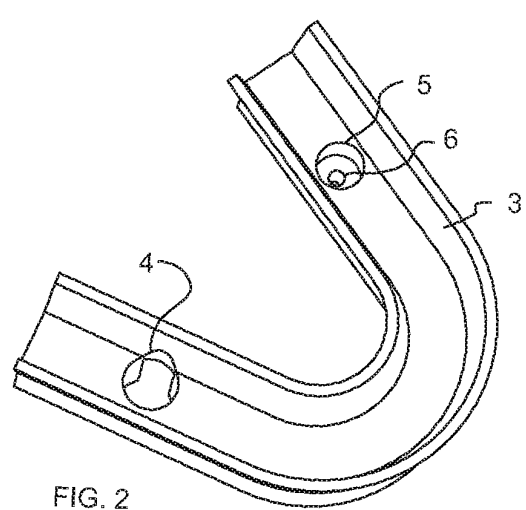


FIG. 2

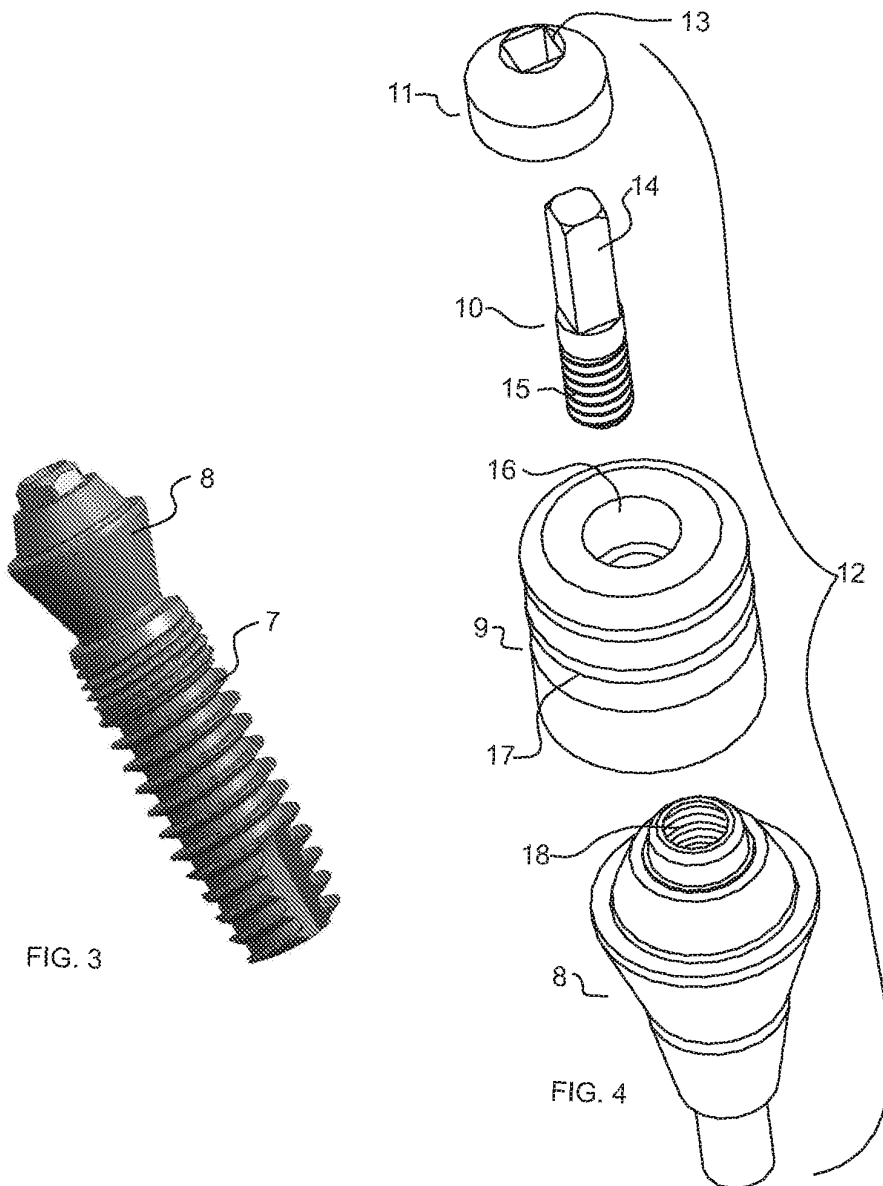


FIG. 3

FIG. 4



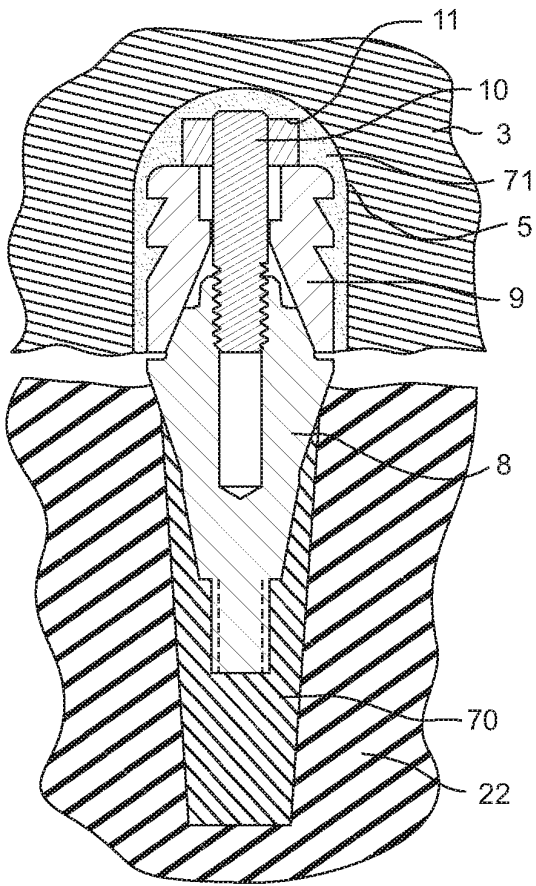


FIG. 5

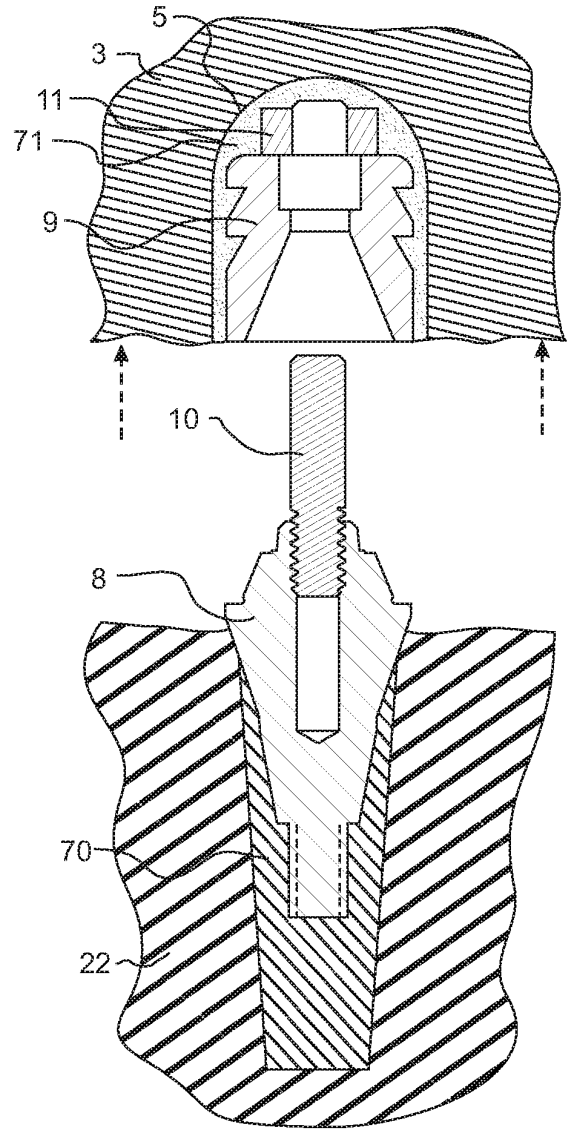


FIG. 6

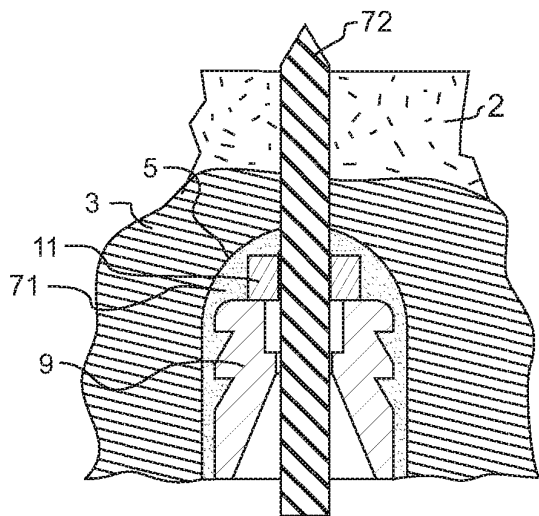


FIG. 7

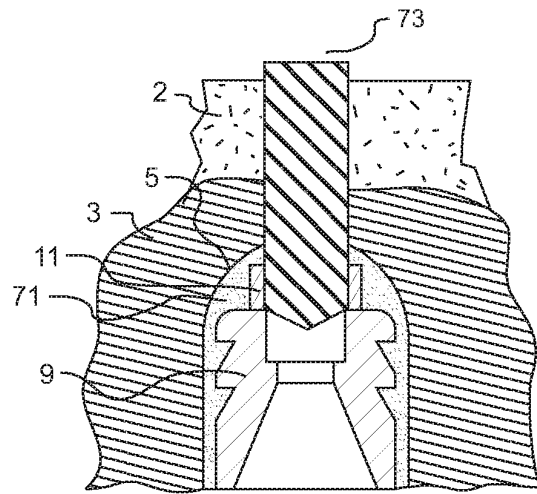


FIG. 8

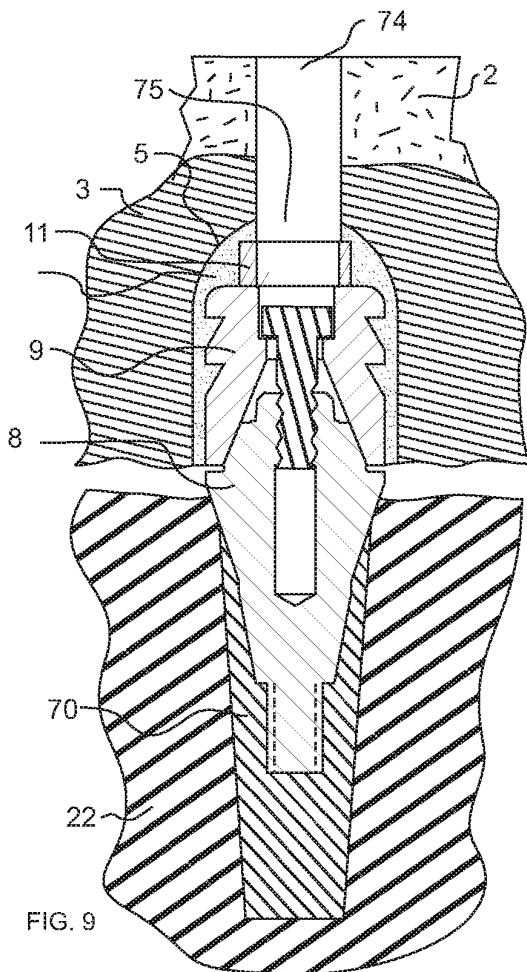
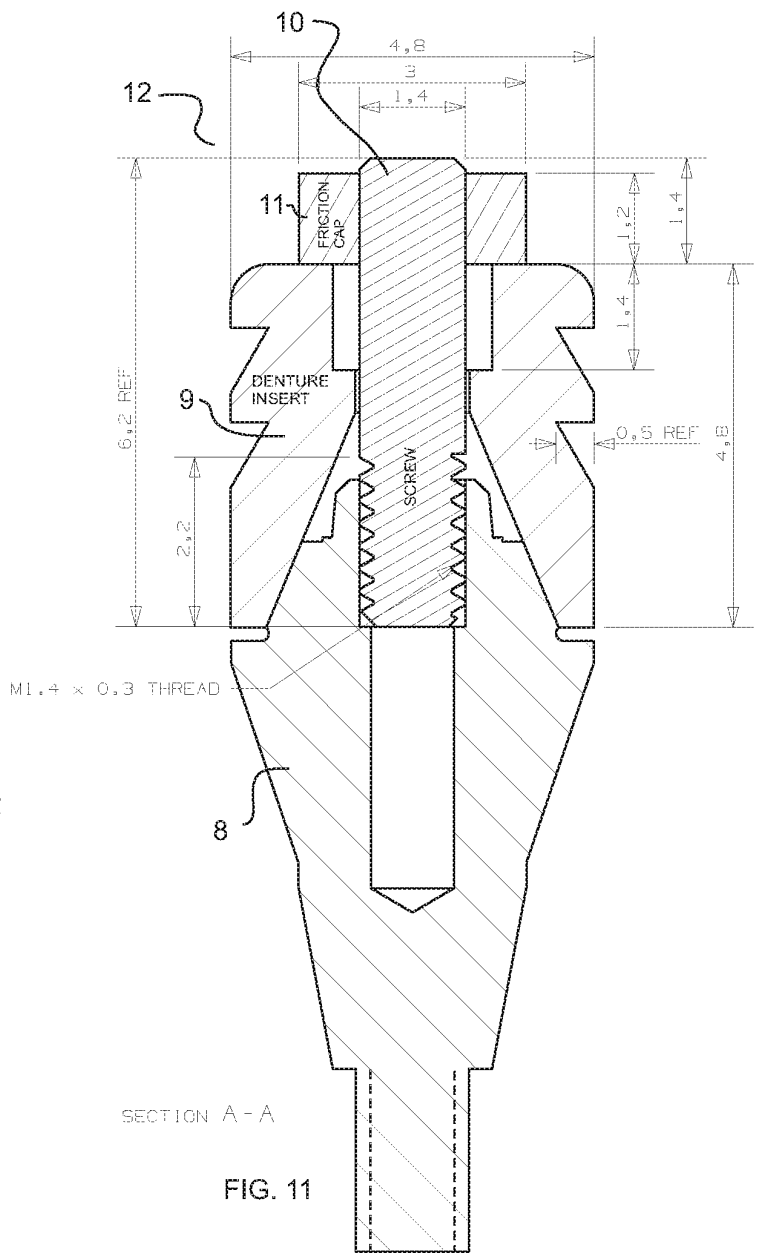
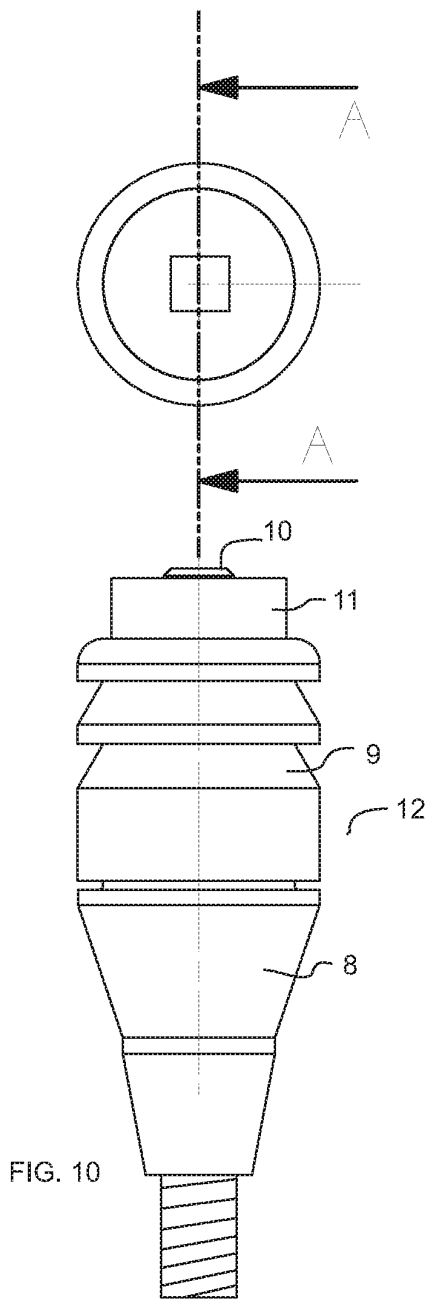


FIG. 9



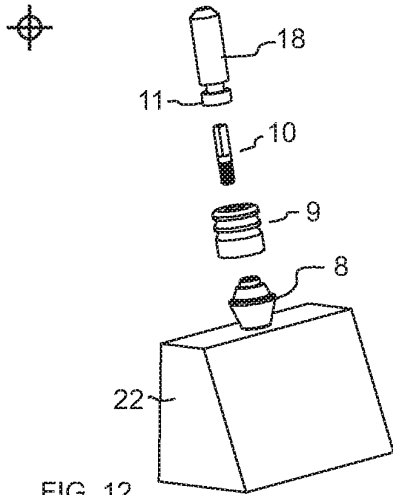


FIG. 12
install insert onto abutment
prior to marking denture

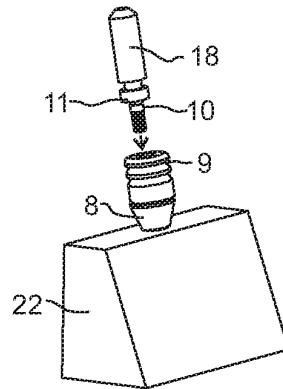


FIG. 13
assemble tool/cap to screw,
assemble insert to abutment

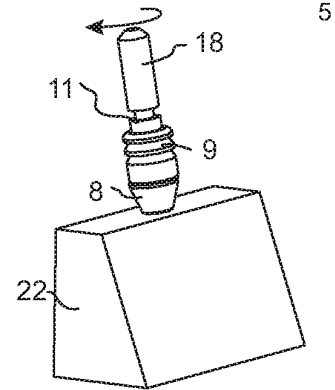


FIG. 14
drive temp screw and
cap to secure insert
to abutment

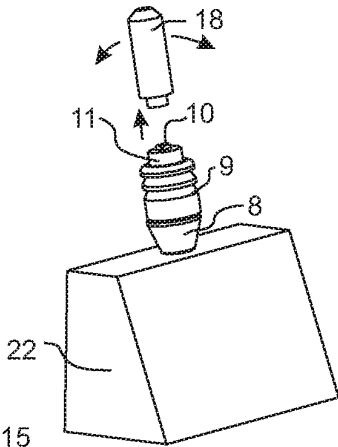


FIG. 15
break-away tool from cap

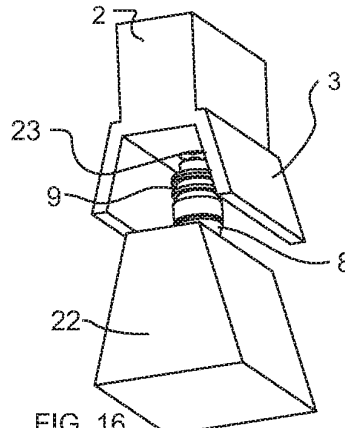


FIG. 16
mark denture for drilling
for insert

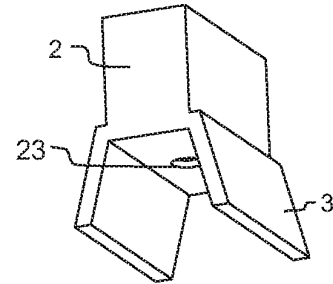


FIG. 17
denture marked for insert
drilling

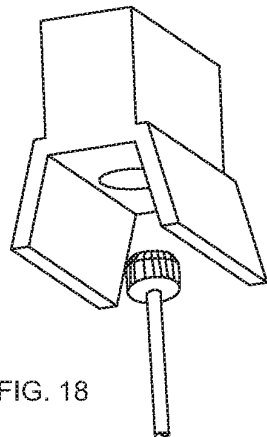


FIG. 18
drill recess for insert
(blind hole)

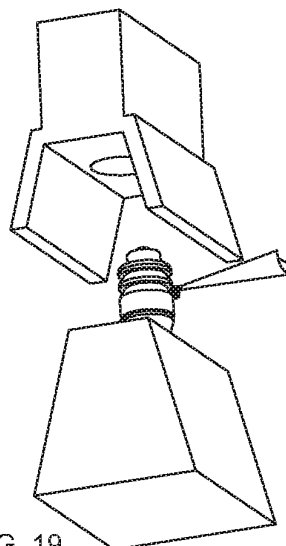


FIG. 19
apply adhesive to insert
and/or denture cavity

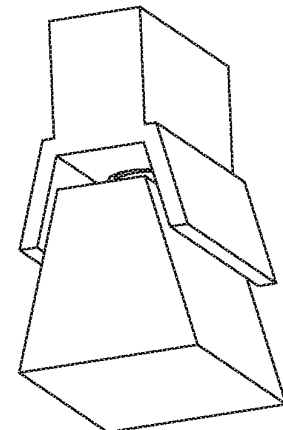


FIG. 20
seat and cure insert and
adhesive

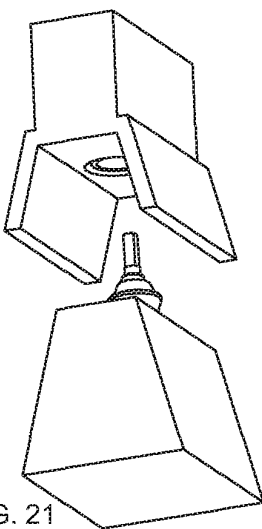


FIG. 21
insert cemented into denture,
denture removed from temp
screw.

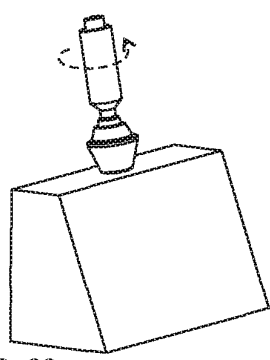


FIG. 22
remove temp screw from
abutment using tool

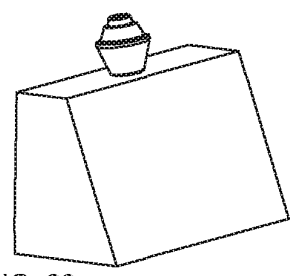


FIG. 23
temp screw removed
from abutment

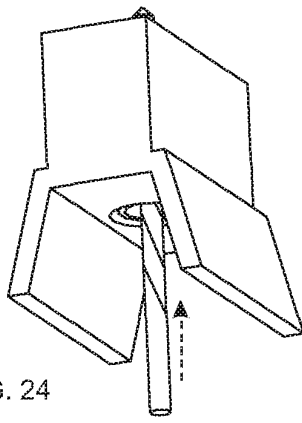


FIG. 24
drill guide hole for
denture attachment screw

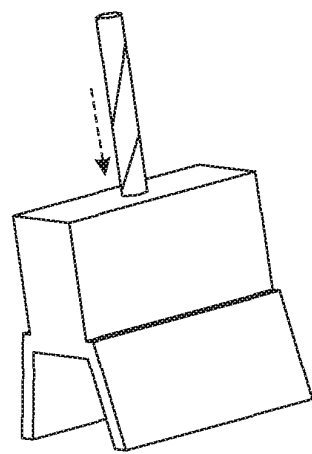


FIG. 25
drill clearance hole for
denture attachment screw

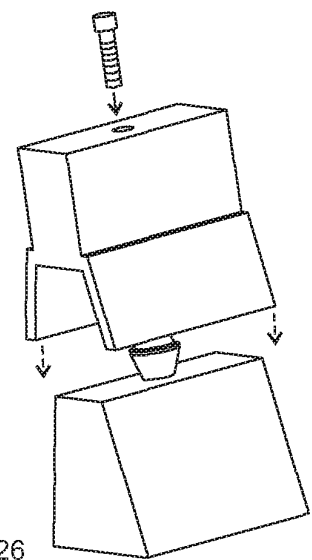


FIG. 26
install denture onto abutment
using denture attachment screw

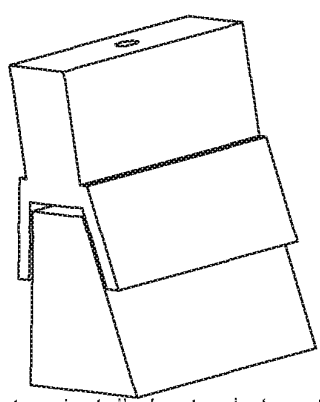
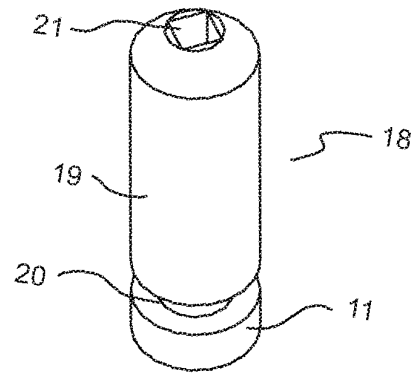


FIG. 27
denture installed onto abutment
using attachment screw



7

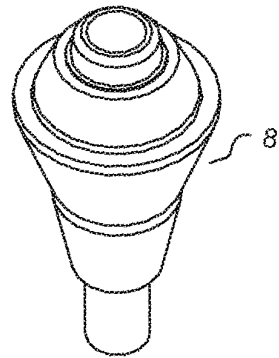
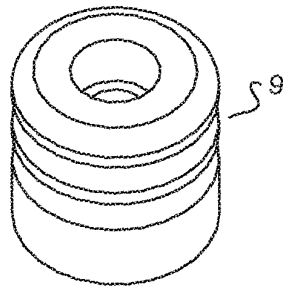
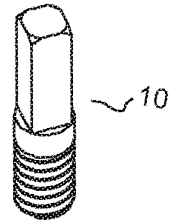


FIG. 28



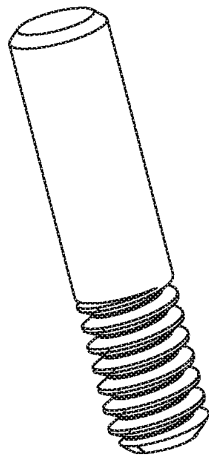
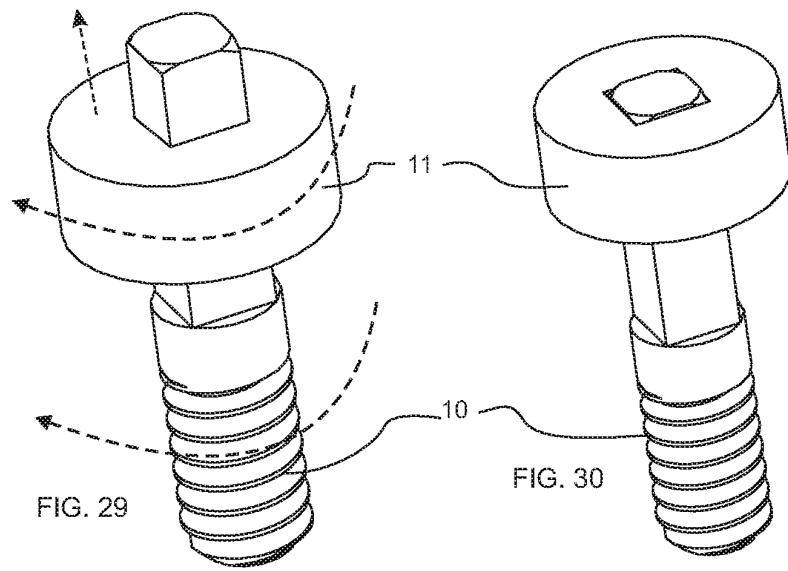


FIG. 31

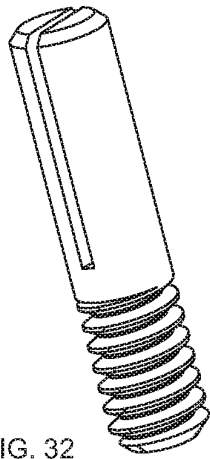


FIG. 32

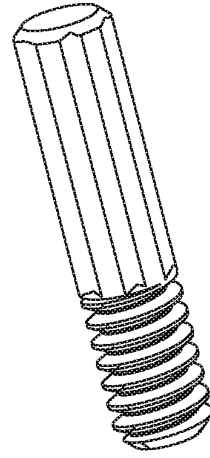


FIG. 33

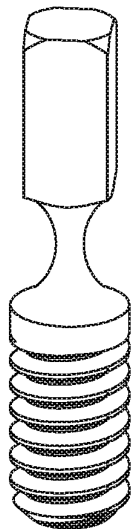


FIG. 34

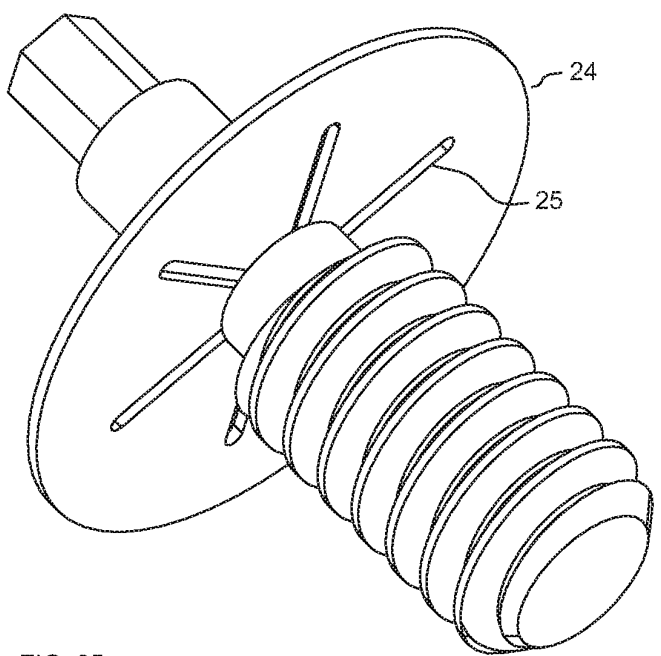


FIG. 35

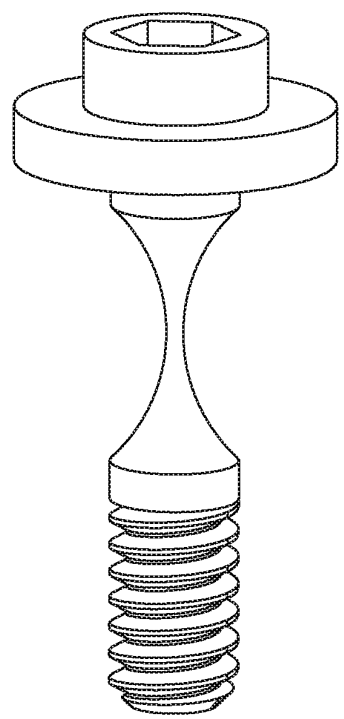


FIG. 36

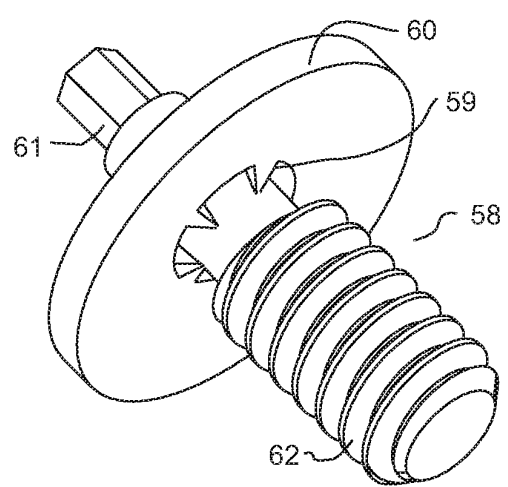
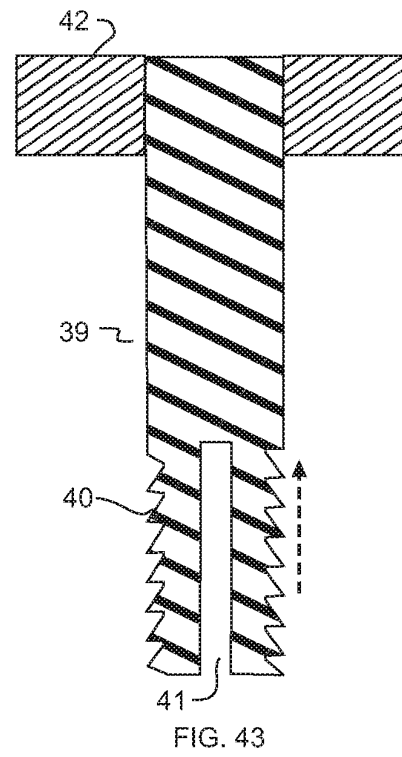
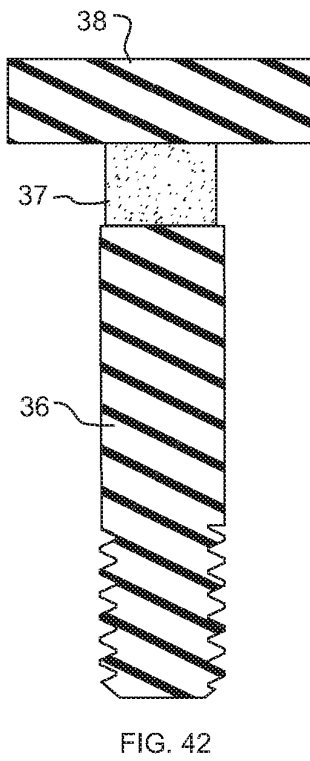
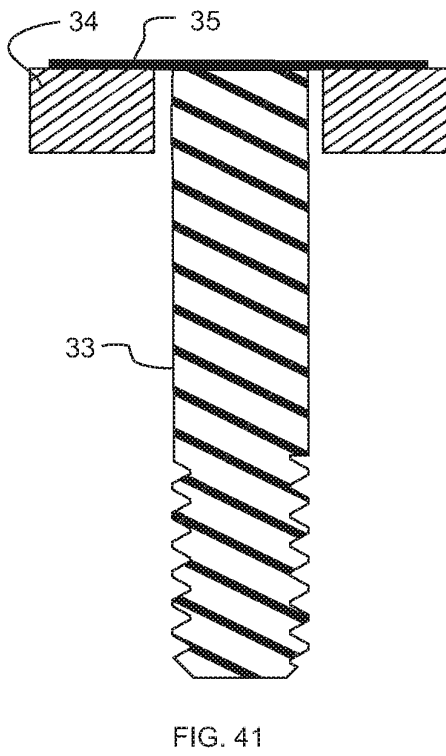
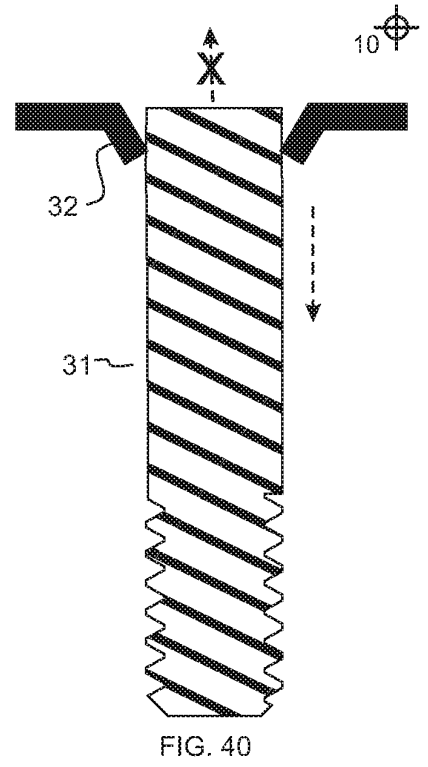
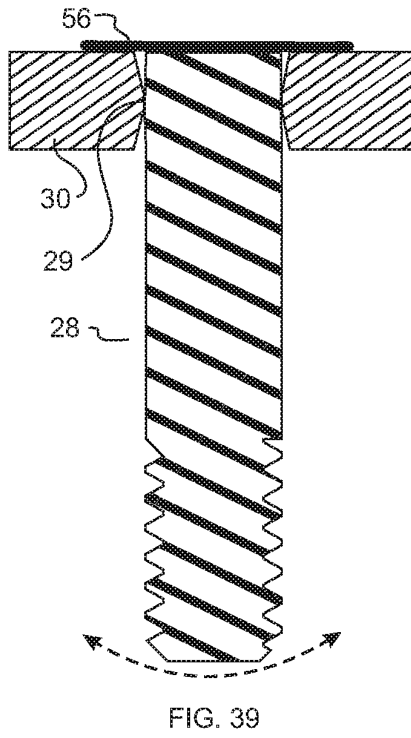
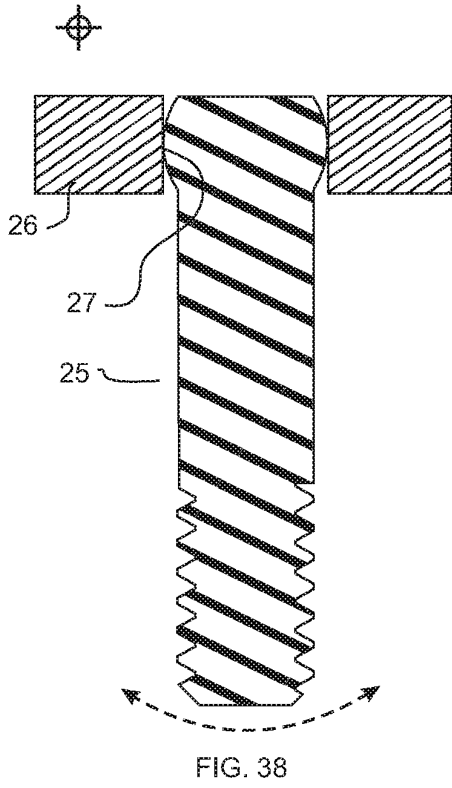


FIG. 37



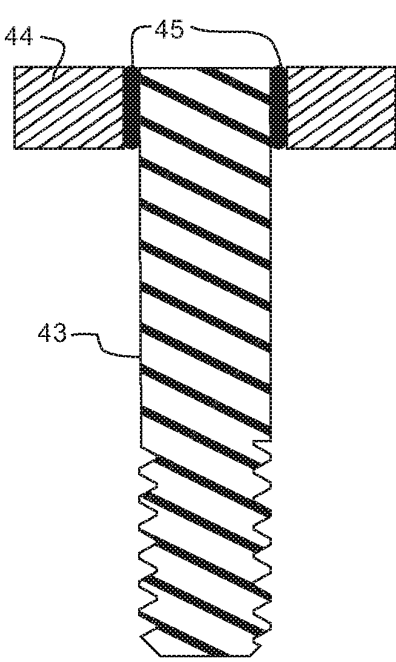


FIG. 44

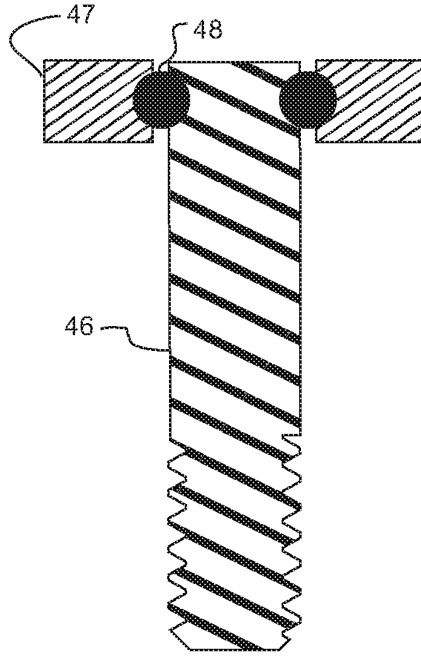


FIG. 45

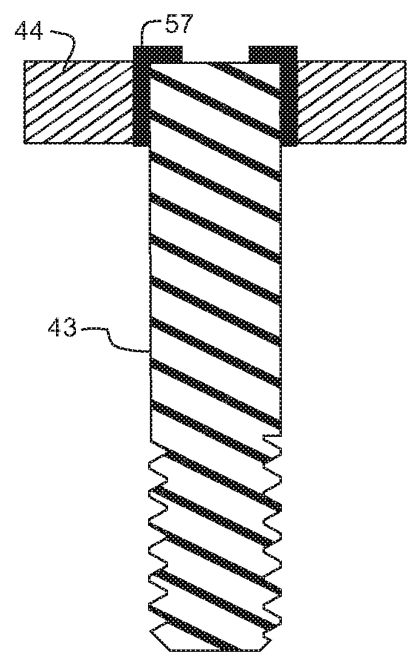


FIG. 46

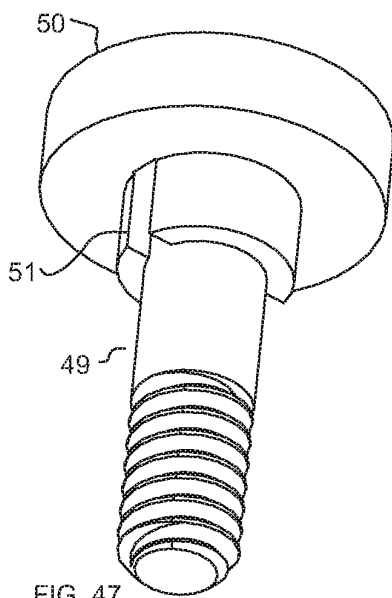


FIG. 47

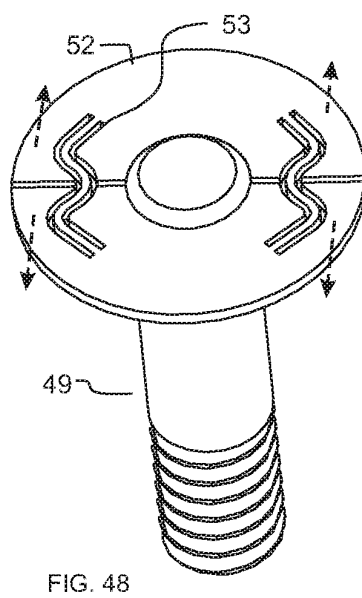


FIG. 48

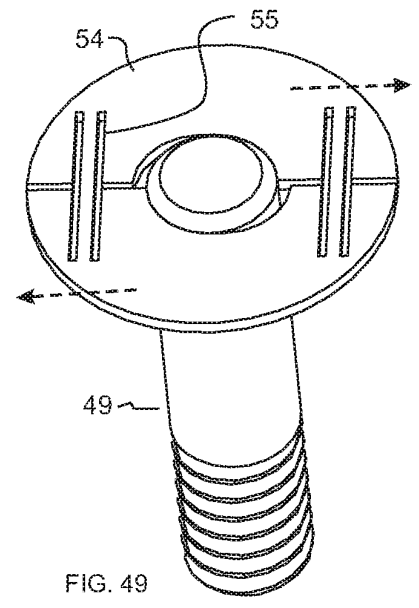


FIG. 49



Separable Fastener Systems and Methods for Adapting Dental Prostheses and Dentures to Dental Implants

Summary

This disclosure describes an improved system for converting and utilizing an existing denture appliance with installed dental implants. Problems addressed and improved by the subject invention include the following:

- a) more simple installation than available methods and parts
- b) less expensive and less complicated mechanical parts
- c) less destructive to the appliance, resulting in less failure and stronger appliance
- d) easily installed and uninstalled with conventional screws versus various “snap on” systems
- e) mating tolerances of the appliance and implants are more accommodating than current methods.
- f) prostheses and dentures may modified and installed in a patient during a single office visit

Background

Current methods of converting a denture into a temporary appliance after dental implants involve relatively complicated interference-fit ball and sockets, and other methods that may be difficult to both install in the denture and difficulty in installing and removal from the patient. These snap-on systems, and other methods that allow the use of a screw-on appliance are also relatively invasive to the denture, decreasing its strength and frequently resulting in mechanical failure of the denture. For example, in Fig.1 and Fig. 2, a schematic isometric view of a denture is shown (tooth side 2 and gum side 3). In current prior-art methods, a large hole 4 must be drilled into the denture in order to place an insert for attachment to the abutment. Fig. 3 shows a typical implant 7 and screw-in straight abutment 8. The current invention allows drilling of a smaller more accurate blind hole 5 for the insert 9, along with a very small hole 6 for the screw used to attach the appliance to the abutment 8.

Embodiments of the invention include a fastener used to temporarily retain an insert on an abutment during cementing of the insert into a “blind” hole located in the gum-side of the denture appliance. The temporary fastener of the subject invention has features to allow easy removal of the denture from the fastener after cementing of the insert into the denture is complete, without the need for tools or access to the fastener. Embodiments include a temporary fastener with a male-threaded bottom portion that is installed into standard abutments (various styles and systems of abutments and implants are commercially available), and a top portion, or cap feature, of the fastener that retains an insert onto an abutment, and the fastener having a separable portion to allow removal of the denture appliance without requiring mechanical access to the fastener. The invention

facilitates easier installation and removal on multiple abutments that may be oriented at multiple compound angles.

Description of Invention and Figures

Fig. 4 shows an exploded view 12 of an embodiment of parts used in the subject invention. Components of this embodiment of the invention include a temporary screw 10 and axially movable cap 11. Cap 11 and screw 10 are constructed such that cap 11 is free to move axially, with a controlled amount of friction, or retention force.

The cap 11 temporarily retains insert 9 onto abutment 8 during cementing of the insert into the denture 1. After the insert is cemented into the denture, the screw is able to be extracted from the insert and cap. An example installation process is described in Fig. 16 through Fig. 31, and will be discussed later in this text.

Fig. 5 through Fig. 9 show example cross-sectional views of some of the different stages of installation of the temporary fastener system into a denture. Fig. 5 shows the stage of the installation process after the insert 9 has been cemented with cement 71 into drilled recess 5 (prior steps not illustrated would include marking of the drilled recess 5, machining of recess 5, etc). Fig 6 shows the temporary fastener 10 extracted from cap 11. Temporary screw 10 is subsequently removed from the abutment 8. Fig. 7 and Fig. 8 show subsequent steps of drilling a pilot hole with drill 72 from the insert-side, and enlargement of the pilot hole with drill 73 to form a clearance-hole 74 for mounting screw 75 from the tooth-side of the denture to accommodate mounting screw 75. Fig. 9 shows the denture mounted to abutment 8 with mounting screw 75.

The axial movement ability between the cap and screw allows removal of the screw from the cap while also retaining the insert onto the abutment during installation and cementing of the insert into the denture. The screw driving torque function may be accomplished in a number of methods, including a press-fit of the cap to a cylindrical top portion of the screw, or engagement with features on the screw such as square, hex or spline features. The retention/axial force of the cap to the screw may be determined by the degree of press-fit and frictional properties between the cap and screw, and/or spring features incorporated into the screw and/or cap. Fig. 28 through Fig. 30 show a square cross-section on the top of the temporary screw that engages a mating square feature in the cap 11. The cap may have an amount of press-fit/interference to the screw to provide an axial retention force of approximately 20 to 500 grams, this force being sufficient to retain insert 9 during assembly while allowing relatively easy removal of the denture from the screw(s) after assembly. In this example, driving torque is provided by the square cross-section of the cap and screw; if the screw top portion were cylindrical (Fig. 31), driving torque would be provided by the friction of the press-fit between the cap and screw. For example a medium press-fit of a 3mm diameter 1 mm thick nylon cap onto a 1.3mm diameter stainless steel cylindrical rod may produce approximately 500 grams of axial retention force and 17 gram-cm driving torque. A typical screw thread size for appliances is m1.4 x 0.3.

Other methods of providing the axial force, in addition to interference-fit of the cap to the screw would be the use of spring features in the screw as shown in the slotted screw of Fig. 32, and/or spring features 25 incorporated into a spring-cap 24 as shown in Fig. 35, and Fig. 47 through Fig. 49. Fig. 48 and Fig. 49 show possible designs of flexure beam features 53 and 54 of figures 48 and 49 respectively. These spring features may be molded or formed into polymer or metal parts, stamped or etched from thin metallic materials. Fig. 47 shows a spit-collar feature 51 on cap 50 which presses onto the temporary screw. Various features such as symmetric axial splines (Fig.33), asymmetric splines or grooves, and textures may also be used to tailor driving torque and retention force of the cap to the screw. Non-symmetric features may also be utilized to tailor different installation torque and extraction forces. Surface finish and coefficient of friction of the mating materials may also be used to control the driving and retention properties.

Fig. 10 and Fig. 11 show some characteristic dimensions of dental abutments and inserts.

Fig 12 through Fig. 27 show schematic isometric views of typical installation steps, expanding on the cross-section views of Fig. 5 through Fig. 9.

Fig. 28 is another exploded isometric view of parts of the invention. In this example, cap 11 is integrated into a breakaway installation tool 18, tool 18 having a breakaway drive and removal section 19, with a drive feature 21 for removal of screw 10. The tool portion 19 may be used to install the screw 10, and then section 19 broken away at separation feature 20. The tool may subsequently be used to remove screw 10 after installation of insert 9 into the denture.

Fig. 37 shows an embodiment of a one-piece screw 58 and cap with a break-away cap 60 molded onto screw with threads 62 and drive-hex feature 61, and small break-away tabs 59.

Referring to Fig. 12 to Fig. 27, an installation sequence is described. In Fig. 12, a schematic isometric view of a portion of the gum 22 is shown with an implant 70 (not shown) installed, and abutment 8 installed into the implant. The insert 9 is placed onto the abutment 8, the top portion of temporary screw 10 is assembled onto cap 11. The top portion of screw 10 and cap 11 are configured such that there is a means to drive the screw into the abutment, while allowing axial movement of the cap 11 relative to the screw axis, the cap/screw interface having sufficient retention force to keep the insert in place on the abutment during subsequent installation steps, and the screw being removable after cementing the insert into the denture.

The following describes the installation process of an exemplary embodiment of Fig. 12 to Fig. 27.

Fig. 12 shows a dental implant (not shown), installed in a portion of the jaw 22, with mating abutment 8 installed. Cap 11 includes a breakaway installation/removal tool 18

Fig. 13 shows the insert 9 placed on the abutment 8 (the insert-abutment surfaces typically comprising a conical or spherical concave feature on the insert 9 that mates with a complementary feature on the top of the abutment 8), and the cap/tool 18 installed onto screw 10.

Fig. 14 shows the screw being threaded into the abutment 8, through a clearance hole in the insert 9. The cap abuts the insert to secure the insert to the abutment. The cap 11 is free to move axially along the screw with a frictional retaining force of the cap to the screw. A known amount of retention force of the insert to abutment is provided by the design and materials used in the cap and screw.

Fig. 15 shows the tool portion of the cap being removed; the tool may be used for removal of the screw at a later step.

Fig. 16 shows marking of the position of the insert onto the denture appliance for drilling a recess for the insert in the denture.

Fig. 17 shows the denture marked 23 with the insert drilling location

Fig. 18 shows the denture after drilling the cavity for the insert; the cavity for the insert may be accurately drilled slightly larger than the insert, without significant unwanted material removal from the denture.

Fig. 19 shows cement being applied to the insert and/or denture

Fig. 20 shows the insert being cemented into the denture

Fig. 21 shows the denture removed from the screw; the screw/cap design allows removal of the denture from the screw, the insert is now cemented into the denture.

Fig. 22 shows the temporary screw being removed with the tool portion of the cap.

Fig. 23 shows the abutment installed in the implant with the temporary screw removed

Fig. 24 shows drilling a small guide-hole (for example 1-2 mm dia), through the clearance hole of the insert, into and through the denture. This guide hole provides a small reference hole for enlargement of the hole to accommodate the denture retaining screw.

Fig. 25 shows enlarging the guide hole to a clearance hole for denture retaining screw, approximately the diameter of the head of the retaining screw (e.g. 1.5-2.5mm). The clearance hole would typically be drilled down to the top surface of the insert.

Fig. 26 shows the denture being installed onto the implant abutment by placing the denture insert onto the abutment, and installing the denture retaining screw.

Fig. 31 shows the assembled denture on the implant.

Note from the above description that minimal material is removed from the denture to provide a screw-on fastening of the denture, thus providing a more intact and stronger denture. The process is very simple with no special additional custom tools required for installation of the parts. The denture is easy to remove, since there are no interference parts as in snap-on systems, and no special tools are required for removal/installation onto the implants. The installation process is fast and non-complicated such that a modified denture may be provided in one visit.

Screws and caps may be made from metal and polymer materials such as titanium, stainless steels, nylon and PEEK and other non-corrosive biocompatible materials.

If additional off-axis accommodation is desired when extracting the screw from the insert after assembly, some flexibility may be incorporated into the screw, such as the necked-down portion of the temporary screw shown in Fig. 34, which allows the screw to flex slightly off-axis. Other means for providing off-axis movement are shown in Fig. 38, which includes rounded portion 27 of screw 25 that engages cap 26. Fig. 39 shows a tapered or rounded portion 29 of cap 30. Fig. 40 shows a thin retaining ring 32 that engages screw 31 (the retaining ring 32 also provides a one-way insertion direction of screw 31). Fig. 40 shows a thin retainer 35 that may be comprised of a metallic or polymer sheet attached to the top portion of screw 33; sheet 35 may be attached to screw 33 using adhesives, plastic or metal welding, etc. Fig. 42 shows a compliant portion 37 incorporated into the screw 39 shaft or cap. Compliant portion 37 may be for example an electrometric material; compliant portion 37 may also function as the separable interface with controlled axial breakaway force. Other methods of separating a compliant portion may include exposure of compliant portion 37 made from a material easily affected by to heat or electromagnetic energy.

The invention is not restricted to a fastener with standard screw threads that engage the abutment. For example, other separable fasteners are possible by providing features that allow the fastener to be removed by other means than a separable cap. For example, as shown in Fig. 43 a fastener 39 may contain a separable threaded or serrated portion 30 that engages the screw in the abutment, but will release with axial force. Fig. 43 shows a screw 39 having a slot 41 and asymmetric threads or serrations 40 that allow the screw to be extracted in the axial direction.

Fig. 44 shows an embodiment where axial flexibility and/or controlled retention between cap 44 and screw 43 is provided by an interface material 45 such as adhesives, silicones, and elastomeric materials. Fig. 45 shows cap 47 retained with o-ring feature 38 to screw 46. Fig. 46 shows a cup-shaped interface material between screw 43 and cap 44.

Any of the embodiments may contain a film or deposited material on top of the cap and screw to prevent adhesion to the screw of cement or other materials used for installation, as shown in the film 56 of Fig. 39.

Temporary screws may be driven using either the cap or the screw itself. Temporary screws and caps may have varied drive features such as male or female knurls, hex, spines, spanner notches/holes.

Other means of attaching/joining a secondary separable portion include insert-molding, use of adhesives, waxes, solders or other metallic materials, heat-staking, and ultrasonic bonding.

Break-away portions may also be formed by two-shot molding, dispensing or otherwise placing a secondary mechanically, thermally, or electromagnetically fusible material on a portion of the fastener to provide the break-away function.

Thin-film or thick-film metallic and polymer coatings may be applied to portions of the fastener to tailor friction and insertion and extraction forces, enhance adhesion of cements, and other properties such as corrosion-resistance.

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