

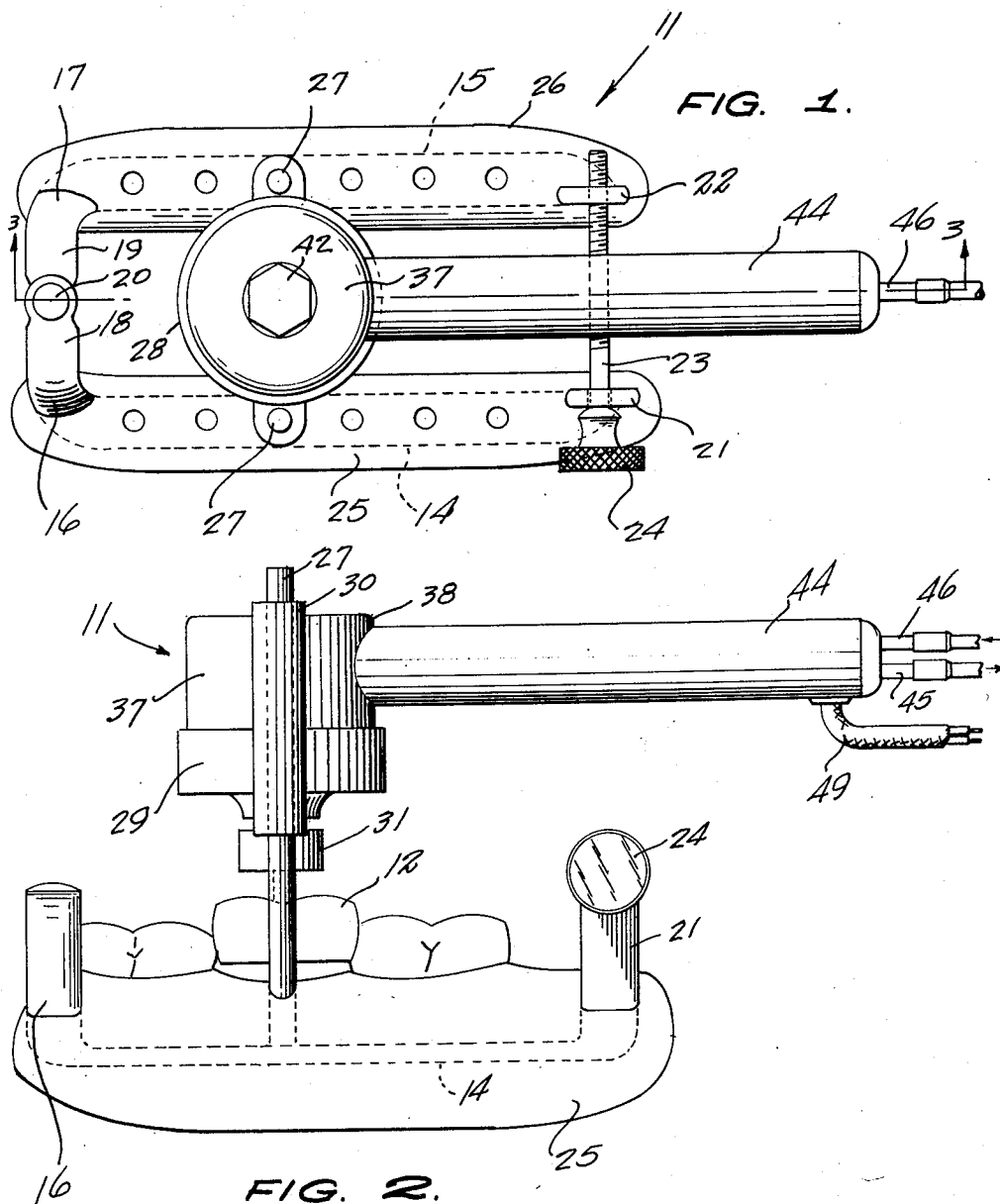
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F. G. REINEKE
INLAY CUTTING DEVICE

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2 Sheets-Sheet 1



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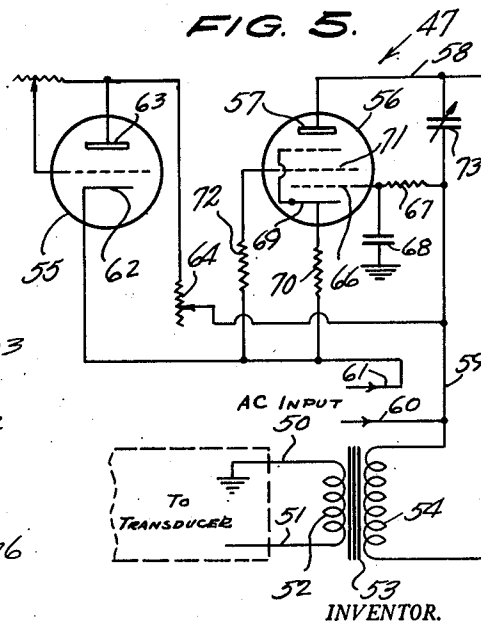
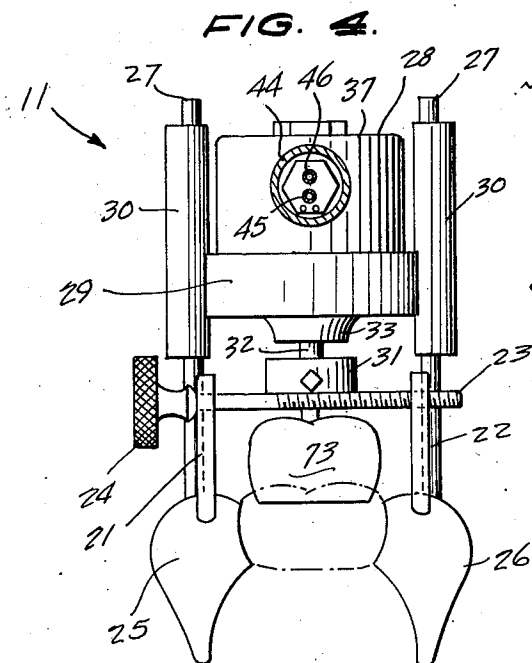
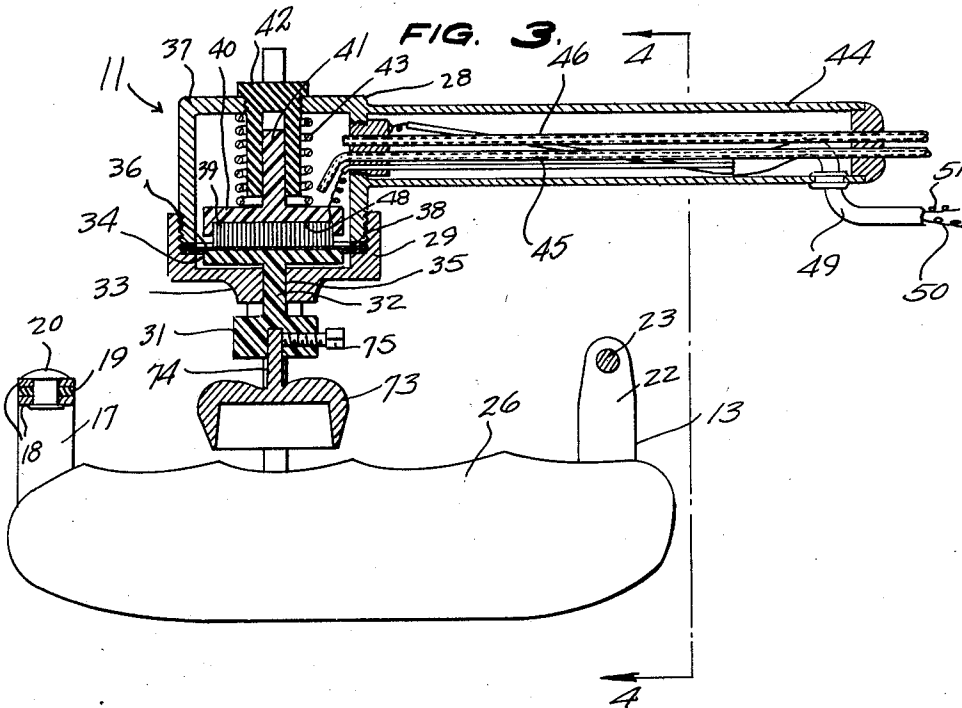
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INLAY CUTTING DEVICE

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3 Claims. (Cl. 32—46)

This invention relates to dentistry, and more particularly to an inlay cutting device.

A main object of the invention is to provide a novel and improved technique for filling teeth, as by placing inlays in teeth, said technique involving relatively simple apparatus, involving relatively few procedural steps, and providing a means of preparing and setting inlays of teeth with a high degree of precision.

A still further object of the invention is to provide an improved apparatus for forming an inlay cavity in a tooth to be filled, said apparatus involving relatively inexpensive components, being easy to operate, and providing a cavity which is shaped to exactly receive the intended inlay.

A still further object of the invention is to provide an improved inlay cavity cutting device which is molded from a cavity corresponding exactly to the cavity required to receive the inlay, said device being easy to manipulate and being provided with means for securely supporting same in the proper position in the patient's mouth to form the required inlay cavity.

A still further object of the invention is to provide an improved technique for placing an inlay in a tooth of a patient, said technique being capable of execution in a relatively short period of time and with a minimum amount of pain and discomfort to the patient, and providing an inlay cavity which receives the intended inlay with a substantially perfect fit, whereby a minimum amount of cementing of the inlay in the cavity is required.

Further objects and advantages of the invention will become apparent from the following description and claims, and from the accompanying drawings, wherein:

Figure 1 is a top plan view of an inlay cavity forming device constructed in accordance with the technique of the present invention.

Figure 2 is a side elevational view of the inlay cavity forming device of Figure 1 shown engaged with the mouth structure of a patient adjacent a tooth to be filled.

Figure 3 is a vertical cross sectional view taken on the line 3—3 of Figure 1.

Figure 4 is a vertical cross sectional view taken on the line 4—4 of Figure 3.

Figure 5 is a schematic wiring diagram of an electronic oscillator employed to drive the transducer element of the inlay cutting device of Figures 1 to 4 at a super-sonic frequency.

Referring to the drawings, and more particularly to Figures 1 to 4, 11 generally designates an inlay cutting device which is employed to form a cavity in a tooth 12 to receive an inlay, in accordance with a procedure presently to be described. The inlay cutting device 11 comprises a clamp 13, said clamp consisting of a pair of generally U-shaped arms 14 and 15 formed at their left end portions, as viewed in Figures 1, 2 and 3, with the upstanding vertical portions 16 and 17 having transversely extending horizontal top portions 18 and 19 which are pivotally connected together at 20, the upstanding portions 16

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and 17 being of substantial height so that the pivotally connected top portions 19 and 18 may overlie the top plane of the patient's teeth when the device is placed in the patient's mouth, as shown in Figure 2.

The arms 14 and 15 are formed at their right ends, as viewed in Figures 1, 2 and 3, with the upstanding vertical portions 21 and 22. Designated at 23 is a clamping screw having the knurled head 24, said screw 23 extending rotatably through an aperture in the top portion of the upstanding element 21 and being threadedly engaged in the top portion of the upstanding element 22, whereby the arms 14 and 15 may be urged toward each other responsive to the tightening of the screw 23.

The arms 14 and 15 are respectively embedded in respective masses of relatively yieldable matrix material, shown at 25 and 26, such as masses of soft metal of relatively low melting point such as soft lead or the like. As will be presently explained, the masses of metal 25 and 26 are molded to conform with the structure of the patient's mouth adjacent the tooth to be filled, the respective masses being shaped to fit against the respective opposite sides of said mouth structure, whereby the screw 23 may be tightened to securely clamp said masses against the associated portions of the patient's mouth structure on the opposite sides of the tooth to be filled without causing excessive pain or discomfort to the patient.

Embedded in the respective masses of matrix material 25 and 26 and rising vertically from the intermediate portions thereof are the respective upstanding guide pins 27, 27. Designated generally at 28 is a tool head comprising the generally circular bottom cover element 29 formed at diametrically opposite portions thereof with the vertical guide sleeves 30, 30 which slidably receive the respective upstanding guide pins 27, 27. As shown in Figures 2 and 4, the sleeves 30, 30 are freely movable vertically on the pins 27, 27, whereby the head 28 may be readily lifted out of engagement with the pins 27, 27 and may conversely be readily engaged on the pins 27, 27.

Designated at 31 is a chuck member having a shank portion 32 extending axially through a depending central boss 33 formed on the cover element 29 and being integral with a disc element 34 received in the cover 29. The chuck element 31 is formed integrally with the shank 32 and the disc element 34 and is of relatively rigid material, the shank element 32 being freely slidable vertically in the axial bore provided therefor in boss 33 and designated at 35.

The disc element 34 is cemented or otherwise suitably secured to the bottom surface of a diaphragm 36 of suitable thin vibratile material, such as thin sheet metal clamped at its periphery between the cover 29 and the rim of the main body 37 of head 28. As shown in Figure 3, the main body 37 is substantially cup-shaped and is threadedly engaged inside the peripheral flange of the cover 29, whereby the rim of the main body 37 clampingly engages the peripheral margin of the diaphragm assembly, said diaphragm assembly being provided with suitable resilient deformable sealing gaskets 38 interposed between the peripheral marginal top and bottom portions of diaphragm 36 and the adjacent surfaces of main body 37 and cover 29.

Designated at 39 is a transducer of suitable piezoelectric material, such as barium titanate crystal, the transducer 39 being cemented to the top surface of the vibratile diaphragm 36 and being secured in a downwardly facing cup-like crystal holder 40 having an upstanding axial stem portion 41. Said stem portion 41 is slidably received in a vertical guide cup 42 threadedly secured in and depending from the top wall of the main body 37 of head 28. A coiled spring 43 surrounds the depending guide cup 42, bearing between the top wall of the main

body 37 and the downwardly facing crystal holder 40, biasing said crystal holder and the central portion of the diaphragm 36 downwardly.

Designated at 44 is a hollow horizontally extending handle which is secured to the upper portion of main body 37 and which extends laterally therefrom. Extending through the handle 44 and into the interior of main body 37 are the coolant inlet conduit 45 and the coolant outlet conduit 46, whereby suitable coolant liquid may be circulated through the interior of the main body 37 of head 28 during the operation of the cutting device.

The transducer 39 is driven at a supersonic frequency by suitable electronic drive means, such as by the electronic oscillator 47 shown in Figure 5, said oscillator being of conventional construction. As is well known to those skilled in the art, the transducer has one grounded face, for example, the face thereof secured to the diaphragm 36, the other face of the transducer being provided with a suitable electrode 48. A cable 49 extends through the handle 44 and has one ground wire 50 and a second wire 51. The wire 51 is connected to the electrode 48 and the ground wire 50 is electrically connected to the metal housing of the head 28, being thus electrically connected to the diaphragm 36. The wires 50 and 51 are connected to the terminals of the secondary winding 52 of a suitable output transformer 53 forming part of the oscillator 47, the primary winding 54 of said transformer receiving the output signal of the oscillator. Thus, the oscillator 47 may comprise a first vacuum tube 55 of the triode type and a second vacuum tube 56 of the pentode type. Tube 56 is employed as the output tube of the oscillator and has the plate 57 connected by a wire 58 to one terminal of the transformer primary winding 54. The other terminal of the primary winding 54 is connected to a wire 59 to which is connected one of the alternating current power line wires 60. The other alternating current power line wire, shown at 61, is connected to the cathode 62 of the vacuum tube 55. The plate 63 of said vacuum tube 55 is connected through a rheostat 64 to the wire 59 to provide rectification of the alternating current supply voltage. Thus, pulsating direct current is applied to the control grid 66 of the oscillator output tube 56 through a suitable resistance 67, a filter condenser 68 being connected between the grid 66 and ground to smooth the pulsating potential available from the wire 59.

The cathode 69 of tube 56 is connected to wire 61 through a suitable cathode resistor 70 and the additional grid 71 of tube 56 is connected to wire 61 through a relatively high value resistor 72. The frequency of the oscillations are regulated by a variable condenser 73 connected across the terminals of the primary 54 of transformer 53, said condenser and primary forming the tank circuit of the oscillator and having the proper values to provide the desired supersonic frequency, for example, a frequency of between twenty-five thousand and thirty thousand cycles per second.

It will be understood that the oscillator itself is conventional and forms no part of the present invention, said oscillator being available commercially.

Designated at 73 is a cutting tool which is shaped exactly in the form of the inlay to be placed in the tooth to be filled, said cutting tool 73 having the upstanding stem 74 which is secured in a central axial bore provided in the chuck 31 by a set screw 75 threadedly engaged through the chuck, as shown in Figure 3.

In operation of the cutting device, the transducer 39 is energized by the oscillator 47 and vibrates at a supersonic frequency, the cutting tool 73 being engaged on the tooth 12 and causing said tooth to be abraded by the vertical reciprocation of the cutting tool 73 to form the desired inlay cavity. During the operation of the cutting tool 73 suitable abrasive material in the form of a slurry comprising a suitable vehicle, such as glycerin or the like, is applied to the tooth surface, the excess abrasive and

tooth fragments being removed by a suitable vacuum device provided with an intake nozzle which may be held adjacent to the tooth 12 to remove the loosened material. The slurry containing the abrasive may be applied in any suitable manner, as by the use of an air pressure supply line in conjunction with a vessel provided with a flexible outlet conduit and supply nozzle shaped to allow accurate discharge of the slurry onto the surface of the tooth being abraded. The slurry may comprise, for example, a glycerin vehicle containing alumina abrasive of suitable consistency.

It will be understood that the output transformer 53 of the oscillator provides a suitable output impedance at its secondary 52 to match the impedance of the load, namely, the impedance of the piezoelectric transducer 39.

The first step in the procedure of the present invention is to make a suitable impression of the structure of the patient's mouth including the tooth 12 to be filled and the mouth structure adjacent thereto, for example, a suitable hydrocolloid impression. From this impression a stone cast is made. In the cast, the replica of the tooth 12 is then drilled to form the required cavity for the inlay to be fabricated.

The next step in the procedure is to cast two inlays from the cavity in the stone model, one inlay to be employed as the tool 73 and the other to be employed as the final inlay. In the inlay to be employed as the tool 73 the sprue is retained and extends parallel to the long axis of the tooth, said sprue defining the stem 74 of the cutting element 73, shown in Figure 3.

The next step in the procedure is to form a suitable box mold, employing modeling clay or the like, in which the stone model is placed, the clamp 21 being then placed around the stone model with the respective arms 14 and 15 thereof disposed adjacent the respective opposite sides of the portions of the stone model corresponding to the mouth structure of the patient on the respective opposite sides of the tooth 12 to be filled. The box mold is suitably shaped to define cavities around the arms 15 and 14 of the clamp in which the respective masses of soft metal 25 and 26 may be molded. Said masses are formed by pouring low fusing metal, such as lead or the like, into the respective mold cavities around the arms 14 and 15. Before the low fusing metal is poured into the mold cavities, the guide pins 27, 27 are placed in the sleeves 30, 30 and the head 28 is engaged with the cutting element 73 formed in the preceding steps, the sprue or stem 74 being secured in the chuck 31. The cutting element 73 is engaged on the portion of the model corresponding to the tooth 12 to be filled, whereby the pins 27, 27 are allowed to engage on the portions of the model on the opposite sides thereof corresponding to the opposite sides of the mouth structure of the patient adjacent to the tooth 12. Thus, the pins 27, 27 are properly positioned so that said pins will be embedded in the masses of soft metal 25 and 26 when said metal is poured into the mold cavities.

After the metal masses have cooled, the tool is completed and the head portion thereof may be disengaged from the pins 27, 27 to allow the clamp portion thereof to be placed in the patient's mouth around the tooth 12 to be filled.

A suitable rubber dam is employed on the portions of the patient's mouth which receive the clamping masses 25 and 26, after which said clamping masses are engaged on the rubber dam and the clamping screw 23 is tightened, whereby the masses of matrix material 25 and 26 exert intimate clamping pressure on the portions of the patient's mouth structure on the opposite sides of the tooth 12.

The sleeve elements 30, 30 of the tool head 28 are then engaged on the pins 27, 27, whereby the head is allowed to descend and whereby the cutting element 73 is positioned properly for making the required inlay cavity. The oscillator 47 is then energized, whereby the cutting action begins and the slurry containing the abrasive material is applied to the surface of the tooth 12 being

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abraded, the head 28 being elevated whenever it is necessary to replenish the slurry. The excess slurry and tooth fragments are removed by using a suitable vacuum device, as above described, for example, a suitable vessel connected to the saliva ejector of the usual dental unit available, a suitable flexible conduit being connected to the vessel, said conduit being provided with a vacuum intake nozzle which may be held closely adjacent to the tooth 12 being abraded.

After the required inlay cavity has been formed, the precast inlay formed in the earlier steps of the procedure may be placed in the cavity and may be suitably cemented therein.

It will be noted that the cutting element 73 has exactly the same shape as the precast inlay, being formed from the same mold in the tooth model, and that therefore the cavity formed by the element 73 receives the precast inlay with almost exact precision. It will be further noted that only a minimum amount of cutting action on the tooth 12 is required, since the tool 73 provides the exact cavity required to receive the precast inlay.

It will be further noted that the procedure of the present invention reverses the usual procedure, namely, in the present invention the cavity is shaped to exactly receive the inlay, whereas in the usual procedure heretofore employed the inlay is shaped to fit a cavity formed in the patient's tooth.

It will be further apparent that by employing a supersonic driving frequency for the cutting element 73, the drilling operation is substantially painless, since the cutting frequency is a substantially higher pitch than is normally perceptible to the human nervous system.

It will be further apparent that in the operation of the cutting device, the tool 73 is reciprocated vertically along the long axis of the tool, and that the reciprocation of the cutting element 73 in cooperation with the action of the abrasive contained in the slurry rapidly cuts the tooth to provide an inlay cavity adapted to exactly receive the precast inlay formed in the earlier portion of the procedure.

A cutting device according to the present invention may be used free-hand in areas where a clamp is not applicable, or where preparation may be required other than for inlays, such as cements, amalgams, or the like, and where an appropriate tool head is selected.

While a specific embodiment of an improved method and means for preparing an inlay and for placing the inlay in the tooth of a patient has been disclosed in the foregoing description, it will be understood that various modifications within the spirit of the invention may occur

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to those skilled in the art. Therefore, it is intended that no limitations be placed on the invention except as defined by the scope of the appended claims.

What is claimed is:

1. An inlay cutting device comprising clamp means engageable with the mouth structure of a patient adjacent a tooth to be filled, upstanding guide means on said clamp means, a supersonic vibrator slidably engaged on said guide means, and an inlay cutting tool connected to said vibrator, said cutting tool being shaped in exact correspondence with the inlay to be placed in said tooth, said guide means being located to support said cutting tool in engagement with the portion of the tooth to be fitted with the inlay.

2. An inlay cutting device comprising a clamp adapted to be positioned around a tooth to be filled, respective bodies of relatively yieldable matrix material on opposite sides of said clamp shaped to engage with the mouth structure of the patient on opposite sides of the tooth, upstanding parallel guide pins on said bodies, a supersonic vibrator slidably engaged on said guide pins, said vibrator comprising a supersonic transducer and electronic oscillator means drivingly coupled to said transducer, and an inlay cutting tool connected to said transducer said cutting tool being shaped in exact correspondence with the inlay to be placed in said tooth, said guide pins being located to support said cutting tool in engagement with the portion of the tooth to be fitted with the inlay.

3. An inlay cutting device comprising a clamp adapted to be positioned around a tooth to be filled, respective bodies of relatively yieldable matrix material on opposite sides of said clamp shaped to engage with the mouth structure of the patient on opposite sides of the tooth, upstanding parallel vertical guide pins on said bodies, a supersonic vibrator slidably engaged on said guide pins, said vibrator comprising a horizontal supersonic transducer and electronic oscillator means drivingly coupled to said transducer, depending chuck means drivingly coupled to the transducer, an inlay cutting tool shaped in exact correspondence with the inlay to be placed in said tooth, and a stem on the cutting tool clampingly engaged in said chuck means, said guide pins being located to support said cutting tool in engagement with the portion of the tooth to be fitted with the inlay.

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