

July 17, 1962

H. HOLLMAN ET AL
PANORAMIC X-RAY MACHINES

3,045,118

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3 Sheets-Sheet 1

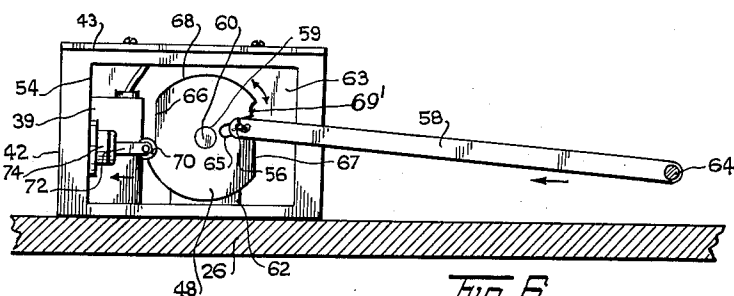


Fig. 6.

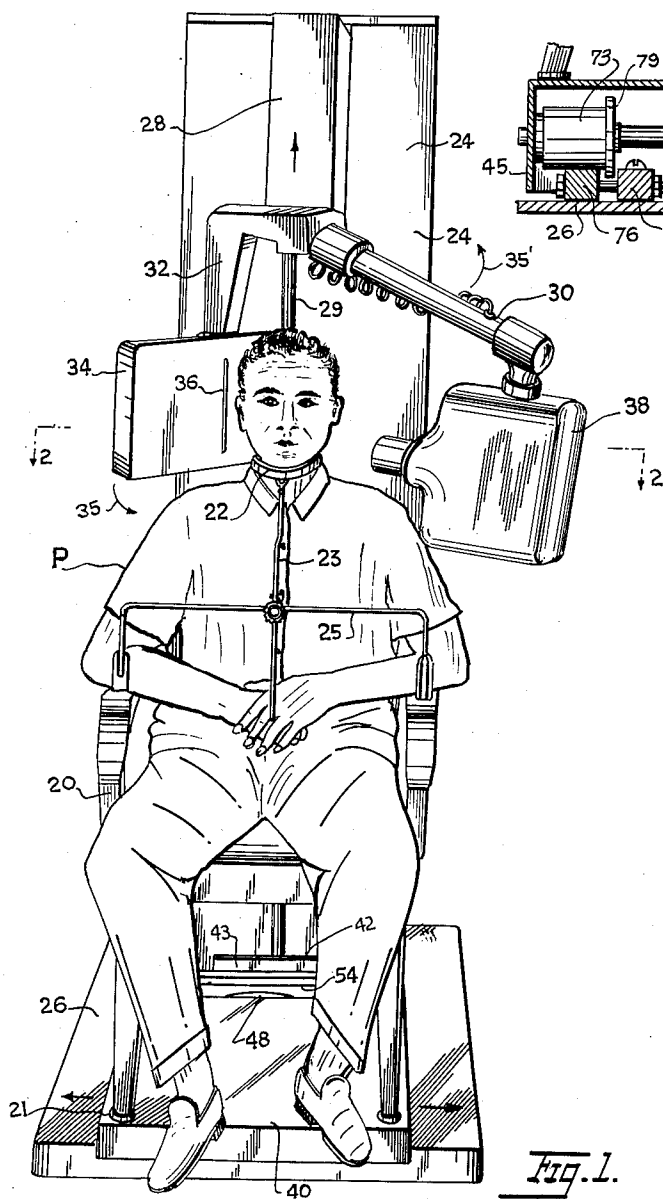


Fig. 1.

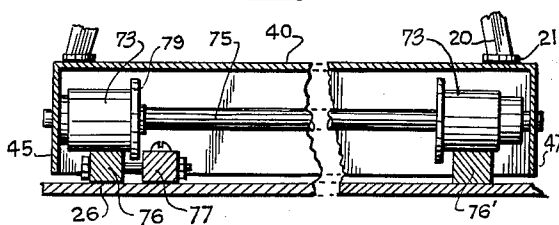


Fig. 3.

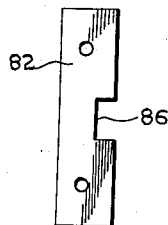


Fig. 5A.

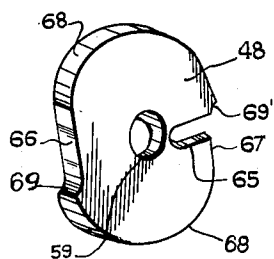


Fig. 7.

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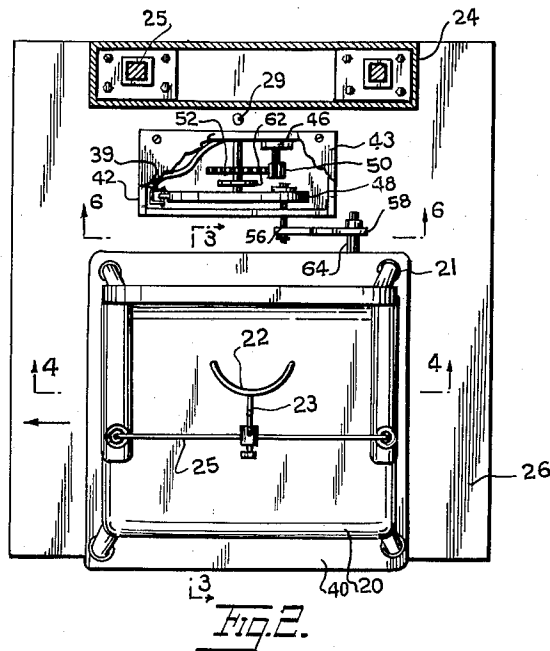
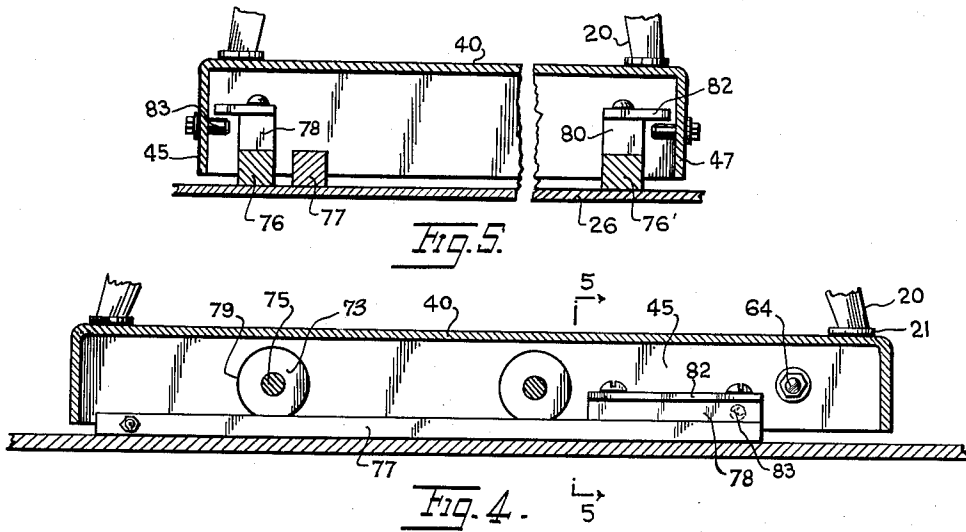
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3 Sheets-Sheet 2



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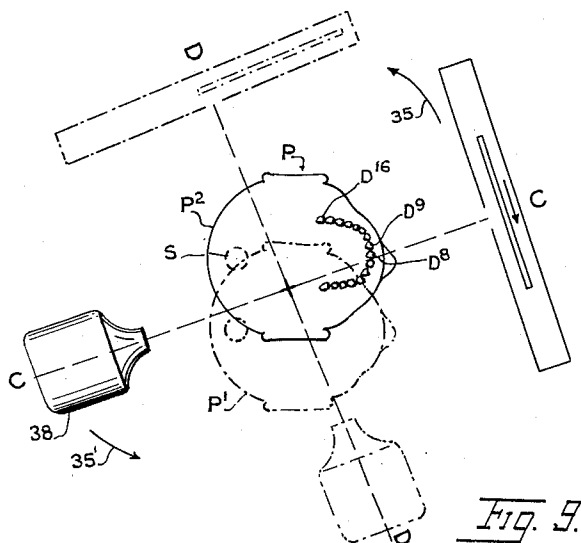
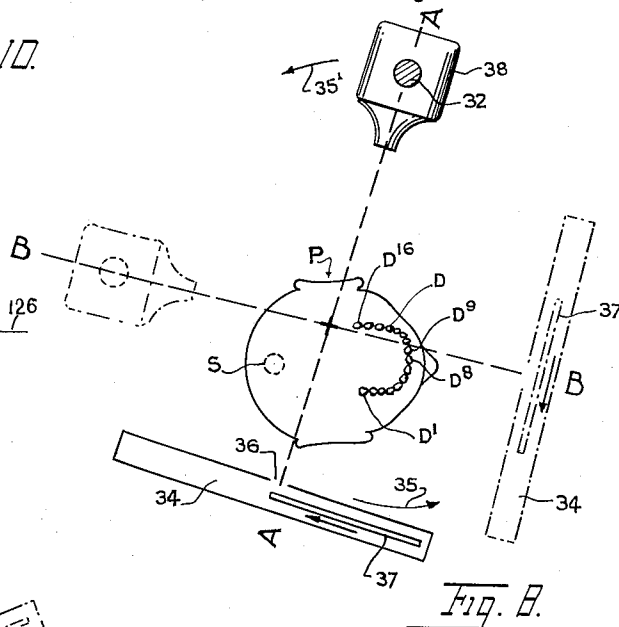
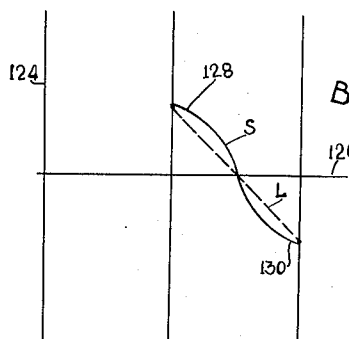
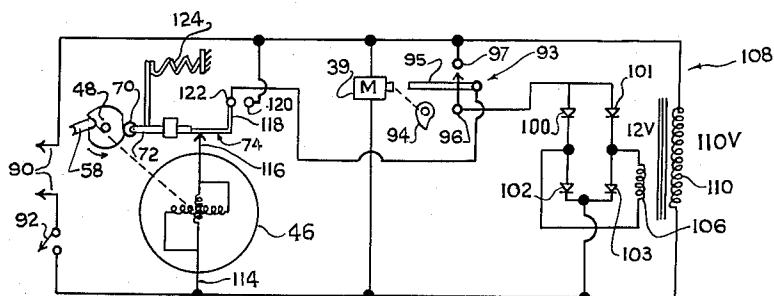
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3 Sheets-Sheet 3



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PANORAMIC X-RAY MACHINES

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7 Claims. (Cl. 250—61.5)

The present invention relates to a device for obtaining full mouth dental radiographs using a film located outside the mouth.

According to the invention there is provided an apparatus for performing dental radiographs by employing an X-ray source and a film both rotatable about a stationary patient. The X-ray source is rotated behind the patient's head while each tooth on upper or lower jaw is radiographed in turn upon an extra-oral film. After one half of an upper or lower denture thus radiographed, the apparatus automatically shifts the patient so that the line of sight between the X-ray source and the film passes the patient's spinal column. During the shifting of the patient, the X-ray source continues its arcuate movement. After the patient is shifted, radiographing of the other half of the denture is begun and continued until the entire denture has been radiographed.

Heretofore, in apparatus employed for performing dental X-rays of the full denture, it has been necessary to stop the rotation of the X-ray source and extra-oral film holder, while the patient was manually shifted. This interruption of the X-ray process to reorient the patient has proven disturbing to the patient in practice and very time consuming. In addition, the manual repositioning of the patient inevitably resulted in some inexactness in relative positioning of the denture and X-ray apparatus so that loss of focus of the X-rays on the film and some inexactitude in the subsequent radiographing was experienced. The present invention avoids these and other difficulties and disadvantages of the apparatus known heretofore.

It is a principal object of the present invention to provide an X-ray apparatus for dental radiography wherein a patient is held stationary while an X-ray source rotates behind a patient and a film holder rotates with the source on a line of sight therewith through the successive teeth being radiographed.

It is a further object to provide an apparatus for performing a full-mouth denture X-ray by continuously moving an X-ray source and extra-oral X-ray film holder, and including means for automatically shifting a patient after a portion of the denture has been X-rayed, so that the remainder of the denture can be X-rayed.

A still further object is to provide a dental X-ray apparatus with a carriage adapted for automatically moving a patient laterally after completion of a portion of a dental radiographic procedure.

For further comprehension of the invention, and of the objects and advantages thereof, reference will be had to the following description and accompanying drawings, and to the appended claims in which the various novel features of the invention are more particularly set forth.

In the accompanying drawings forming a material part of this disclosure:

FIG. 1 is a frontal perspective view of an apparatus embodying the invention with a patient seated thereon in position for performing a radiographing of a full mouth denture.

FIG. 2 is a top plan view of a portion of the apparatus, taken generally on line 2—2 of FIG. 1, with the patient absent therefrom. Parts being broken away and parts being shown in section.

FIGS. 3 and 4 are sectional views on an enlarged scale

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of a platform and base of the apparatus taken on lines 3—3 and 4—4, respectively, of FIG. 2.

FIG. 5 is a sectional view taken on line 5—5 of FIG. 4.

FIG. 5A is a plan view of a flange plate employed in the apparatus.

FIG. 6 is a sectional view on a further enlarged scale of a portion of the platform driving mechanism taken on line 6—6 of FIG. 2.

FIG. 7 is a perspective view of a drive disk and switch cam employed in the apparatus.

FIGS. 8 and 9 are plan views diagrammatic in form employed in explaining the mode of operation of the invention.

FIG. 10 is a simplified electrical circuit diagram of the platform drive circuit.

FIG. 11 is a graph showing the sinusoidal movement of the chair.

The apparatus shown in FIGS. 1 and 2 includes a chair 20 on which the patient P can be seated while the dental radiographing procedure is performed. The chair is removably held in sockets 21 on a platform. An arcuate chin rest 22 mounted adjustably on bracket members 23, 25 is provided for supporting the patient's head in a desired position in the apparatus. The bracket members are supported on the arms of the chair. A cabinet 24 is disposed behind the patient's chair and includes posts 25 mounted on a rectangular base 26. The cabinet carries a trolley 28 adapted for vertical movement therein. The trolley is guided by a vertical guide rail 29. The trolley supports a boom 30 and a bracket beam 32. A film holder cabinet 34 is carried in a depending position by the beam. In the film holder is longitudinal slit 36 through which a flat beam of X-rays is passed from an X-ray emission tube and projector 38 carried on the outer end of boom 30.

The film holder cabinet 34 and the X-ray emitter 38 are movable arcuately together as indicated by arrows 35, 35', with the X-ray emitter 38 moving around the back of the patient's head. In trolley 28 is a motor 39 for driving the boom 30 and beam 32. The motor 39 is shown schematically in FIG. 10.

To the extent described, the apparatus is equivalent to that described in U.S. Patent 2,798,958 to Hudson et al. The present invention departs from the disclosure of the patient in the provision of a platform 40 upon which the chair 20 is disposed. The platform is laterally movable on the base 26. In order to move the platform there is provided a drive mechanism partially housed in a casing 42 located on the base 26 behind the platform.

Referring to FIGS. 2—7, there is shown the rectangular casing 42 provided with a removable cover 43. Within the casing is a motor 46 operatively arranged to drive a disk 48 via speed reducing gears 50, 52. The casing has a frontal opening 54 through which extends a crankshaft 56 attached at one end eccentrically to the disk 48 and at the other end to one end of a connecting bar or link 58. The disk has a center hole 59 which receives a shaft 60 on which the disk rotates. Shaft 60 is journaled in a bracket 62 and in rear wall 63 of the casing.

The other end of the bar 58 is pivotally attached to a rear wall 45 of the platform by a connecting pin 64.

Disk 48 has a radially extending slot 65 in which the crankshaft 56 can be adjustably positioned and secured. The disk has two flat parallel peripheral camming faces 66 and 67, on opposite ends of two circularly curved peripheral sections 68. The flat camming faces each terminate at one end in a smoothly curved step 69 and 69' extending outwardly to the adjacent end of a curved section 68, as best shown in FIG. 7. The flat face 67 is interrupted by slot 65 but this does not interfere with the operation of the disk as a camming member.

When rotated on shaft 60, the disk 48 is contacted

peripherally by a roller 70 at the end of a switch operating handle 72. The switch 74 is a double pole electrical component which is mounted in the casing 42 and is set to one position or another by the positioning of handle 72, depending on whether the roller 70 is in contact with a flat camming face 66 or 67 or a curved section 68 of the disk 48. Disk 48 also serves as a drive member in rotation on shaft 60 since rotation of the disk causes the bar 58 to be reciprocated in a pitman motion to move the platform 40 laterally right and left.

The platform 40 is carried by flanged wheels 74 mounted on axles 75 and secured in front and rear walls 47, 45, respectively, of the platform, as best shown in FIGS. 3 and 4. The wheels move on rails 76, 76'. The rails are provided with risers 78, 80 having removable outwardly extending flange plates 82. Pins 83 are mounted in the front and rear walls of the platform and ride under the flange plates 82 to prevent accidental removal of the platform from the rails. The flange plates 82 are rectangular in form and are provided with cutouts 86 as best shown in FIG. 5A so that the platform can be removed from the rails by passing the pins 83 through the cutouts. The rails 76, 76' are secured to base 26 by screws or bolts. A supplementary rail 77 is provided adjacent to rail 76 for providing a channel in which ride the flanges 79 of the rear wheels 74.

Within casing 42 may be mounted a box 39 for containing electrical components of the drive system for the platform. The electrical circuitry for the drive system is best shown in FIG. 10. This includes a power line 90 adapted for plugging into a suitable A.C. power line, such as a 110 volt line. A main switch 92 is connected in this line. A motor 39 is connected across the line. This motor is normally located at the trolley 28 and serves to rotate the film holder 34 and X-ray projector 38 while simultaneously driving the film contained in the holder in coordination with movement of the holder and projector. The mechanism used for this coordination movement is of a known type and beyond the scope of the present invention. In the aforementioned Patent 2,798,958 there is described a suitable circuitry and mechanism for effecting coordination of movement of the film, film holder and X-ray projector.

Motor 39 drives a cam 94 positioned to move a switch contact 95 at one point in the rotation of the cam. Contact 95 is normally closed with a contact 96 but can be moved by cam 94 to close contacts 95, 97 momentarily. Contact 96 is connected to rectifiers 100—103. The rectifiers are connected to one terminal of a low voltage secondary winding 106 of a transformer 108. The primary 110 of the transformer is connected to the line 90. The primary and secondary windings are connected through rectifiers 102, 103 to one terminal 114 of the A.C. motor 46. The other terminal 116 of the motor is connected to contact 118 in switch 74. Contact 118 is movable between contacts 120 and 122 by switch handle 70 with the periphery of cam disk 48. Contact 118 is normally biased by spring 124 in the switch to close with contact 122. Contact 122 is connected to contact 95 of switch 93. This switch has its contact 97 connected to line 90. Contact 120 in switch 74 is also connected to this line.

FIG. 10 represents the normal inactive position of the circuit. If switch 92 is closed, motor 39 is operated and rotates cam 94. It will be noted that closing of switch 92 causes application of a low rectified D.C. voltage to motor 46. This D.C. voltage maintains the motor in a braked, non-rotating condition. When the pointed end of cam 94 reaches contact 95 it closes contacts 95, 97 so that the full A.C. line voltage is applied to the motor 46 via contacts 118, 122 to start this motor. At the same time contacts 95, 96 are open so that the rectified D.C. voltage is no longer applied from the rectifiers 100—103.

As soon as the motor 46 starts rotating, roller 70 moves

away from the flat faces 66 or 67 on to a curved section of the periphery of disk 48 so that contacts 118, 120 close. This provides a holding A.C. circuit for motor 46 while motor 39 continues to rotate cam 94 away from contact 95 so that a D.C. voltage is applied to the open contact 122. The closed contacts 118, 120 permit the A.C. voltage to be applied to the motor while the roller 70 is in contact with a curved section 68 of disk 48. During this time, which occupies just a few seconds, the disk 48 is driven by motor 46 to actuate bar 58 and move the platform 40 laterally a distance of about two inches. The motion of the motor 46 begins slowly as the roller 70 rides away from the curved step 69 or 69'. When the roller 70 reaches the next flat face 66 or 67, switch contacts 118, 122 are closed and contacts 118, 120 are opened. This causes application of the D.C. voltage to the field coils of motor 46, so that the coasting of the motor is stopped after the motor is deenergized. By reason of the disk and bar connection of the motor 46 and platform 40, the chair is given a sinusoidal kinematic motion, the acceleration of which at the beginning and at the end of the movement is zero. This movement is illustrated in the graph shown in FIG. 11 comparing the sinusoidal kinematic motion of the chair with a straight linear motion. In this graph, the full line S represents the sinusoidal kinematic motion of the chair drive, and the broken line L represents the true linear motion. The line 124 represents acceleration or velocity and the horizontal line 126 the time element. It will be seen that the start of the chair movement as indicated at 128 on the graph is smooth and that the finish of the chair movement as indicated at 130 is also smooth.

By reason of this sinusoidal movement of the chair with its smooth start and smooth finish, no jarring or jerking takes place and the patient is given a smooth ride and often times does not even sense that he has been moved.

The purpose of this sinusoidal movement in the radiographing process will be explained with reference to FIGS. 8 and 9. In FIG. 8 it will be noted, that the patient P is in the initial position at the start of radiographing his denture D, somewhat as shown in FIG. 2. Molar tooth D₁ is the first one to be X-rayed and the projector 38 casts a flat beam of light in a vertical plane including line of sight A—A through tooth D₁ and through slit 36 in film holder 34 to the film 37 shown in dotted lines in FIG. 8. The projector 38 rotates in the direction 35' to the rear of the patient's head while the film holder 34 moves arcuately forward in direction 35. At the same time film 37 is advanced as has been mentioned above in coordination with the rotation of the film holder and X-ray projector. The patient remains stationary and the film holder and projector rotate until the radiographing of the eighth tooth D₈ is completed. As the apparatus completes the radiographing of this eighth tooth the projector and slit 36 are aligned in line B—B and are in the dot-dash position shown in FIG. 8. At this point the line B—B is adjacent the spinal column S of the patient. The apparatus cannot properly radiograph the next tooth D₉ since the spinal column S and the molar tooth D₁₆ of the patient would be disposed in the line of sight of the apparatus. It therefore becomes necessary to shift the patient laterally about two inches sufficient to move the line of sight of the apparatus past the spinal column of the patient.

As soon as the radiographing of tooth D₈ is completed, cam 94 closes contacts 85, 97 of the platform drive mechanism shown in FIG. 10. Motor 46 is unlocked from the braked position and rotates the disk 48 to move the platform laterally. As shown in FIG. 9, the patient is moved laterally from the dot-dash position P₁ to the full line position P₂. At the same time, motor 39 has continued movement of the projector 38 and film holder 34 from the dot-dash position of FIGS. 8 and 9 to the full line position of FIG. 9 so that the new line of sight of the

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apparatus is now at C—C passing through tooth D₈ of the denture. In moving the patient laterally and simultaneously advancing the line of sight of the apparatus, the spinal column S of the patient has been passed. As soon as the apparatus reaches the solid line position of FIG. 9, movement of the patient is halted by application of the D.C. voltage to motor 46 as explained above and radiographing of tooth D₈ is begun. This radiographing procedure continues while the projector rotates around the rear of the patient until the projector and film holder are disposed in the dashed line position of sight D—D where tooth D₁₆ is radiographed. At this point the radiographing of the denture is completed. Due to the slit-like exposure of the film it is impossible to radiograph a full mouth denture, i.e., teeth of upper and lower jaws, in one arcuate movement of the projector and film holder.

If desired, the patient can leave the apparatus after the full denture has been radiographed and the next patient may be dentally radiographed without resetting the apparatus, i.e., the radiographing will be started with the components on line of sight D—D and will terminate with the components on line of sight A—A.

The switching apparatus for controlling the X-ray emission is performed in a known manner and reference is again made to the aforementioned patent for a fuller description of suitable circuitry for accomplishing this purpose.

It will now be apparent that the apparatus has made possible radiographing a full denture of a patient without disturbing the patient to manually reset him during the radiographing procedure. The focus of the apparatus on the teeth is always maintained even while the patient is automatically moved laterally. The entire procedure is accomplished without jarring the film holder or projector since these components remain in continual motion beginning to end of the radiographing procedure. The motion of the platform is begun automatically and is terminated electrically a few seconds thereafter in a novel fashion without the patient being jarred or disturbed in any way.

While we have illustrated and described the preferred embodiment of our invention, it is to be understood that we do not limit ourselves to the precise construction herein disclosed and that various changes and modifications may be made within the scope of the invention as defined in the appended claims.

Having thus described our invention, what we claim as new, and desire to secure by United States Letters Patent is:

1. In an X-ray apparatus including a film holder and an X-ray source arranged in a line of sight for simultaneous rotation about a patient to radiograph a denture of the patient in said line of sight, in combination: a drive means for said film holder and X-ray source, a base, a platform laterally movable on said base and adapted to support said patient in a stationary position during the radiographing of said denture, means supporting said drive means for arcuate movement of the film holder and X-ray source with respect to the patient supported on said platform, a motor operatively connected to said platform for moving the same, switch means in circuit with said motor, whereby the motor is actuated when the switch means is closed at a predetermined point in the rotation of said film holder and X-ray source to move the platform laterally a predetermined distance to relocate the patient so that his spinal column is out of the line of sight between the film holder and X-ray source for completion of the radiographing of said denture, a disk driven by said motor through a gear train, and a bar connected at one end eccentrically to said disk and at the other end to said platform, whereby said platform is moved laterally during rotation of said motor, said disk having a cam face disposed to close said switch means at said predetermined point in the rotation of the film holder and X-ray source.

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2. In an X-ray apparatus including a film holder and an X-ray source arranged in a line of sight for simultaneous rotation about a patient to radiograph a denture of the patient in said line of sight, in combination: a drive means for said film holder and X-ray source, a base, a platform laterally movable on said base and adapted to support said patient in a stationary position during the radiographing of said denture, means supporting said drive means for arcuate movement of the film holder and X-ray source with respect to the patient supported on said platform, a motor operatively connected to said platform for moving the same, switch means in circuit with said motor, whereby the motor is actuated when the switch means is closed at a predetermined point in the rotation of said film holder and X-ray source to move the platform laterally a predetermined distance to relocate the patient so that his spinal column is out of the line of sight between the film holder and X-ray source for completion of the radiographing of said denture, said motor having field coils placed in circuit with an A.C. voltage source upon actuation of said switch means for operation of the motor, said field coils being normally in circuit with a D.C. voltage source for retaining the motor in an inoperative position during rotation of said film holder and X-ray source while radiographing said denture.

3. In an X-ray apparatus including a film holder and an X-ray source arranged in a line of sight for simultaneous rotation about a patient to radiograph a denture of the patient in said line of sight, in combination: a drive means for said film holder and X-ray source, a base, a platform laterally movable on said base and adapted to support said patient in a stationary position during the radiographing of said denture, means supporting said drive means for arcuate movement of the film holder and X-ray source with respect to the patient supported on said platform, a motor operatively connected to said platform for moving the same, switch means in circuit with said motor, whereby the motor is actuated when the switch means is closed at a predetermined point in the rotation of said film holder and X-ray source to move the platform laterally a predetermined distance to relocate the patient so that his spinal column is out of the line of sight between the film holder and X-ray source for completion of the radiographing of said denture, an A.C. voltage source, a D.C. voltage source, said D.C. voltage source being normally connected to field coils of said motor through said switch means to hold the motor in an inactive position during rotation of said film holder and X-ray source, said A.C. voltage source being connected to said field coils through said switch means to start rotation of said motor at said predetermined point in the rotation of said film holder and X-ray source.

4. In an X-ray apparatus including a film holder and an X-ray source arranged in a line of sight for simultaneous rotation about a patient to radiograph a denture of the patient in said line of sight, in combination: a drive means for said film holder and X-ray source, a base, a platform laterally movable on said base and adapted to support said patient in a stationary position during the radiographing of said denture, means supporting said drive means for arcuate movement of the film holder and X-ray source with respect to the patient supported on said platform, a motor operatively connected to said platform for moving the same, switch means in circuit with said motor, whereby the motor is actuated when the switch means is closed at a predetermined point in the rotation of said film holder and X-ray source to move the platform laterally a predetermined distance to relocate the patient so that his spinal column is out of the line of sight between the film holder and X-ray source for completion of the radiographing of said denture, an A.C. voltage source, a D.C. voltage source, said D.C. voltage source being normally connected to field coils of said motor through said switch means to hold the motor in an inactive position during rotation of said film holder and X-ray source, said

A.C. voltage source being connected to said field coils through said switch means to start rotation of said motor at said predetermined point in the rotation of said film holder and X-ray source, a disk driven by said motor, a bar connected between said disk and said platform for moving the platform laterally during rotation of the motor, another switch means controlled by said disk and connected in circuit with said A.C. and D.C. voltage sources, said other switch means being effective to apply the A.C. voltage to said motor to continue operation thereof after the cam driven by said drive means opens the first-named circuit.

5. In an X-ray apparatus including a film holder and an X-ray source arranged in a line of sight for simultaneous rotation about a patient to radiograph a denture of the patient in said line of sight, in combination: a drive means for said film holder and X-ray source, a base, a platform laterally movable on said base and adapted to support said patient in a stationary position during the radiographing of said denture, means supporting said drive means for arcuate movement of the film holder and X-ray source with respect to the patient supported on said platform, a motor operatively connected to said platform for moving the same, switch means in circuit with said motor, whereby the motor is actuated when the switch means is closed at a predetermined point in the rotation of said film holder and X-ray source to move the platform laterally a predetermined distance to relocate the patient so that his spinal column is out of the line of sight between the film holder and X-ray source for completion of the radiographing of said denture, an A.C. voltage source, a D.C. voltage source, said D.C. voltage source being normally connected to field coils of said motor through said switch means to hold the motor in an inactive position during rotation of said film holder and X-ray source, said D.C. voltage source being connected to said field coils through said switch means to start rotation of said motor at said predetermined point in the rotation of said film holder and X-ray source, a disk driven by said motor, a bar connected between said disk and said platform for moving the platform laterally during rotation of the motor, another switch means controlled by said disk and connected in circuit with said A.C. and D.C. voltage sources, said other switch means being effective to apply the A.C. voltage to said motor to continue operation thereof after the cam driven by said drive means opens the first-named circuit, said disk including a cam face operative to actuate said other switch means to reapply said D.C. voltage to said motor for braking the motor when said cam face contacts said other switch means, whereby movement of said platform is halted.

6. In an X-ray apparatus including a film holder and an X-ray source arranged in a line of sight for simultaneous rotation about a patient to radiograph a denture of the patient in said line of sight, in combination: a drive means for said film holder and X-ray source, a base, a platform laterally movable on said base and adapted to support said patient in a stationary position during the radiographing of said denture, means supporting said drive means for arcuate movement of the film holder and X-ray source with respect to the patient supported on said platform, a motor operatively connected to said platform for moving the same, switch means in circuit with said motor, whereby the motor is actuated when the switch means is closed at a predetermined point in the rotation of said film holder and X-ray source to move the platform laterally a predetermined distance to relocate the patient so that his spinal column is out of the line of

sight between the film holder and X-ray source for completion of the radiographing of said denture, an A.C. voltage source, a D.C. voltage source, said D.C. voltage source being normally connected to field coils of said motor through said switch means to hold the motor in an inactive position during rotation of said film holder and X-ray source, said A.C. voltage source being connected to said field coils through said switch means to start rotation of said motor at said predetermined point in the rotation of said film holder and X-ray source, a disk driven by said motor, a bar connected between said disk and said platform for moving the platform laterally during rotation of the motor, another switch means controlled by said disk and connected in circuit with said A.C. and D.C. voltage sources, said other switch means being effective to apply the A.C. voltage to said motor to continue operation thereof after the cam driven by said drive means opens the first-named circuit, said disk including a cam face operative to actuate said other switch means to reapply said D.C. voltage to said motor for braking the motor when said cam face contacts said other switch means, whereby movement of said platform is halted, said platform being mounted on flanged wheels, and rails mounted on said base and engaged by said flanged wheels for guiding lateral movement of said platform.

7. In an X-ray apparatus including a film holder and an X-ray source arranged in a line of sight for simultaneous rotation about a patient to radiograph a denture of the patient in said line of sight, in combination: a drive means for said film holder and X-ray source, a base, a platform laterally movable on said base and adapted to support said patient in a stationary position during the radiographing of said denture, means supporting said drive means for arcuate movement of the film holder and X-ray source with respect to the patient supported on said platform, a motor operatively connected to said platform for moving the same, switch means in circuit with said motor, whereby the motor is actuated when the switch means is closed at a predetermined point in the rotation of said film holder and X-ray source to move the platform laterally a predetermined distance to relocate the patient so that his spinal column is out of the line of sight between the film holder and X-ray source for completion of the radiographing of said denture, an A.C. voltage source, a D.C. voltage source, said D.C. voltage source being normally connected to field coils of said motor through said switch means to hold the motor in an inactive position during rotation of said film holder and X-ray source, said A.C. voltage source being connected to said field coils through said switch means to start rotation of said motor at said predetermined point in the rotation of said film holder and X-ray source, a disk driven by said motor, a bar connected between said disk and said platform for moving the platform laterally during rotation of the motor, another switch means controlled by said disk and connected in circuit with said A.C. and D.C. voltage sources, said other switch means being effective to apply the A.C. voltage to said motor to continue operation thereof after the cam driven by said drive means opens the first-named circuit, said disk being radially slotted, said bar being secured in the radial slot in said disk for adjustable positioning thereon.

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