Another object of my invention is to provide novel dental apparatus for performing dental inlay work by which a near perfect fit between an inlay and the drilled out cavity of the inlay receiving tooth may be achieved.

Still another object of my invention is to provide novel dental inlay apparatus the use of which substantially reduces the required number of visits to the dentist's office by a patient.

Yet another object of my invention is to provide novel dental inlay work which does not require that a patient be subjected to a second drilling of his teeth by eliminating the necessity for using temporary fillings.

In the past, the practice has been to make a set of X-rays of the patient's mouth and, in accordance with the information revealed, to then drill out various portions of the teeth for which the inlays are to be made. Impressions of the drilled out tooth areas are then taken, from which the inlay is made. Since some time is required in order to cast or otherwise form the inlays, temporary fillings are placed in the patient's teeth so that normal mouth functions will not be interfered with unduly until such time as the inlays themselves may be fitted into the teeth. When the inlays are ready, the patient must then return to the dentist and have the temporary fillings removed so that the inlays may be placed in the teeth. If any extensive amount of inlay work is required, for example work involving a large number of teeth, it is the usual practice to drill only a few teeth at a time and to make the inlays for these teeth, before proceeding to further inlay work on other teeth. As a consequence, a number of visits to the dentist are generally required that can result in a great loss of time to the patient from his normal schedule of activity, such lost time frequently representing an appreciable amount of inconvenience.

By the use of the apparatus according to my invention, it is generally possible to limit the required number of visits to the dentist to only two. On the first visit, the dentist takes a set of mouth X-rays and also an impression of the upper and/or lower set of teeth in the patient's mouth. At this time, no drilling of the patient's teeth whatever is done so that the normal mouth functions remain completely intact and the discomfort and annoyance of temporarily filled teeth is eliminated. From the mouth casts the dentist may construct a model, and the teeth of the model may then be drilled out according to the information revealed by the X-rays. From the drilled-out teeth of the model, and the inlays themselves may be prepared. Upon the return of the patient to the dentist, the patient's teeth may be drilled in exact conformance with the drillings in the model, and hence, the inlays prepared from the model will fit precisely into the patient's teeth and may be installed as soon as any given tooth has been so drilled. It will be appreciated that the precision of fit of the inlay into the teeth of a patient is much greater when the necessity of removing a temporary filling is avoided. This is because such removal entails further dental drilling and the drilling of unnecessarily, at least somewhat, changes the shape of the inlay cavity and, therefore, a perfect fit with an inlay made from an impression cannot be obtained. Accordingly, it is a primary object of my invention to provide novel dental apparatus for performing dental inlay work which does not require that a patient be subjected to a double drilling of his teeth by eliminating the necessity for using temporary fillings.
One possible clamping system is illustrated in FIGURES 1, 5 and 6 and includes a chin rest 30 (illustrated in FIGURE 5) secured to the mount 20 by a bracket 31 and a pair of machine screws 32. Additionally provided is a jaw clamp including a generally T-shaped center support having a pair of laterally opposite extending fixed arms 34 and a central depending stem portion 35, the stem portion of the clamp central support being fixed upon the mount 20 by the machine screw 33. Each of the center support fixed arms 34 is horizontally slotted at its extremity to receive the broad end of a horizontally swingable clamp arm 36 pivotally secured within the slots by means of the pins 37. Both of the swingable clamp arms 36 are provided with a plurality of longitudinally spaced key holes 38 by means of which the crescent shaped hooks 39 may be detachably secured thereat to a desired position along the arm length by extending downward therefrom the stud 40 which projects from the undersurface of the hooks 39.

A shaft 41 is threaded through the T-shaped center support and has swivelly secured to its forward end a wedge 42 adapted to be brought into engagement with the central incisors as the shaft is rotatably advanced by means of the knob 43 secured to its rearward end. By turning the knob 43, the jaw is shifted rearward so as to lock the hooks 39 behind the rear molars and effect jaw clamping. The absence of a rear molar may be compensated for by moving the appropriate hook 39 forward for securement within a different key hole 38. For a better understanding of this jaw clamping apparatus reference may be had to my co-pending application for United States Letters Patent, Serial No. 3,178, now Patent No. 3,060,579.

Head straps or other devices, none of which are shown, may also be employed if considered necessary. Finally, in order that the entire apparatus may be supported by the patient's jaw a support arm 44, a fragment of which is shown in FIGURE 5 secured to the mount 20 by the machine screw 45, may be clamped to the dental chair so that the latter supports the weight of the apparatus and carries it along with the dental chair when any chair motion occurs.

Turning now to a consideration of the carriage 21 which carries the unity ratio pantograph, and the means by which the carriage is supported upon the mount 20, as best seen in FIGURE 5, a vertical post 54 is secured upon the mount 20 by means of the machine screw 55 which passes through a hole drilled in the mounting plate 20 and upward into a threaded bore extending upwardly into the post 54 from the bottom thereof. Seated within a pair of holes extending from front to back through the post 54 and spaced one above the other are a pair of ball bearing assemblies 56 and 57 secured therewithin by means of the C-washers 58. Disposed within and extending fore and aft of the ball bearing assemblies 56 and 57 are a pair of cylindrical shafts 59 and 60 to which the carriage 21 is secured and by means which the entire carriage and pantograph assembly is smoothly and easily shiftable fore and aft in a horizontal plane.

As best seen in the showing of FIGURE 1, the carriage 21 has a main frame which includes a horizontally oriented generally C-shaped member 61 the arms of which extend rearwardly and laterally outwardly, the arm ends 62 turning into parallel relationship with one another and forming the axes of the cylindrical shafts 59 and 60. Secured to the intermediate portion of the arms of the C-shaped member 61 and extending rearwardly therefrom in parallel relationship on opposite sides of the post 54 are a pair of bracket members 63 secured at their rear ends by means of a tie plate 64. The upper carriage shaft 59 is recessed into the tie plate 64 at the rear of the carriage and also into the central region of the C-shaped member 61 at the fore end of the carriage and non-rotatably secured by means of the vertically extending pins 65. Secured at opposite ends of the carriage 21 and extending vertically downward therefrom are a pair of rigid plate members 66 and 67 into which opposite ends of the lower cylindrical cavities drilled in for example by shrink fitting, so that the carriage 21 is rigidly secured to both of the shafts 59 and 60. This ball bearing mounted double shaft arrangement eliminates any tendency toward rotational play of the carriage 21 in a vertical plane.

As best seen in the showing of FIGURES 1, 3 and 6, and particularly in the showing of FIGURE 3, each of the arm ends 62 of the C-shaped member 61 is fitted with a ball bearing assembly 68 which rotatably supports one end of a shaft 69, the other end of each of the shafts 69 being rotatably journalled in the ball bearing assemblies 70 fitted into the bracket members 63. Fixedly secured to and rotatable with each of the rotatable shafts 69 is an angle bracket 71 which extends laterally outward beyond the main frame of the carriage 21 for pivotal securement respectively with the pantograph arms 22 and 23. The bearing mounted shafts 69 and associated angle members 71 allow for rotational motion of the pantograph arms in a vertical plane. As also best seen in the showing of FIGURE 3, the outer extremities of the angle members 71 are pivotally connected to the underside of the pantograph arms 22 and 23 by means of the ball bearing assemblies 72 and 73 by means of the ball bearing assemblies 72 and 73 are free to pivot laterally in planes parallel to the axis of the co-axial rotatable shafts 69.

Disposed toward the rear ends of the pantograph arms 22 and 23 and bridging therebetween is the pantograph arm 24 pivotally secured at opposite ends to the under-surface of the pantograph arms 22 and 23 respectively as for example by means of the ball bearing assemblies 73 seen in dotted outline in the showing of FIGURE 2. The spacing between the ball bearing assemblies 72 and 73 on each of the arms 22 and 23 is identical the same, and the lateral spacing between the ball bearing assemblies 72 at the fore end of the pantograph arms 22 and 23 is the same as the lateral spacing between the ball bearing assemblies 73 located at the rear of the arms 22 and 23, so that the pantograph is a unity ratio device.

The function of the pantograph including the arms 22, 23, 24 and 24' is to enable a dental drill 50, secured to the arm 22 in a manner to be described, to exactly follow the movements of the tracing arm 53 secured to the arm 23 in the same manner as that of securing the drill 50. At the fore end of the tracing arm 53 is a feeler pin 51 which traces the inside surface of the teeth of the dental model 26. As shown in FIGURES 1 and 2 the pin 51 is positioned within the inlay cavity of the tooth 28. The position of the feeler pin 51 controls the position of the drill bit 52 mounted at the fore end of the drill 50, and since the pantograph is designed for unity arm ratio, a given displacement of the feeler pin 51 always causes an identical displacement of the drill bit 52.

In this way, it can be seen that as the feeler pin 51 traces out the outline and depth of the cavity in for example the tooth 28, the drill bit 52 will drill an identical cavity in the tooth 28 of the patient's mouth.

The previously described pantograph arrangements which interconnect the pantograph arms 22, 23 and 24 and the carriage 21, together with the mechanical coupling system involving the arm 24', still to be described, allows for three-dimensional rotation together with the longitudinal shifting of the carriage 21 is required in order to accurately follow the surface of the inlay cavities drilled in the teeth of the dental model 26. The structure for securing the dental drill 50 and tracing arm 53 to the pantograph arms 22 and 23 in a manner which allows for rotation of the drill 50 and tracing arm 53 about their long axes will now be described, principally in connection with the showings of FIGURES 1, 4 and 6.

Each of the pantograph arms 22 and 23 has formed at its fore end a hollow cylindrical formation 74 and at its rear end a hollow cylindrical formation 75, the forma-
What is claimed as new and useful is:

1. Contour duplicating apparatus comprising a stand, a carriage mounted on said stand and translationally shiftable relative to the latter, a pantograph having arms pivotally mounted to said carriage for translation therewith and rotation relative thereto, a cutting tool, a sensing element, first means carried by said pantograph arms rotatably securing thereto said cutting tool and said sensing element in spaced relationship, and second means so intercoupled with said cutting tool and said sensing element that rotational motions of the sensing element relative to said pantograph produce corresponding rotational motions of the cutting tool.

2. The apparatus according to claim 1 wherein said first means comprises a plurality of pairs of coaxial sleeves, one sleeve of each pair being closely fitted inside the other for rotation relative thereto about the common axis, the outer sleeve of at least one of said coaxial sleeve pairs being fixedly secured to one arm of said pantograph and the outer sleeve of at least a second of said pairs being fixedly secured to another of said pantograph arms, said inner sleeve of said first pair including means fixedly securing it to said cutting tool, and the inner sleeve of said second pair including means fixedly securing it to said sensing element.

3. The apparatus according to claim 2 wherein said inner sleeve of each coaxial pair includes an enlarged diameter end located externally and in abutment with the end of the associated outer sleeve whereby relative axial shifting between said sleeves is possible in only one direction at most.

4. The apparatus according to claim 2 wherein said second means includes an arm having a ball joint at opposite ends thereof, one ball joint being fixedly connected to the inner sleeve of said first coaxial pair and the other ball joint being fixedly connected to the inner sleeve of said second coaxial pair.

5. The apparatus according to claim 1 wherein said first means comprises a plurality of pairs of coaxial members, a first member of each pair being closely fitted within the second for rotation relative thereto about the common axis, one member of at least two of such pairs being fixedly secured respectively to different arms of said pantograph, the unsecured member of one of said at least two pairs including means fixedly securing it to said cutting tool, and the unsecured member of the other of said at least two pairs including means fixedly securing it to said sensing element.

6. The apparatus according to claim 5 wherein one member of each coaxial pair includes means for restricting axial shifting thereof relative to the other member of the pair to one direction at most.

7. The apparatus according to claim 1 wherein said stand includes a vertical post member supporting in vertically spaced parallel relation a pair of open-ended bearings, said carriage includes a pair of vertically spaced parallel extending horizontal shafts fixedly secured thereto at opposite ends, and said carriage shafts are disposed within said post bearings for rectilinear shifting therethrough.

8. The apparatus according to claim 1 wherein said carriage includes a main frame fixedly secured to a horizontally extending shaft, said shaft being disposed within and extending outwardly beyond the outer ends of a stand carrying bearing which supports said shaft for rectilinear shifting in a horizontal plane.

9. Contour duplicating apparatus comprising a stand, a carriage mounted on said stand and translationally shiftable relative to said stand, a pantograph pivotally mounted to said carriage for translation therewith and rotation relative thereto, and means carried by said pantograph for rotatably securing thereto said cutting tool and said sensing element in spaced relationship, said cutting tool and said sensing element being simultaneously intercoupled said cutting tool and said sensing element so that rotational motions of the latter relative
to said pantograph produce corresponding rotational motions of the cutting tool.

10. Contour duplicating apparatus comprising a stand, a carriage mounted on said stand and translationally shiftable relative to the latter, a pantograph having arms pivotally mounted to said carriage for translation therewith and rotation relative thereto, first means carried by said pantograph arms for rotatably securing thereto a cutting tool and a sensing element in spaced relationship, and second means for so intercoupling the cutting tool and sensing element when they are so secured by said first means that rotational motions of the sensing element relative to said pantograph produce corresponding rotational motions of the cutting tool, said first and second means being themselves at least partially intercoupled and the intercoupled parts being detachable from said pantograph arms.

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