

SDC005

FIG. 16 is a side isometric view of the marked prosthesis from FIG. 15.

FIG. 17 is a side isometric view of the marked prosthesis from FIG. 16 with blind clearance hole and boring tool.

FIG. 18 is an exploded side isometric view of the prepared embodiment of FIG. 17 as adhesive is schematically applied to the coping fixed to the abutment with the temporary screw.

FIG. 19 is a side view of the prosthesis in position for curing of the adhesive applied in FIG. 18.

FIG. 20 is a bottom side isometric exploded view of the coping incorporated in FIG. 19 being picked-up as the prosthesis is removed from the implant abutment.

FIG. 21 is a top side isometric view schematically showing the post of the temporary screw being unscrewed from the implant abutment.

FIG. 22 is a top side isometric view of the implant abutment prepared for attachment of a prosthesis with a definitive screw.

FIG. 23 is a bottom isometric view of the prosthesis with picked-up coping from FIG. 20 being drilled from the bottom to provide clearance for the threaded shaft of a definitive screw following coping pick-up.

FIG. 24 is a top isometric view of the prosthesis with picked-up coping from FIG. 20 with a drill applied from the top to provide clearance for the definitive screw head.

FIG. 25 is top exploded isometric view of the prepared prosthesis from FIG. 24 with the definitive screw.

FIG. 26 is a top isometric view of the prepared prosthesis from FIG. 24 after attachment to the implant abutment with the definitive screw.

FIG. 27 is a schematic description of a process for aligning dental implant abutments, copings and a prosthesis for definitive screw-attachment.

SDC005

FIG. 28 is an exploded bottom isometric view of a third embodiment of a system for aligning a dental implant abutment, coping and prosthesis for definitive screw-attachment with tool oriented for assembly.

FIG. 29 is an assembled bottom isometric view of the embodiment of FIG. 28 with temporary screw and coping inserted into tool.

FIG. 30 is a side view of the system of FIG. 29 after assembly with the implant abutment.

FIG. 31 is a cross-sectional view of the assembly of FIG. 30 along C-C.

FIG. 32 is a side view of the assembly of FIG. 28 after the pick-up process showing the removal end of the tool engaging the retained temporary screw post.

FIG. 33 is a cross-sectional of the assembly of FIG. 32 along D-D.

FIG. 34 is an exploded isometric view of another embodiment of a temporary screw of a system for aligning a dental implant abutment, coping and prosthesis for definitive screw-attachment.

FIG. 35 is an isometric view of the temporary screw of FIG. 34 from the screw thread end.

FIG. 36 is an isometric view of the temporary screw of FIG. 34 from the cap end.

FIG. 37 is a bottom isometric view of a jaw with multiple abutments in preparation of marking a prosthesis as part of the process for aligning a dental implant abutment, coping and prosthesis for definitive screw-attachment.

FIG. 38 is a top isometric view of the prosthesis of FIG. 37 showing abutment location markings.

FIG. 39 is a top isometric view of the prosthesis with clearances milled to receive copings for pick-up.

FIG. 40 is a bottom isometric view showing installed copings and the assembly of a coping to an implant abutment with a temporary screw and torque driver.

SDC005

FIG. 41 is a top isometric view showing adhesive being dispensed in recesses of the prosthesis.

FIG. 42 is a bottom isometric view of the abutments with attached copings in the process of being positioned into the recesses of the prosthesis after adhesive is dispensed.

FIG. 43 is a top isometric view of the copings attached to the prosthesis after adhesive curing and pick-up.

FIG. 44 is a bottom isometric view showing the removal of temporary screw posts from the implant abutments after the pick-up process.

FIG. 45 is a top view of a drill in position to create a pilot hole in the prosthesis of FIG. 43.

FIG. 46 is bottom view showing the pilot holes from the process of FIG. 45 extending through the prosthesis to exit on the occlusion side.

FIG. 47 is a bottom isometric view showing a counterbore positioned on the occlusion side of the prosthesis to provide clearance for the definitive screw.

FIG. 48 is a bottom isometric view illustrating a reamer positioned to clean residue from the bore.

FIG. 49 is a bottom isometric view of the prepared prosthesis with definitive mounting screws prior to fastening to the abutments.

FIG. 50 is a top isometric view corresponding to FIG. 49.

FIG. 51 is a top isometric view of an embodiment of a component suitable for use as a scan flag for digital capture and a laboratory analog for physical model creation.

FIG. 52 is a bottom isometric view of the component from FIG. 51.

FIG. 53 is a bottom isometric view showing the component of FIG. 51 positioned for screw attachment to the converted prosthesis of FIG. 49.

FIG. 54 is a top isometric view of FIG. 53.

SDC005

FIG. 55 is a top isometric view showing the assembly of FIG. 54 mounted on a stand in preparation for scanning.

FIG. 56 is a side view of FIG. 55.

FIG. 57 is an isometric view of the assembly of FIG. 54 with reinforcing bars mounted prior to pouring of dental stone.

FIG. 58 is a schematic flow chart illustrating options for creating and attaching a permanent prosthesis.

FIG. 59 is an exploded isometric view of the torque driver shown in FIG. 40.

FIG. 60 is top isometric view of the torque driver of FIG. 59 partially assembled.

FIG. 61 is a top isometric view of the post removal tool shown in FIG. 44.

FIG. 62 is a top isometric view of an embodiment of a temporary screw similar to FIG. 1 schematically illustrating axial motion of the cap away from the post threads from screwing after the coping contacts the abutment.

FIG. 63 is a top isometric view of the embodiment of FIG. 62 in which the temporary screw post end has become flush with the top of the cap.

FIG. 64 is a top isometric view of a temporary screw post embodiment having a cylindrical stem.

FIG. 65 is a top isometric view of a split temporary screw post embodiment having deflecting sections.

FIG. 66 is an isometric view of a temporary screw post embodiment having symmetric axial splines.

FIG. 67 is an isometric view of a temporary screw post embodiment having a weakened portion facilitating lateral movement during pick-up.

FIG. 68 is a bottom isometric view of a temporary screw embodiment having a spring cap.

SDC005

FIG. 69 is a bottom isometric view of a one-piece temporary screw embodiment designed to fracture under axial loading.

FIG. 70 is a cross-sectional view of a temporary screw embodiment incorporating a rounded interface between cap and post facilitating pivotal movement as illustrated.

FIG. 71 is a cross-sectional view of a temporary screw embodiment incorporating a restricted interface between cap and post facilitating pivotal movement and protective film.

FIG. 72 is a cross-sectional view of a temporary screw embodiment incorporating a spring cap with preferential axial movement in the pick-up direction.

FIG. 73 is a cross-sectional view of a temporary screw embodiment incorporating a laminar cap fixed to the end of the post.

FIG. 74 is a cross-sectional view of a temporary screw embodiment incorporating a compliant interface between the cap and post.

FIG. 75 is a cross-sectional view of a temporary screw embodiment incorporating a split post that has deflecting sections with screw threads shaped to facilitate axial separation without unscrewing the post threads.

FIG. 76 is a cross-sectional view of a temporary screw embodiment incorporating an interface material between the cap and post.

FIG. 77 is a cross-sectional view of a temporary screw embodiment incorporating an O-ring interface between the cap and post.

FIG. 78 is a cross-sectional view of a temporary screw embodiment incorporating a cup-shaped interface material between the cap and post.

FIG. 79 is a bottom isometric view of a temporary screw embodiment incorporating a split collar cap.

FIG. 80 is a top isometric view of a temporary screw embodiment incorporating a planar spring that flexes when pulled perpendicular to the diameter indicated.

SDC005

FIG. 81 is a top isometric view of a temporary screw embodiment incorporating a planar spring that flexes when pulled parallel perpendicular to the diameter indicated.

FIG. 82 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which the coping is held by mechanical interference to the proximal end of the threaded post.

FIG. 83 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which the coping has spring fingers holding the proximal end of the threaded post.

FIG. 84 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which the coping has collet-type spring fingers holding the proximal end of the threaded post.

FIG. 84A is a top view of the embodiment of FIG. 84.

FIG. 85 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which the proximal end of threaded post has a slotted spring section holding the coping.

FIG. 86 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which a compressed ring holds the coping to the proximal end of the threaded post.

FIG. 87 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which a compressed ring with a u-shaped cross-section holds the coping to the proximal end of the threaded post.

FIG. 88 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which a thin cap fixes the coping to the proximal end of the threaded post.

FIG. 89 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which

SDC005

a filler material is placed in the bore of the coping at the proximal end of the threaded post.

FIG. 90 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment showing a tool engaging features of the coping to screw in the threaded portion of the post.

FIG. 91 is a bottom isometric view schematically illustrating the material removed from an existing denture necessary with inventive concepts disclosed in preparation for pick-up.

FIG. 92 is a top isometric view schematically illustrating the material removed from an existing denture necessary with inventive concepts disclosed in preparation for pick-up.

FIG. 93 is a bottom isometric view schematically illustrating the material removed from an existing denture necessary using prior art impression screw systems.

FIG. 94 is a top isometric view schematically illustrating the material removed from an existing denture necessary using prior art impression screw systems.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 shows an exploded view of one embodiment of a temporary alignment system 12 for use in a direct coping pick-up process for screw attachment of a prosthesis. Implant abutment 8 has a distal end which may include attachment feature portion 135 illustrated as a screw thread for direct attachment to the patient's jaw and a proximal end with an abutment shaped to accommodate a coping 9. The abutment includes threaded section 18. The coping has a central bore 16 to accommodate screw fastening and may include ridges 17 or other structures or surface treatments to increase retention to the prosthesis with adhesive. The coping and abutment mating surfaces as shown in FIG. 1 are symmetrical. The inventive concepts of this disclosure may also be applied to abutment and coping systems that are keyed to restrict mating orientation.

22 Specification

The coping may be mounted onto the abutment through rotation of a temporary adjustment screw comprising a threaded post 10 and cap 11. The cap 11 is mechanically attached to post 10 in a manner that allows relative axial motion with the application of a predetermined force. As illustrated in FIG. 1, cap 11 has a square central bore 13 that is press-fit onto a square portion 14 of post 10. The cap 11 temporarily retains coping 9 onto the implant abutment 8 during the pick-up process of the coping into the prosthesis with a force aligned directly along the same axis as the semi-permanent screw that will be used for definitive prosthesis mounting. The portion of the post engaging the abutment threads also prevents any pick-up material from contacting the abutment screw threads. After the coping is picked-up into the prosthesis, the cap and coping may be released from the abutment by applying an axial force. In the embodiment shown, the post threads 15 remain engaged with abutment threads 18 after the pick-up process. The post can then be removed from the abutment by unscrewing it. The prosthesis with embedded coping can be subsequently processed to accommodate semi-permanent screw attachment as will be described later.

FIGS. 2 and 3 show a side and top view of the assembled system of FIG. 1; FIG. 4 shows a cross-sectional view along the axis as indicated. As shown in FIG. 4, matching conical surfaces on the exterior of the implant abutment 8 and the interior of the coping 9 are engaged. The coping is pulled into alignment by an axial force from the lower surface of the cap 11 pushing against the upper surface of the coping from screwing the threads of post 10 into the implant abutment. The distal end of the abutment may be directly attached to the patient's jaw or attached to a separate implant attached to the jaw. The inventive concepts are not dependent upon the nature of the implant, so the distal end attachment feature 135 is represented schematically.

The capability for relative axial movement between the cap 11 and temporary attachment post 10 allows separation of the temporary attachment post from the cap without tools after retaining the coping onto the abutment during fitting and bonding of

SDC005

the coping into the prosthesis. These parts are accurately aligned during the bonding process since the temporary post engages the abutment threads to provide an axial force holding the coping to the abutment just like the screw used for final attachment.

The cap may be sized to have an amount of press-fit mechanical interference to the temporary attachment post to provide an axial retention force of approximately 20 to 900 grams, this force being sufficient to retain coping 9 during assembly while allowing relatively easy pick-up removal of the coping and prosthesis from the temporary attachment post after assembly. The temporary attachment post 10 may include indicators (not shown) in the end by the cap 11 to provide intermediate visual and/or tactile feedback on the depth of threaded engagement of the post during screw attachment of the coping to the abutment.

In this embodiment, screw driving torque is provided by the square cross-section of the cap aperture and temporary attachment post. In the cross-sectional view of FIG. 4, the post 10 has been screwed in so that only a small beveled surface of the post extends above the top of the cap when the post threads bottom out in the abutment. During installation, this optional configuration provides feedback to the dental practitioner when the torque increases as the threads bottom. The square drive tool engagement can also be designed to disengage at a pre-designed minimum extension of the square post above the top of the cap. Alternatively, a tool with a specified maximum torque may be used to ensure engagement of the coping and abutment surfaces.

The screw driving torque function may be accomplished by engaging other features on the temporary attachment post such as hex or spline or asymmetric features.

Alternately, the cap may be used to engage a screwdriver or other tool for torqueing. For example, in the case of a cylindrical temporary attachment post top portion, driving torque can be provided by the friction of the press-fit between the cap and temporary attachment post. For example, a medium press-fit of a 3mm diameter 1 mm thick nylon

SDC005

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. The retention/axial force of the cap to the temporary attachment post may be determined by the degree of press-fit and frictional properties between the cap and temporary attachment post, and/or spring features incorporated into the temporary attachment post and/or cap.

In actual trial installations, polymer caps of approximately 1.2 mm thickness press fit onto posts of approximately 1.4 mm diameter with cylindrical axial bores have been sufficient for installation and pick-up removal of a single prosthesis from multiple implant abutments in which the axes of the screw threads in the implant abutments are not mutually parallel.

The separable mechanical attachment means may include any combination of techniques, including frictional forces from interference, adhesives, waxes, chemical bonding, solders, elastically or inelastically deformable spring, snap or interlocking structures, thermally or electromagnetically fusible materials, fracturing structures, etc.

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 a cross-sectional view of the assembly of the first embodiment during the initial phase of the coping pick-up process. As illustrated, the implant abutment 8 is attached to a schematic implant 70. The implant 70 has an interface 7 (shown schematically) that is attached to the patient's jawbone 22. The coping 9 is held against the implant abutment 8 through the temporary screw comprising the post 10 and cap 11. A blind clearance hole 5 in the prosthesis 3 is sized to accommodate the coping and temporary screw. Pick-up material 71 is positioned in the clearance hole 5 to capture the coping in proper alignment within the prosthesis. After the pick-up material has set up, the prosthesis 3, coping 9 and temporary screw cap 10 assembly is pulled off the patient's jaw as shown

25 Specification

by the arrows in FIG. 6. The coping 9 and cap 11 are released from the implant abutment 8 and post 10, while the threads of the post 10 keep it engaged in the implant abutment 8. The post 10 is subsequently removed to make the abutment threads 18 available for holding the prosthesis in proper alignment with a definitive screw.

The prosthesis/coping assembly must be processed after the pick-up process for screw attachment. A pilot hole is drilled with bit 72 from the bottom side of the assembly. As shown in FIG. 7, the diameter of the bit may be selected to use the interior bores of the coping and cap to act as guides for hand processing. Alternately, a drill guide may be employed that engages a portion of the interior of the coping may be used to align the pilot hole. The pilot hole provides guidance for a tool to provide clearance for the definitive screw shaft and head. FIG. 8 shows a stepped drill 73 that cuts both clearances in a single process. Alternatively, the shaft and head clearance may be drilled with two drills in two process steps. If desired, the cap 11 of the temporary screw can be fabricated of a material that is easier to drill than the coping material to provide feedback on the drill position. It has been found that it is possible to distinguish where the drill is positioned by feel at the interfaces between the pick-up adhesive and the top of the cap (as shown in FIG. 8) and the bottom of the cap and the top of the coping. Since pick-up material was blocked from entering the coping, drilling resistance decreases rapidly upon breaking through the bottom of the cap and entering the interior channel of the coping. Color differences in the materials can also be detected. Alternatively, a tool can be configured to fit within the bore of the coping to limit the depth of the drill.

Once clearance for the definitive screw has been made from the top of the prosthesis, the prosthesis is ready for mounting to the implant with definitive screw 75 as shown in FIG. 9. The screw clearance hole in the prosthesis may be filled with Teflon tape and color-matching composite materials for aesthetic purposes. In the illustrated embodiment, the coping bore has a shoulder to engage a flat surface on the underside

SDC005

of head of the screw. Alternate configurations are possible without deviating from the temporary screw system for coping pick-up disclosed.

FIG. 10 is another exploded isometric view of parts of an embodiment of the invention. In this example, cap 11 is integrated into a breakaway installation tool 18. The tool portion 19 may be used to install the temporary attachment post 10, and then section 19 broken away at mechanically weak separation feature 20, for example, when the post bottoms out in the abutment leaving the cap portion 11 in position. Alternatively, the tool can be designed to increase stress on the separation feature as the top of the post moves axially down relative to the weakened section. As illustrated, after the cap portion 11 breaks away from the tool portion 19, drive feature 21 in the tool portion may be used to remove the post 10 after the pick-up process. One or both ends of the tool may be shaped to subsequently engage and remove the temporary attachment post 10 after installation of coping 9 into the denture.

FIGS. 11-26 provide schematic isometric views of the process steps for using the elements of an exemplary embodiment introduced in FIG. 10 for a single implant system such as a crown. In FIG. 11, a schematic isometric view of a portion of the patient's jaw 22 is shown with an implant 70 (not shown) installed, and implant abutment 8 installed into the implant. The coping 9 is placed onto the implant abutment 8, the top portion of temporary attachment post 10 is assembled onto cap 11. The top portion of temporary attachment post 10 and cap 11 are configured such that there is a means to drive the temporary attachment post into the abutment, while allowing axial movement of the cap 11 relative to the temporary attachment post axis, the cap/temporary attachment post interface having sufficient retention force to keep the coping in place on the abutment during subsequent installation steps, and the temporary attachment post being removable after picking up the coping into the prosthesis. Cap 11 may be attached to a break-away installation/removal tool 18.

SDC005

FIG. 12 shows the coping 9 placed on the implant abutment 8 and the cap/tool 18 installed onto temporary attachment post 10. The coping-abutment surfaces may comprise a conical or spherical concave feature on the coping 9 that mates with a complementary feature on the top of the implant abutment 8, as illustrated. Alternatively, keying features may be employed to restrict relative rotational orientation, particularly in the case of single implants.

FIG. 13 shows the temporary attachment post being threaded into the implant abutment 8, through a clearance hole in the coping 9. The cap abuts the coping to secure the coping to the abutment. The cap 11 is free to move axially along the temporary attachment post with a frictional retaining force of the cap to the temporary attachment post. A known amount of retention force of the coping to the abutment is provided by the design and materials used in the cap and temporary attachment post.

FIG. 14 shows the tool portion of the cap being removed after the cap has broken away; the tool may be used for removal of the temporary attachment post at a later step.

FIG. 15 shows marking of the position of the coping onto the appliance for drilling a recess for the coping in the prosthesis.

FIG. 16 shows the prosthesis with coping drilling location marking 23.

FIG. 17 shows the prosthesis after boring the cavity for the coping; the cavity for the coping may be accurately drilled slightly larger than the coping, without significant unwanted material removal from the prosthesis.

SDC005

FIG. 18 shows pick-up material being applied to the coping and/or prosthesis after confirmation of freedom to provide proper occlusion during dry testing. Although not illustrated, the cavity of the prosthesis or the coping may optionally include features to provide venting of excess pick-up material if desired.

FIG. 19 shows the bonded coping being picked-up into the prosthesis

FIG. 20 shows the prosthesis removed from the temporary attachment post; the temporary attachment post/cap design allows removal of the prosthesis from the temporary attachment post. The coping is now incorporated into the prosthesis.

FIG. 21 shows the temporary attachment post being removed with the tool portion of the cap.

FIG. 22 shows the abutment installed in the implant with the temporary attachment post removed.

FIG. 23 shows drilling a small guide-hole (for example 1-2 mm diameter), through the clearance hole of the coping, into and through the prosthesis. This guide hole provides a small reference hole for enlargement of the hole to accommodate the prosthesis retaining screw.

FIG. 24 shows enlarging the guide hole to a clearance hole for prosthesis 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 coping.

SDC005

FIG. 25 shows the prosthesis being installed onto the implant abutment by placing the prosthesis coping onto the abutment, and installing the prosthesis retaining screw.

FIG. 26 shows the assembled prosthesis on the implant.

FIG. 27 contains a summary of a generalized process extending the basic process described above for a prosthesis attached to multiple implant abutments.

Another embodiment of a prosthesis and implant alignment system and tool are shown in FIG. 28. In this case, the cap is in the form of a hex nut 63 that is press fit onto alignment post 62 to act as the temporary alignment screw. The drive tool 64 includes a concave hex socket 68 that fits temporary post nut 63, and coping retaining portion 69 that retains coping 61 with a slight interference fit. Thus, as shown in FIG. 29, the temporary screw comprising nut 63 with post 62 is engaged with the socket portion of the tool, and the coping 61 is retained in the tool. The coping is seated onto the abutment 60 by using the hex portion of the driver to rotate the nut and engage the threads 66 on the temporary screw post 62. FIGS. 30 and 31 show an exterior and cross-sectional view of the mounting of the coping on the abutment with the tool. The tool may also have an integrated feature for removing the post as shown in FIG. 32. For example, FIG. 33 shows a tapering feature 172 on the narrow end of tool 64 which may be used to unscrew the post. FIG. 28 illustrates optional undercut 67 for stronger adhesive locking. Optional anti-rotation flat 65 is shown. Such an anti-rotation flat may be used on mating surfaces in circumstances in which there is a preferred orientation around the axis of the screw threads.

Another embodiment of the inventive concepts in which the cap of the temporary screw is shaped to engage the driving tool is shown in FIGS. 34-36. Cap 102 is mechanically attached to alignment post 101 at end portion 101A to form temporary alignment screw

30 Specification

SDC005

100. This mechanical attachment may result from press-fitting a polymeric cap 102 onto a metal post 101 to provide adequate resistance to rotary slip to temporarily attach the coping to the implant abutment while still allowing relative axial movement during the pick-up process. A hexalobular internal (Torx) drive feature is shown in the end of the cap 102, although other bit socket shapes are possible. As previously discussed, other mechanical engagement means besides an interference fit are possible. The post may be made of different materials than these, or even be of unitary construction with weakened sections that fracture under a desired pick-up axial force.

In a preferred embodiment the post 101 is made from stainless-steel or titanium, and the cap of polymer such as PEEK or acetal. The short length of the post and threaded fastener in this embodiment allows separation at high degrees of angularity of the assembled parts in use. This tolerance for off-axial removal has been found to be particularly advantageous when the prosthesis is to be definitively screw mounted to multiple implant abutments. Testing has verified cap axial release forces of up to about 5 pounds and the application of torque to the cap of about 1.6 inch-ounces without slipping.

The general process for converting an existing removable denture for definitive screw attachment onto four implants with this embodiment is illustrated in FIGS. 37-50. This prosthesis may be, for example, a removable denture that was used prior to implant surgery or a duplicate of such an existing denture as described in US Provisional Patent Application 62/774,402 incorporated herein in its entirety.

FIG. 37 shows a schematic representation of a human jaw portion 106 with implant abutments 107 installed. It does not matter for this discussion if the abutments are separable from the implanted portion of the implant or not. Prosthesis 103 is shown with occlusion side 104 and intaglio side 105. Pick-up marking caps 108 are installed onto abutments 107. The location of implant abutments 107 is marked onto the prosthesis using customary methods by mating the prosthesis with the abutments. FIG. 38 shows the abutment positions 109 marked onto prosthesis 103. FIG. 39 shows boring of blind holes 110 slightly larger than copings 112 in marked locations with burr tool 111.

31 Specification

FIG. 40 shows the installation of copings 112 onto abutments 107 using separable fastener assembly 100, and torque driver 113 (described in more detail later). The torque driver 113 prevents over-tightening of temporary screw 100 and possible separation of the cap 102 from the post 101 due to rotary motion. The cap 102 and/or post 101A of the separable fastener 100 may be mechanically captured or adhered to the coping 112, or may be designed to loosely fit into the bore of the coping as illustrated with axial force from tightening the separable fastener holding the coping to the abutment 107. The prosthesis is placed over the mounted copings to ensure proper fit.

FIG. 41 shows application of acrylic or other adhesive 114 with adhesive dispenser 144 into cavities 110 of prosthesis 103, which is subsequently fitted onto copings 112.

FIG. 42 shows prosthesis 103 being mated with copings 112. After the adhesive sets, the separable fasteners allow easy removal of the prosthesis from the abutments with the copings incorporated into the prosthesis. The angular tolerance for removing the prosthesis from multiple abutments allows applying pick-up forces sequentially around the edge of the prosthesis to work the caps 102 off the posts 101. The caps 102 remain in the prosthesis with the copings 112, while the posts 101 remain in the abutments.

FIG. 43 shows the prosthesis with incorporated copings 112 after the pick-up process.

FIG. 44 shows the removal of the threaded post 101 from the implant abutment with removal tool 115. This allows the implant abutment threads to be accessible for subsequent definitive screw attachment.

FIG. 45 shows the drilling of the small pilot hole 117 (e.g. using a drill bit 116 of approximately 1.4 mm diameter), from the intaglio side 105 of the prosthesis out through the occlusion side 104. It has been found that the bore of the coping 112 and the bore of the cap provide

SDC005

adequate guidance for this hole, although a tooling guide could readily be designed to mate with the particular coping used. The pilot hole is drilled completely through the prosthesis to the occlusion side 104 as shown in FIG. 46.

FIG. 47 shows enlarging of the pilot hole 117 to allow clearance for a prosthetic mounting screw 121. The clearance holes 119 are drilled down to the top of the coping using counterbore drill 118. This requires only a small diameter enlargement (for example, approximately 2.4 mm).

FIG. 48 shows a step of a final hand reaming with reamer 120 of the coping bore to clean out any debris or remaining material from the cap that would interfere with the definitive screw.

FIGS. 49 and 50 show the final installation of prosthesis 103 onto abutments 107 using definitive prosthetic screws 121. The screw holes may be subsequently filled to use the modified prosthesis depending upon the anticipated use as a short-term or more permanent prosthesis. This sequence of process steps essentially follows the material provided in FIG. 27.

Note that in the above procedure very little material is removed from the prosthesis during the coping pick-up installation process. The boring process in FIG. 39 need only be sufficient to provide clearance for the coping and temporary screw. Angular variation in the axes of the implant abutments does not appreciably increase the size of the cavity boring required in this closed tray process compared to the additional prosthesis material that must be removed with relatively long impression screws and sleeves in a conventional open tray conversion process for definitive screw attachment. FIGS. 91-92 provide a schematic comparison of the size of the recess borings required using the concepts disclosed compared to the prior art conversion process with larger through holes in FIGS. 93-94.

The converted prosthesis with copings and screw-access channels may also be used as an accurate digital scan model of abutment positioning for creating a new prosthesis. In this embodiment, dual purpose scan flag and lab analogs 122 shown in FIGS. 51-52 may be fastened to the provisional or duplicate prosthesis 103, for example, after the clearance hole

33 Specification

SDC005

cleaning shown in FIG. 48. Features that may be present on the scan-flag/analog include a scan-flag reference portion 123 near the top of the analog, reference scan-flag features such as flats 124, axial and radial retention feature 128, screw attachment 125 for scanning fixture and/or reinforcement wire attachment. The abutment features 126 are specific to various systems commercially available. The figures show a tapered abutment mating surface 126 and female thread 127.

FIGS. 53-54 show scan flag/analog 122 attached to converted prosthesis 103 with copings 112 using definitive screws 121.

FIGS. 55-56 show converted prosthesis 103 with scan flags/analog 122 mounted to fixture 130 by attaching one or more scan flags 122 to the base with adjustable means to orient the prosthesis properly for scanning. For illustration an approximate mounting angle of 45 degrees is shown. In this example, the converted prosthesis 103 is mounted to articulated arm 131 with screw 129 that fits into the threaded hole of scan-flag/analog 122. Base 132 is mounted onto the base of the scanning machine.

The provisional or duplicate prosthesis with attached scan flags/lab analogs is scanned into the design software. This process captures the accurate position of the implant multi-unit abutment relative to the soft tissues and it also captures the tested prosthetic contours to aid in the design of the definitive prosthesis. After the prosthesis has been scanned in, a physical model may optionally be created by creating a soft tissue moulage and pouring dental stone into the provisional or duplicate prosthetic utilizing the scan flags as the laboratory analogs.

FIG. 57 schematically shows the application of solder or brazing preforms 133 to attach reinforcement bars 134 prior to pouring dental stone. Preforms 133 may be inserted into holes in the scan-flag/analog and heated to attach bars 134. Low-temperature solders, brazing compounds, and hot-melt or other adhesives may be utilized in a preform or dispensed method to increase the rigidity of the analog assembly prior to casting.

34 Specification

This method ensures a fast and efficient means of transferring all pertinent and relevant information from a converted denture required for designing a definitive prosthesis from digital scanning and creating the most accurate and precise physical model that can be mounted in an articulator with the aid of a bite registration in preparation for post-processing of the machined prosthesis, for example to verify passivity of fit, occlusion, etc.

In addition to the screw attachment of the scan flags to the modified prosthesis, scan flags may be attached to the prosthesis with incorporated copings of FIG. 43 prior to the drilling operations shown in FIGS. 45-47. In this case, another embodiment of the scan flag (not shown) with a post feature equivalent to post feature 101A of separable screw would be inserted into copings 112 of the modified prosthesis and retained by the embedded cap 102. If the separable fastener uses a snap-fit feature to retain the cap to the post, drilling may not be required through the prosthesis to mount the scan flags or lab analogs to the prosthesis or to attach the modified prosthesis to the abutments after lab use. For example, US Provisional Patent Application 62/774,402 describes the use of spring fingers and O-rings for separable fastening of the coping to the abutment for lift-off, and the use of films to prevent adhesive from entering interior portions of the separable fastener. Scan flags and lab analogs may also be engaged with transferred copings using similar mounting features as the post used in the transfer pick-up process. The referenced patent application also includes separable systems in which the post attaches directly to the coping without a cap which may be applied for mounting scan flags or lab analogs as variations of the methods described above. Since the dimensions of the coping and its engagement with the abutment is precisely controlled, having snap-in scan flags engage with a cavity between the top of the coping and the separable cap or an internal groove or other feature of the coping may be desirable.

Variations of using the modified prosthesis as a digital scan model, or using the inventive concepts disclosed to create a permanent prosthesis will be recognized as possible to dental practitioners. For example, instead of using a dual-purpose scan flag and lab analog, single purpose scan flags can be mounted into the provisional prosthesis for scanning, and subsequently replaced with lab analogs prior to casting. In addition to the attachment of scan flags to a modified prosthesis for digitization, the separable fastener may be used to transfer a coping and cap to a new impression after implant surgery. A scan flag or lab analog may be

SDC005

attached and held to the impression with transferred coping for digitization or casting by substituting the new impression for the modified prosthesis in any of the processes above. FIG. 58 describes a work-flow for using the temporary alignment fasteners with a permanent prosthesis fabricated from a digital model based on an impression.

FIGS. 59-60 show an embodiment of a simple torque-driver 113 that can be used for the temporary coping attachment process discussed in reference to FIG. 40. Shaft assembly 135 contains a spring friction cylinder portion 141 and drive portion 138 designed to engage the temporary screw 100. Spring 136 has an interference fit with cylinder 141, and thus when spring 136 is rotated in the "unwind" direction of the spring, a designed amount of slip torque is present between the spring and cylinder. In the "wind" direction, the spring binds on the cylinder. This provides unequal drive torque capability in the two rotation directions. Slot 139 in drive cap 137 engages spring end 140, and snaps onto the end of the shaft assembly, thus when the cap is rotated in the clockwise direction, cylinder and drive slip at a known torque. When the cap is rotated in the counterclockwise direction, the spring binds on the shaft to provide a higher screw removal torque before slipping.

FIG. 61 shows an embodiment of a temporary screw post extractor 115 which may be used to remove post 101 after the pick-up process as shown in FIG. 44. The extractor utilizes a hollow metal tubular split-cylinder end portion 142 that deflects to grip the end of the temporary screw post 101, allowing removal of the separable fastener posts or other types of fasteners. FIG. 61 illustrates a hand-operated knurled end, but other torque tool systems known in the dental industry such as 3/32" friction and latch designs may be used.

FIGS. 62-63 schematically illustrate how the position of the temporary screw post 10 of the first embodiment relative to the implant abutment can be determined. As the temporary screw is rotated clockwise, the cap 11 will be pushed axially away from the screw threads of the post by the coping. The depth of threaded engagement and the length of the temporary screw post 10 and cap can be designed to have the top of the post 10 coincide with the top of the cap 11 as shown in FIG. 63 when the temporary screw is properly positioned. At this point, a drive tool

SDC005

with a square socket cavity (not illustrated) would disengage from the temporary screw assembly since the post 10 would no longer extend into the tool socket cavity.

FIGS. 64-66 illustrate different embodiments of the end of the temporary screw post that engages the cap. FIG. 64 shows a modified version of the cylindrical post 101 designed for frictional engagement on cylindrical portion 85 with a cap having a circular bore similar to that shown in FIG. 34. In FIG. 65, the cylindrical post is slotted, and the resulting beam portions 86 sprung open to provide additional frictional retention of a cap through spring action with the deflecting beams. Various features such as symmetric axial splines 87 (FIG. 66), asymmetric splines or grooves, and textures may also be used to tailor driving torque and axial retention force of the cap to the temporary attachment post. Non-symmetric features may also be utilized to tailor different installation torque and extraction forces. Surface finish and coefficients of friction of the mating materials may also be used to control the driving and retention properties. Temporary attachment posts 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 temporary attachment post from the coping after pick-up, some flexibility may be incorporated into the temporary attachment post, such as the necked down portion 88 of the temporary attachment post shown in FIG. 67, which allows the temporary attachment post to flex slightly off-axis during the pick-up process. Under tension, the alignment of the temporary screw axis with this necked-down portion can be designed to align the axis of the implant abutment threads with the coping threads but allow some bending when the tension is released. Note that this alignment flexibility will generally not be required during the final screw attachment process. The final attachment process is more accommodating of axial misalignment of multiple abutments than the coping pick-up process. During pick-up, the prosthesis with copings incorporated must be removed from all abutments simultaneously. For final attachment, each definitive screw is attached individually after the copings of the prosthesis are positioned on the implant abutments.

FIG. 68 shows an embodiment of a temporary screw cap 94 that includes spring features 95 that engage the outer diameter 96 of the temporary post. If desired the portion of the

SDC005

temporary screw cap with the spring features may be made of a different material than the remainder of the cap.

Although the temporary screw of FIG. 69 has a similar appearance to that shown in FIG. 68, it has distinct functionality. FIG. 69 shows an embodiment of a temporary alignment screw 58 having threaded portion 62, breakaway flange 60 and hex drive portion 61. The flange 60 pushes down on the top of the coping as the temporary alignment screw threads 62 are rotated into the implant abutment. The flange portion may be molded onto a temporary attachment post with threaded portion 62 and drive portion 61 by insert molding if different materials are desired. Preferable, all portions of the alignment screw are molded integrally of a single material. The cap and post do not slide axially relative to one another. Instead, small break-away tabs 59 in the flange portion are designed to yield under axial force during the prosthesis and coping assembly removal after the bonding step. The breakaway portions are designed to fracture at an axial force exceeding the force applied to align the coping to the implant abutment for pick-up.

FIG. 67 employed a temporary alignment screw post with a waist that can bend during prosthesis removal in the pick-up process. It is also possible to provide additional off-axis accommodation during coping pick-up with temporary screws that do not bend. For example, in FIG. 70, a temporary alignment screw post 25 includes a rounded portion 27 that bears against the central straight bore of cap 26. FIG. 71 shows a tapered profile 29 on cap 30 which engages a straight cylindrical portion of post 28. It is preferable to prevent the incursion of adhesive in the gaps between the post and cap that allow the post to pivot. FIG. 71 includes a thin protective film 56 for this purpose. This film should be chosen to deform easily when the post is pivoted.

FIG. 72 shows a thin retaining ring 32 that engages temporary attachment post 31. The retaining ring 32 also provides a one-way insertion direction of temporary attachment post 31. This preferential insertion direction also corresponds to the relative motion of the post and retaining ring for release in the pick-up process.

SDC005

FIG. 73 shows another embodiment of a temporary alignment screw that does not have relative axial sliding between the post and cap. In this embodiment a thin retainer 35 that may be comprised of a metallic or polymer sheet is attached to the top portion of temporary attachment post 33 and optional cap 34. The sheet 35 may be attached to temporary attachment post 33 using adhesives, plastic or metal welding, etc. After the adhesive has cured holding the coping to the implant abutment, the mechanical connection between the post and cap is overcome by axial force in the pick-up process. The mechanical connection can be designed to fail by adhesive failure or by fracture of the joint or the sheet 35.

FIG. 74 shows another embodiment of a temporary alignment screw without relative sliding between the cap portion and the post portion. In this embodiment, a compliant or frangible portion of the post 37 is used to attach a cap 38 to the post. Under tension, the cap portion 38 holds the coping in position against the abutment for pick-up into a prosthesis. Compliant portion 37 may be for example an elastomeric material to provide some angular motion during prosthesis removal after the pick-up material sets. The compliant portion 37 itself or one of its interfaces with the cap or post may provide a 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 heat, any wavelength of electromagnetic energy, or a chemical reaction that may be applied externally or as part of the pick-up process.

The inventive concepts disclosed are not meant to be restricted to a temporary attachment post with standard screw threads that both engage and disengage the threads in the implant abutment through rotations. For example, alternate separable temporary attachment posts embodiments are possible providing features that allow the post to removably hold the coping to the abutment by other means than a separable cap. For example, as shown in FIG. 75 an alignment fastener 39 may contain a separable threaded or serrated portion 40 that engages the screw threads in the abutment for pick-up, but that will release with axial force after. FIG. 75 shows a temporary attachment post 39 having a slot 41 and asymmetric threads or serrations 40 that allow the temporary attachment post to be inserted through rotation for alignment for coping pick-up but may be subsequently extracted with a separation force in the axial direction. Although the threads could be designed to provide engagement with the implant

39 Specification

SDC005

abutment threads through axial motion in the opposite direction to the arrow shown in FIG. 75, rotation to a design torque on engagement is generally preferred. If the post 39 is designed to be pulled out of the abutment during the coping pick-up process, it will subsequently need to be removed from flange 42 and the prosthesis assembly. Since there is no processing impact on patient comfort, higher mechanical forces or a broader range of energy or chemical processing may be employed to remove the post from the prosthesis after coping pick-up.

Further permutations of the separable alignment screw features disclosed above are possible. FIG. 76 shows an embodiment where axial flexibility and/or controlled retention between cap 44 and temporary attachment post 43 is provided by an interface material 45 such as adhesives, silicones, and elastomeric materials contained in the space between the bore of the cap 44 and the post 43. FIG. 77 shows cap 47 retained with an O-ring 48 held in grooves in the cap 47 and temporary attachment post 46. FIG. 78 shows a cup-shaped interface material 57 located within the bore of the cap 44 and extending over a portion of the end of the post 43. FIG. 79 shows a split-collar feature 51 on cap 50 which presses onto the temporary attachment post 49. FIGS. 80 and 81 show alternate designs of flexure beam features in caps gripping a post. In FIG. 80, the pressure on the post 49 is reduced by pulling the cap 52 perpendicular to a diagonal of the cap as indicated by the arrows. In FIG. 81, the pressure on the post 49 is reduced by pulling in opposite directions with moment arms as shown to open the spring.

It is understood that the concept of the temporary attachment of the coping with the abutment with an axially separable temporary post is not dependent upon having a separate cap 11 or nut 63 on the post. If desired the cap or nut can be eliminated and the coping may be directly fixed and axially separable from the temporary attachment post. That is, the coping can be designed to have an equivalent mechanical interface to the post as the caps in the embodiments above. The mechanical interface between the coping and post may be tailored to provide equivalent rotational engagement and relative axial movement above a designed minimum axial force.

Example embodiments of the coping and post being the separable components include the following:

40 Specification

SDC005

FIG. 82 shows temporary attachment post 71, engaging an interference fit of coping 72 at a position above the threaded portion. Metal, metal-reinforced, ceramic, and polymer copings, posts and fasteners may be included in this and other embodiments. Any of the parts may have surface treatments to control friction or adhesion.

FIG. 83 shows temporary attachment post 71 engaging integral spring-finger features 78 of coping 73.

FIG. 84 shows a temporary attachment post 71 engaging collet-type spring fingers 77 of coping 74, these collet-type features may be formed using slots in the coping 74 as shown in FIG. 84A.

FIG. 85 shows a slotted spring feature 79 formed in the temporary attachment post 76. The spring-features engage a smaller bore portion 90 of the coping 75. Such features may be of varied shapes including slots, eyelets, swaged portions, tubular swaged parts, etc. A film 56 (not shown) may be used to prevent the ingress of pick-up material into any voids at the top of the post/coping assembly similar to that shown in FIG. 71.

FIG. 86 shows temporary attachment post 71 and coping 75 engaged using an O-ring or washer 80. Such washers may be elastomers, polymers, metals, etc. and may be forms in varied shapes, such as the u-shaped retainer 81 of FIG. 87.

FIG. 88 shows temporary attachment post 71 retained to coping 75 using a sheet cap 82. Sheet cap 82 may be a tape, or other polymers or metals joined using adhesives, thermal and ultrasonic bonding, welding, and brazing, etc. This is similar to the embodiment shown in FIG. 73, except the sheet cap 82 does not have thicker cap element 34.

FIG. 89 shows temporary attachment post 71 retained using a filler material 83 in the counterbore of coping 75. Fillers may include a variety of polymer adhesives or fillers, such as silicones, acrylics, epoxies, and/or soft metallic materials. Since the coping 75 in this

SDC005

embodiment is fixed to the post 71, the mating surfaces of the coping 75 and implant abutment must allow relative rotational motion until the predetermined torque is achieved.

Installation of these embodiments may also be accomplished with simple polymer or metal tools 84, for example, as shown in FIG. 90 that engage the flats or other features of the coping 75, and/or of features on top of the threaded post 71.

Although the descriptions above use rotational engagement of the bottom of the post with internal threads of the abutment as a preferred approach, this is not meant to be limiting. Alternate approaches for engaging a temporary attachment post with abutment threads through axial insertion without rotation are considered to be part of this disclosure. For example, the split post bottom structure shown in FIG. 75 which allows axial extraction can also be used for axial insertion. Similarly, an interference fit between the bottom of the post with the threads may also be designed to provide sufficient engagement to provide adequate alignment and fixing of the coping for the pick-up bonding process described earlier. For non-rotary extraction of the post, it is not necessary to have the extraction force of the post-abutment thread interface greater than the force required for relative movement of the coping or cap with the upper end of the post. That is, if the temporary attachment post remains fixed to the coping during the pick-up step, the post can be removed from the dental appliance after removal from the patient's mouth.

Although axially symmetric interfaces between coping and abutment have been described for most embodiments, the inventive concepts may also be applied to asymmetric abutments and copings as long as the coping doesn't need to rotate on the implant abutment as noted, for example, with the embodiment of FIG. 89 .

Various embodiments have been described to illustrate the disclosed inventive concepts, not to limit the invention. Combining inventive elements of one or more of the embodiments with known materials, components and techniques in dental science to create further embodiments using the inventive concepts is considered to be part of this disclosure.

42 Specification

SDC005

Any of the embodiments may contain a film or deposited material on top of the cap and temporary attachment post to prevent adhesion to the temporary attachment post of materials used for pick-up, as shown in the film 56 of FIG. 71.

Temporary attachment posts may be rotationally driven into the abutment threads using either the cap, coping or the temporary attachment post itself. Temporary attachment posts and caps may have varied drive features such as male or female knurls, hex, spines, spanner notches/holes. These design alternatives are driven by functional requirements of a particular implementation.

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 pick-up materials, and other properties such as corrosion-resistance.

We claim:

1. A method for aligning a dental prosthesis for definitive screw attachment to a threaded implant abutment, wherein the definitive screw has a threaded shaft and a head wherein the diameter of the head is larger than the diameter of the shaft, the method using a coping and a temporary fastener, wherein the temporary fastener has a threaded post portion suitable for attachment to the implant abutment threads and a separable cap portion, the method comprising:

placing the coping on the implant abutment, wherein the coping has a distal end shaped to fit on the proximal end of the implant abutment and wherein the coping has an aperture sized larger than the shaft diameter and smaller than the head diameter of the definitive screw,

inserting the threaded post portion of the temporary fastener into the aperture from the proximal end, wherein the cap portion of the temporary fastener is larger than the coping aperture,

engaging the post portion threads with the implant abutment threads,

applying a predetermined rotary torque to the separable fastener sufficient to cause the cap portion to hold the coping against the implant abutment for pick-up processing without separating the cap portion from the post portion,

bonding the cap portion and the coping to the dental prosthesis, wherein the dental prosthesis has a cavity for bonding on the intaglio side,

applying an axial separation pick-up force sufficient to cause the cap portion to separate from the post portion, wherein the cap portion and coping remain bonded to the prosthesis and the post portion remains attached to the implant abutment.

2. The method of Claim 1 further comprising:

forming a clearance bore through the dental prosthesis for a definitive screw,

removing the post portion from the implant abutment threads,

mounting the dental prosthesis to the implant abutment with a definitive screw, wherein the forming a clearance bore and removing the post portion steps may occur in either order.

3. The method of Claim 1 further comprising mechanical attachment of a first component to the exposed post retained in the implant abutment after applying the pick-up force.

4. The method of Claim 3 further comprising removing the post from the implant abutment by rotating the first component.

5. The method of Claim 1 further comprising attaching a second component to the cap portion retained in the dental prosthesis after applying the pick-up force.

6. The method of Claim 5 wherein the second component is a scan flag.

7. The method of Claim 2 wherein the forming the clearance bore comprises drilling a through hole from the intaglio side of the dental prosthesis.

8. The method of Claim 7 further comprising using the through hole as a guide for drilling a counter bore from the occlusal side of the dental prosthesis for the head of the definitive screw.

9. A kit of dental parts for aligning a dental prosthesis for definitive screw attachment to a threaded implant abutment according to Claim 1, wherein the kit comprises:

a temporary fastener, the temporary fastener comprising:

a post having an axis, a first post end and a second post end, wherein the first post end is threaded to mate with the implant abutment threads; and

a cap having an axis, a first cap end and a second cap end, wherein the cap has an axial bore at the first cap end sized to receive the second post end through an insertion length; and

wherein the second post end is mechanically attached inside the bore of the cap; and

wherein the mechanical attachment is configured to prevent relative rotary movement between the post and cap below a predetermined screw engagement torque and to

allow relative axial movement between the post and cap above a predetermined axial separation force; and

a coping.

10. The kit of dental parts according to Claim 9 further comprising a post-attachable component that is configured to mechanically attach to the second post end after the cap has been separated, wherein the post-attachable component is mechanically attached to the second post end by application of an axial force towards the first post end.

11. The kit of dental parts according to Claim 10 wherein rotating the post-attachable component disengages the first post end from the implant abutment.

12. The kit of dental parts according to Claim 11 wherein the post-attachable component comprises a torque driver, wherein the torque driver comprises:

a shaft; and

a spring member, wherein the spring member surrounds a portion of the shaft;
and,

a drive cap, wherein the drive cap is attached to one end of the spring member;

wherein rotating the drive cap in a first direction causes the spring to apply a torque to the shaft below a predetermined first torque before slipping, and wherein rotating the drive cap in a second direction causes the spring to apply a second torque on the shaft wherein the magnitude of the second torque is greater than the magnitude of the first torque.

13. The kit of dental parts according to Claim 9 further comprising a cap-attachable component that is configured to mechanically attach to the cap after the post has been separated, wherein the cap-attachable component is mechanically attached to the cap by insertion of a portion of the cap-attachable component into the bore of the cap.

14. The kit of dental parts according to Claim 13 wherein the cap-attachable component comprises a surface profile portion that corresponds to a portion of the surface profile of the implant abutment.

15. The method for aligning a dental prosthesis for definitive screw attachment to a threaded implant abutment according to Claim 1 applied to converting an existing denture for definitive screw attachment to a plurality of threaded implant abutments, the method further comprising:

at a time prior to bonding the cap portions and the copings to the dental prosthesis,

marking the position of the implant abutments on the intaglio side of the denture,

boring blind clearance cavities for the coping/separable fastener assemblies at the marked positions,

after applying the axial separation pick-up force sufficient to overcome the mechanical attachment in the axial overlap region to cause the cap portion to separate from the post portion,

unscrewing the threaded portions of the separable fasteners from the implant abutments,

forming definitive screw clearance holes in the denture,

mounting the denture to the implant abutments with definitive screws that engage the same implant abutment threads as the separable fastener post portions,

wherein the mounting of the pick-up copings with the separable fasteners and the marking of the implant abutment positions on the denture may occur in either order, and wherein the unscrewing the threaded portions of the temporary screws and the forming definitive screw clearance holes in the denture may occur in either order.

16. The method of Claim 15 further comprising:

mounting scan flags to the bonded pick-up copings in the converted denture; and

digitally scanning the converted denture and scan flags into prosthesis design software.

17. The system of Claim 15 further comprising:

mounting laboratory analogs to the bonded pick-up copings in the converted denture;
and

casting a physical model of the implant abutments and soft tissue using the converted denture and laboratory analogs.

18. A method for aligning a dental prosthesis with a threaded implant abutment for definitive screw attachment wherein the definitive screw has a threaded shaft portion and a head, the method employing a coping wherein the coping comprises a distal end shaped to align with the implant abutment when a force is directed in a direction along the axis of the implant abutment threads and a proximal end with an aperture sized to allow the shaft portion of the definitive screw to pass through and the head to apply the axial force toward the implant abutment, the method employing a separable screw, the method comprising:

mounting the coping on the implant abutment with the separable screw, wherein the temporary screw comprises a distal end portion adapted to engage the threads of the implant abutment and a proximal end portion having temporary engagement means for attachment adjacent to the proximal end of the coping; and wherein the temporary screw holds the distal end of the coping in alignment against the implant abutment when the distal end portion of the temporary screw engages the implant abutment threads and wherein the temporary engagement means releases the coping without disengaging the threaded distal end portion of the temporary screw upon the application of a predetermined axial force in the proximal direction;

bonding the coping to the prosthesis with adhesive;

applying an axial pick-up force in the proximal direction to disengage the coping from the threaded abutment and distal end portion of the temporary screw;

drilling a clearance bore for the definitive screw in the prosthesis, wherein the clearance bore allows the threaded shaft of the definitive screw to extend through the aperture of the coping.

19. The method of Claim 18 wherein the temporary engagement means includes at least one of a reversible mechanical engagement means and a breakaway mechanical engagement means.

20. The method of Claim 19 wherein the breakaway mechanical engagement means comprises at least one of a structure that fractures at a force below the predetermined axial force, a material that softens with the application of thermal energy, a material that is weakened by the application of electromagnetic energy and an adhesive with a bonding strength below the predetermined axial force.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	SCREW-ATTACHED PICK-UP DENTAL COPING SYSTEMS AND METHODS
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As the below named inventor, I hereby declare that:

This declaration is directed to: The attached application, or
 United States application or PCT international application number _____
filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: Charles Albert Rudisill Date (Optional) : _____

Signature: /Charles Albert Rudisill/

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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Application Number	
Filing Date	2022-03-04
First Named Inventor	Brandon D Kofford
Title	SCREW-ATTACHED PICK-UP DENTAL COPING SYSTEMS AND METHODS
Art Unit	
Examiner Name	
Attorney Docket Number	SDC005

SIGNATURE of Applicant or Patent Practitioner

Signature	/Daniel John Whittle, #54,537/	Date (Optional)	
Name	Daniel John Whittle	Registration Number	54,537
Title (if Applicant is a juristic entity)			

Applicant Name (if Applicant is a juristic entity)

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

*Total of 2 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Table with 2 columns: Application Number, Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

- Checkboxes for appointing Patent Practitioner(s) or Practitioner(s) named in the attached list. Includes a text box with '000112823'.

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

- Checkboxes for recognizing or changing the correspondence address. Includes a text box with '000112823'.

Form fields for Firm or Individual Name, Address, City, State, Zip, Country, Telephone, Email.

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

Empty text box for Applicant name.

- Checkboxes for identifying the applicant: Inventor or Joint Inventor, Legal Representative, Assignee, or Person with Proprietary Interest.

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature fields for Signature, Name, Title, and Date (Optional).

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

Total of 2 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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POWER OF ATTORNEY BY APPLICANT

No more than ten (10) patent practitioners total may be appointed as set forth below by name and registration number. This page need not be submitted if appointing the Patent Practitioner(s) associated with a Customer Number (see form PTO/AIA/82B):

Name	Registration Number

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

- I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 000112823
- OR**
- I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

- The address associated with the above-mentioned Customer Number
- OR**
- The address associated with Customer Number: 000112823
- OR**

Firm or Individual Name				
Address				
City	State	Zip		
Country				
Telephone	Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

- Inventor or Joint Inventor (title not required below)
- Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)
- Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)
- Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	Date (Optional)	10-07-2019
Name	Brandon D Kofford	
Title		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	SCREW-ATTACHED PICK-UP DENTAL COPING SYSTEMS AND METHODS
<p>As the below named inventor, I hereby declare that:</p> <p>This declaration is directed to: <input checked="" type="checkbox"/> The attached application, or <input type="checkbox"/> United States application or PCT international application number _____ filed on _____</p> <p>The above-identified application was made or authorized to be made by me.</p> <p>I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.</p> <p>I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.</p> <p style="text-align: center;">WARNING:</p> <p>Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.</p>	
<p>LEGAL NAME OF INVENTOR</p> <p>Inventor: <u>Brandon Dale Kofford</u> Date (Optional): <u>10-07-2019</u></p> <p>Signature: </p>	
<p><small>Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.</small></p>	

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA/82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	
Filing Date	2019-10-08
First Named Inventor	Brandon Dale Kofford
Title	SCREW-ATTACHED PICK-UP DENTAL COPING SYSTEMS AND METHODS
Art Unit	
Examiner Name	
Attorney Docket Number	SDC001

SIGNATURE of Applicant or Patent Practitioner			
Signature	/Daniel John Whittle, #54,537/	Date (Optional)	
Name	Daniel John Whittle	Registration Number	54,537
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			
<p>NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.</p>			
<p><input checked="" type="checkbox"/> *Total of 2 forms are submitted.</p>			

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