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Ensslin et al.

[11] **3,906,227**

[45] **Sept. 16, 1975**

[54] **DENTAL X-RAY MACHINE**

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[73] Assignee: **Sybron Corporation,** Rochester, N.Y.

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[52] **U.S. Cl.** **250/320;** 250/444; 250/521; 250/523

[51] **Int. Cl.²** **G03B 5/17**

[58] **Field of Search** 250/320, 323, 439, 444, 250/445, 446, 447, 454, 456, 475, 478, 479, 490, 521, 522, 523, 525

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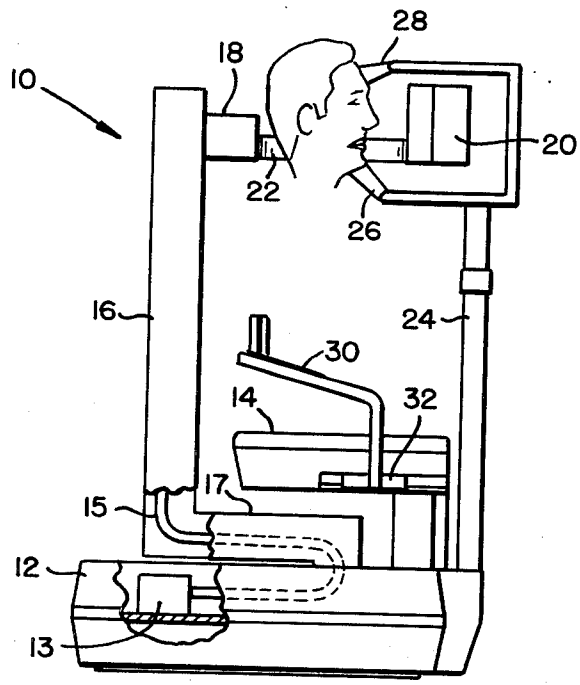
Primary Examiner—Davis L. Willis

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[57] **ABSTRACT**

A dental x-ray machine for taking a panoramic x-ray of a patient's dental arch having located beneath the seat of the patient chair, the apparatus for rotating the x-ray source and film holder around the head of the patient. Also located below the chair seat is a cam controlled X–Y drive for driving the rotating x-ray source and film holder through a predetermined closed path of travel which, together with the rotation of the x-ray source produces a net movement that approximates the curve of the dental arch. The size of the pattern traced by the X–Y drive is continuously variable for adapting the pattern to dental arches of all sizes.

18 Claims, 7 Drawing Figures



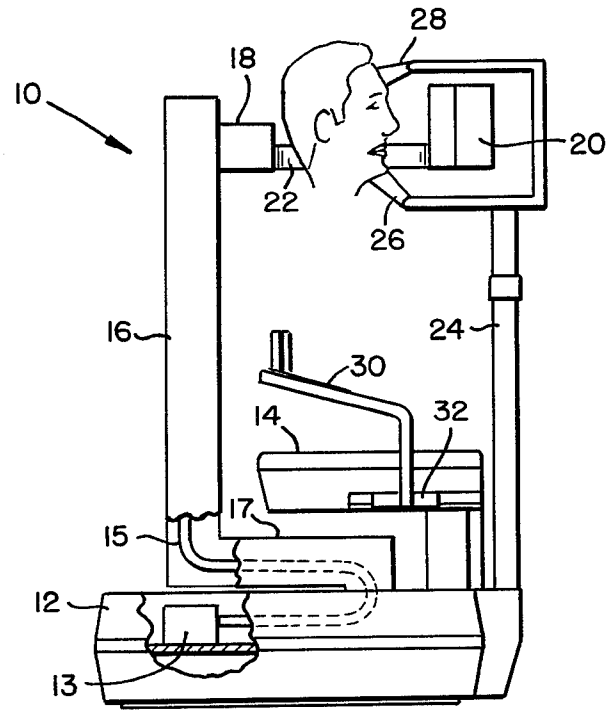

28
18
10
20
22
26
16
24
30
14
32
17
15
12
13
X

FIG. 1

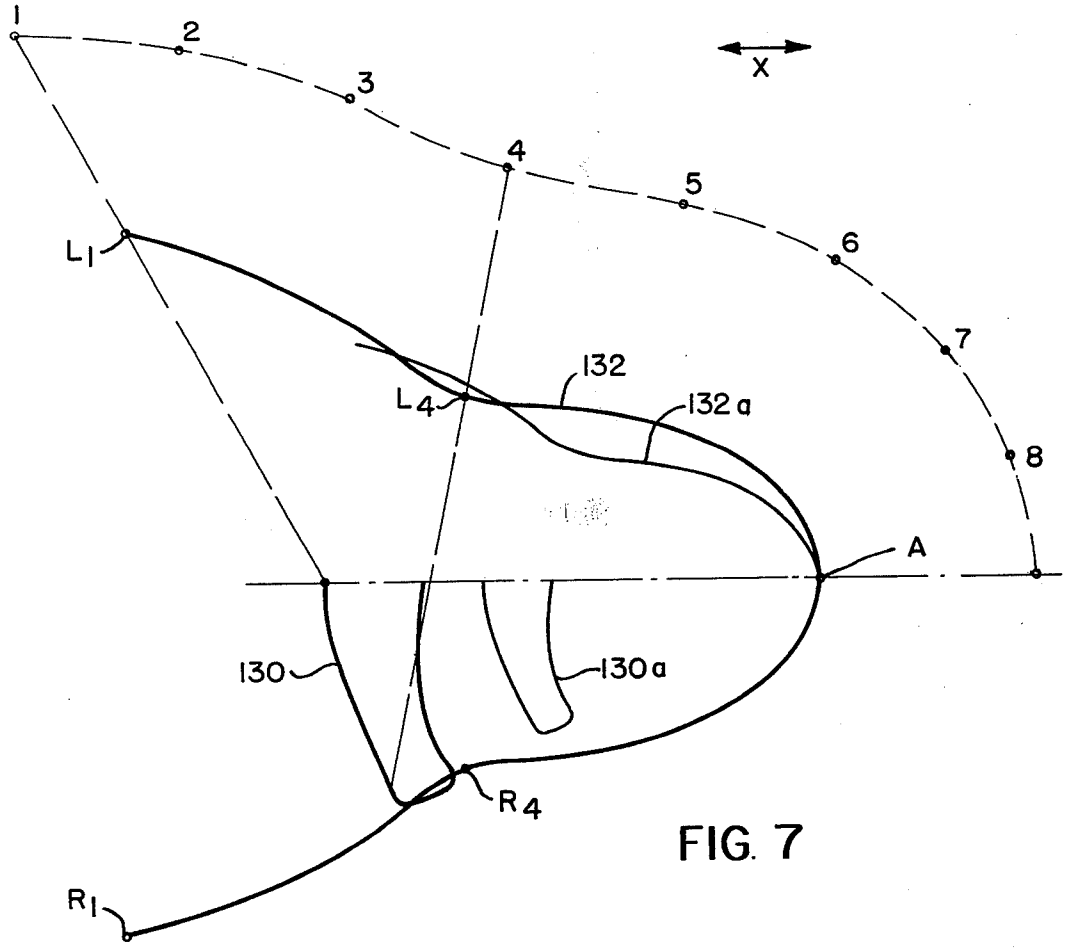

1
2
3
4
5
6
7
8
L1
L4
132
132a
A
130
130a
R4
R1

FIG. 7

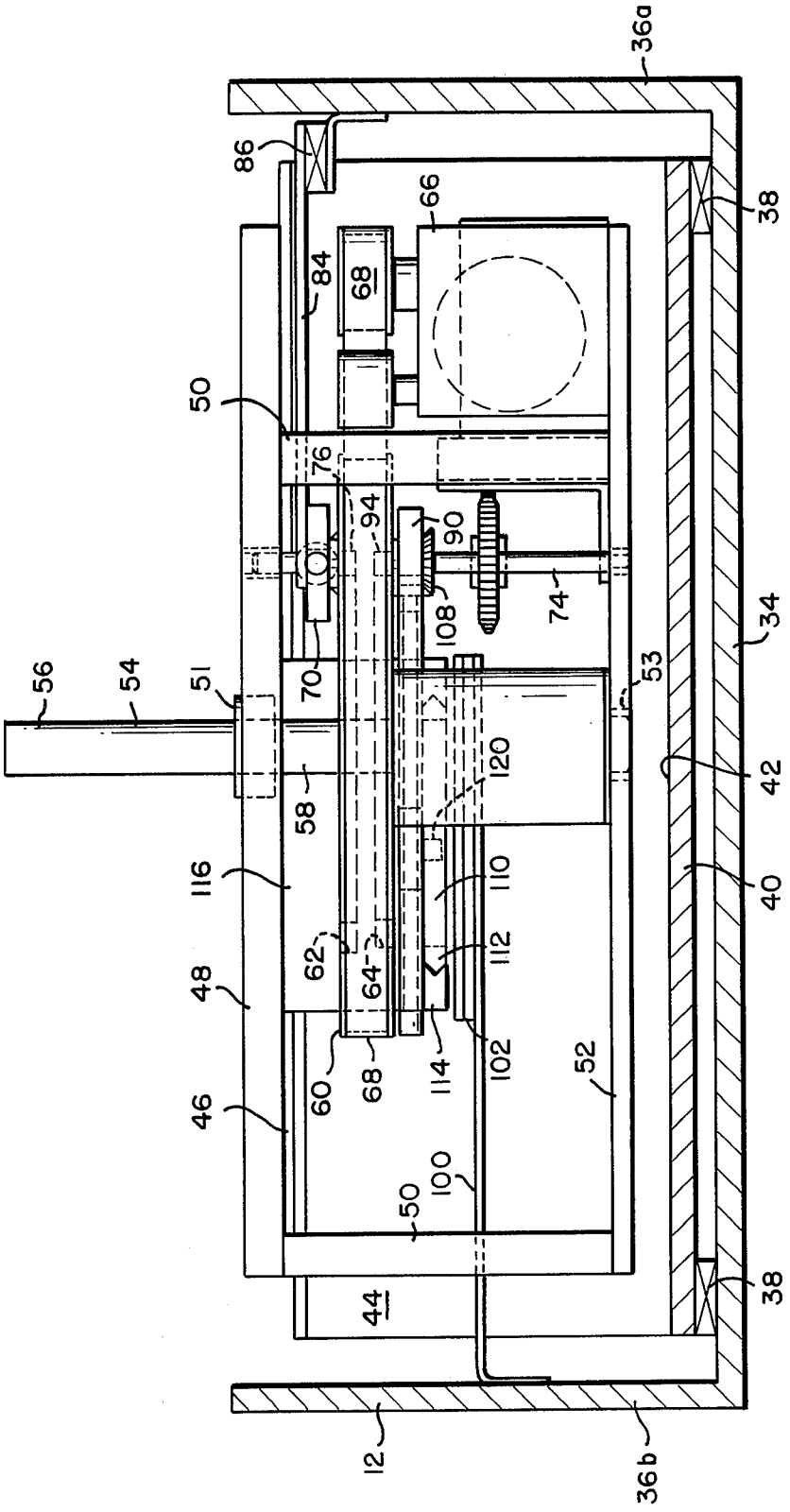

36a
86
66
38
84
68
50
76
94
90
74
108
34
56
54
51
70
53
120
42
58
116
110
40
62
64
112
48
Y
60
68
114
102
52
46
100
50
44
38
12
36b

FIG. 2

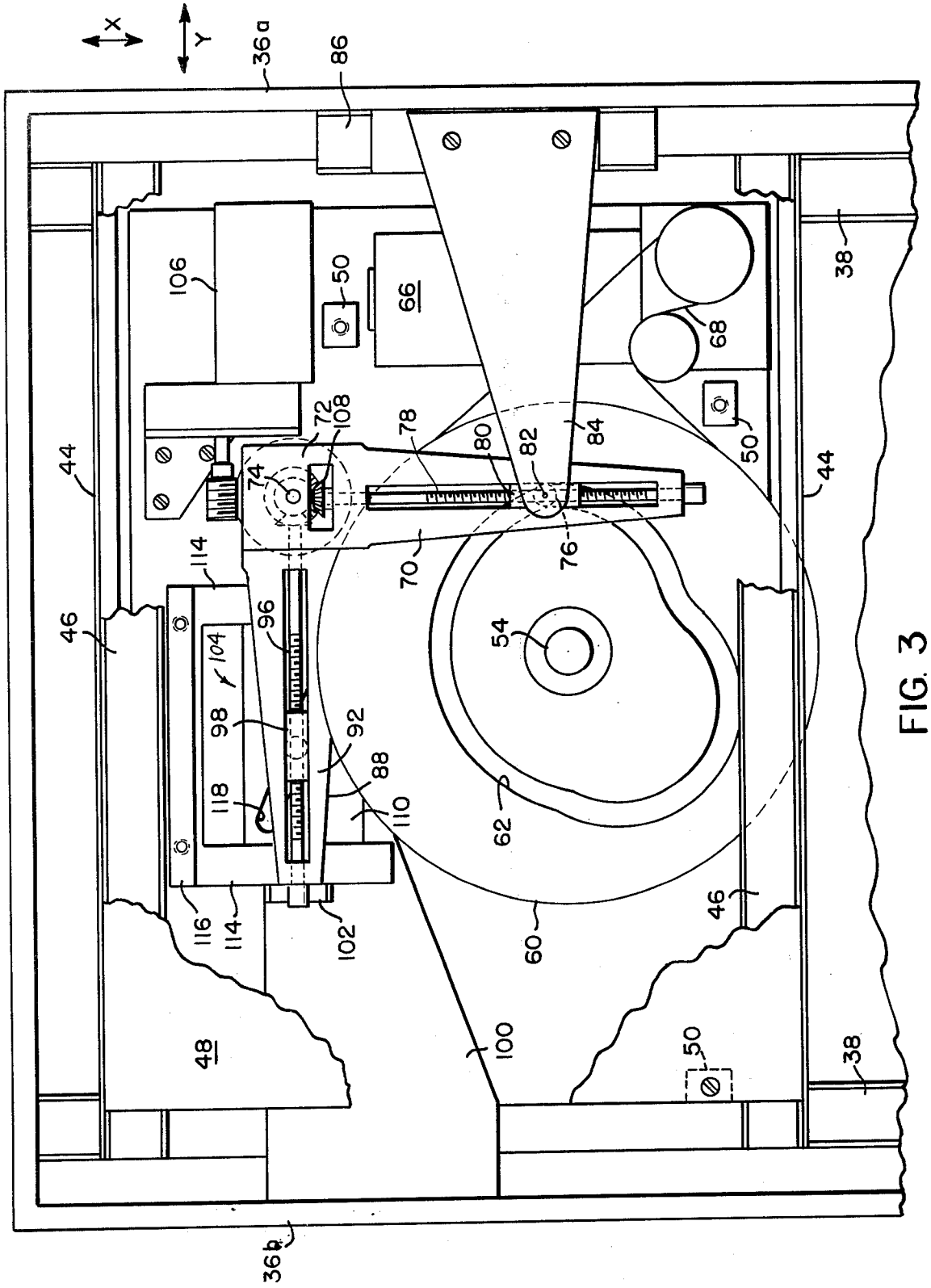

X
Y
36a
86
106
50
66
68
38
72
108
78
80
82
84
74
44
114
70
76
46
96
54
104
98
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88
118
110
62
116
114
102
60
46
48
100
50
38
36b

FIG. 3

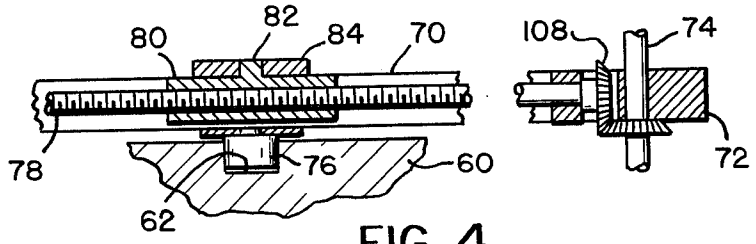


FIG. 4

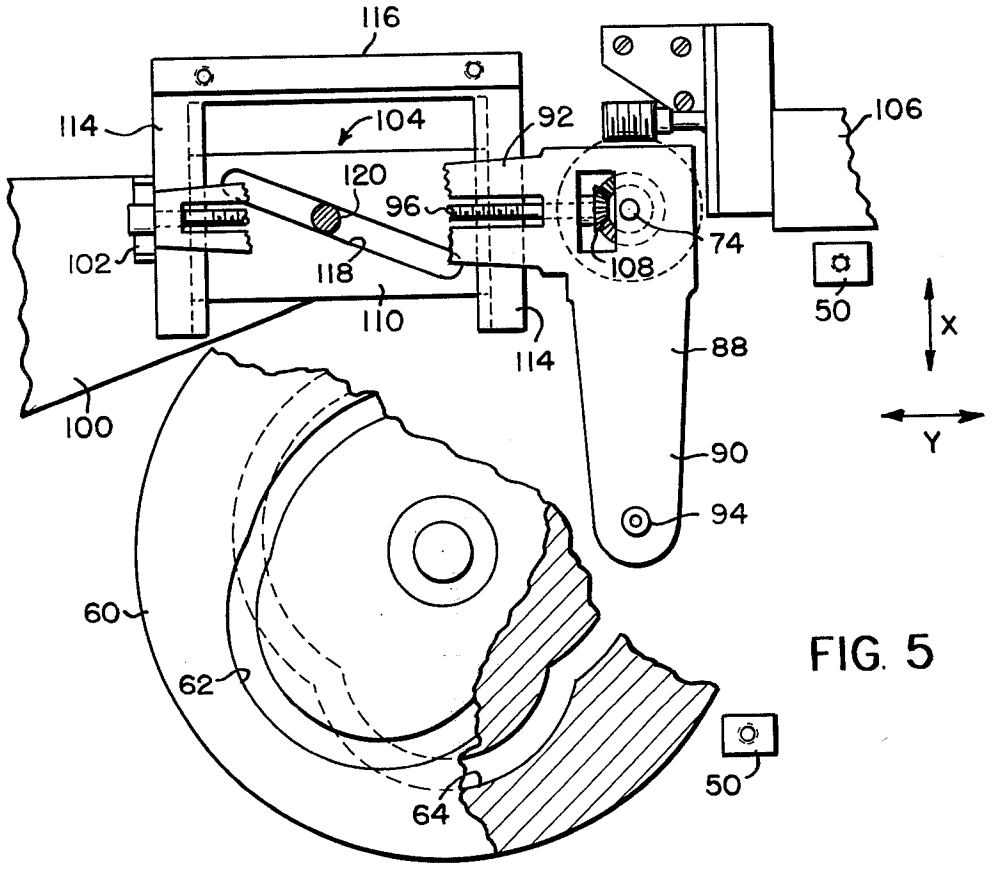


FIG. 5

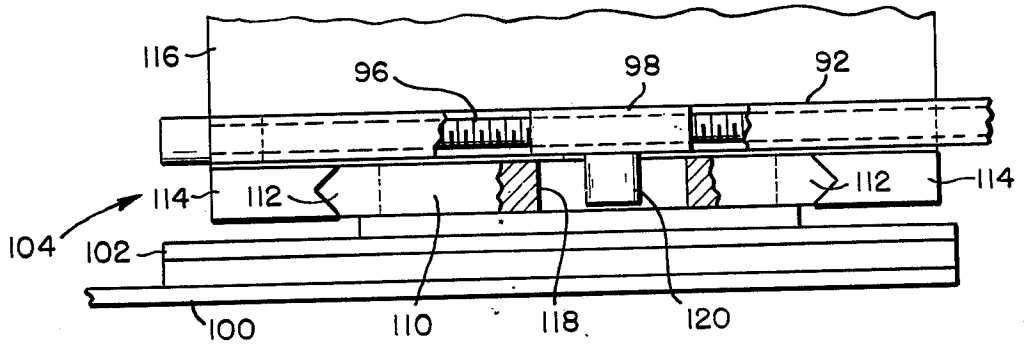


FIG. 6

DENTAL X-RAY MACHINE

BACKGROUND OF THE INVENTION

The present invention relates generally to a dental x-ray machine for taking a panoramic or full mouth x-ray of the patient's teeth. More specifically, the present invention relates to a dental x-ray for taking full mouth x-rays by rotating the x-ray source and x-ray film about the head of the patient through a path of travel which closely approximates the shape of the dental arch.

Various techniques and apparatus for taking a full mouth x-ray are well known in the art. When taking a full mouth x-ray, it is important that the x-ray source and film be moved about the head of the patient through a path of travel which closely parallels the dental arch with the depth of focus between the x-ray source and film following along a path on the dental arch. In this way, only the particular tooth being radiographed remains in focus. The difficulty is that the dental arch is not easily approximated so that systems of the prior art only generally followed the dental arch by rotation around a double or triple center of rotation or utilized and ellipsograph-type drive to move the x-ray source and film around the outline of an ellipse. Other systems required that the patient be moved laterally in order to change the center of rotation or stepped the drive through several centers of rotation in an attempt to approximate the shape of the dental arch.

The size of the dental arch varies from patient to patient and with the exception of the ellipsograph type drive, the apparatus of the prior art could only adjust the pattern size in very coarse steps requiring considerable effort on the part of the operator.

Prior art panoramic x-ray machines also located the drive mechanism as well as the high voltage power supply for the x-ray source above the head of the patient. This required relatively massive support columns and in some cases the structure had to be wall mounted to prevent toppling of the top heavy apparatus. Wall mounting is also necessary in order to dampen any vibration produced by the drive as such vibrations will reduce the quality of the x-ray picture. Vibrations are caused, in particular, by drives of the prior art in which the mechanism is stepped from one center of rotation to another.

The x-ray of the present invention overcomes the drawbacks of the prior art by locating an X–Y drive mechanism and the high voltage power supply in the base of the apparatus beneath the seat of the patient chair thus avoiding any massive overhead structure and the need for wall mounting. The X–Y drive mechanism is controlled by a cam which produces a smooth motion and this motion, when coupled with rotation of the x-ray source and film holder about the head of the patient, produces a net movement which allows the focal plane between the x-ray source and film to follow along the shape of the dental arch. The cam drive also allows the size of the pattern to be quickly and easily changed in an infinite number of steps over the entire adjustment range.

Another feature of the present invention is an automatic apex adjustment which displaces the x-ray axis of rotation towards or away from a fixed reference point whenever the pattern size is respectively decreased or increased. This allows positioning both the addult and child patient at the same fixed reference point corresponding to the front of the patient's mouth so that the x-ray source and film holder will be properly oriented to the patient regardless of his or her size.

SUMMARY OF THE INVENTION

The present invention may be characterized in one aspect thereof by the provisions of a fixed base supporting a patient chair; a platform carried on the base beneath the seat of the patient chair and supported for movement through a closed path of travel in an *x–y* plane; a column upstanding from the platform and rotatable about a vertical axis, the upper portion of the column supporting the x-ray source and a film holder for movement about the head of the patient; and means on the platform cooperating with the fixed base for both rotating the column and moving the platform along a closed curved path of travel in an *x–y* plane, the rotation of the column and the movement of the platform together producing a net movement of the x-ray source and a film holder along the path of travel which closely parallels the dental arch of the patient seated in a chair.

OBJECTS OF THE INVENTION

One object of the present invention is to provide a dental x-ray apparatus for taking a full mouth x-ray, including the mandibular joints, in which the motion of the x-ray source and film holder about the head of the patient closely follows along a path paralleling the shape of the patient's dental arch.

Another object of the present invention is to provide a dental x-ray apparatus wherein the size of the pattern followed by the x-ray source and film holder about the head of the patient is quickly and easily adjusted.

A further object is to provide a panoramic dental x-ray apparatus wherein the means for controlling the rotation of the x-ray source and film holder about the head of the patient as well as the means for moving the axis of rotation is located in the base of the apparatus beneath of the seal of the patient chair.

Still another object is to provide a panoramic dental x-ray system wherein the high voltage power supply for the x-ray source is located in the base of the apparatus, the power supply being cable connected to the x-ray source located at a distance from the power supply.

Yet another object is to provide a panoramic dental x-ray machine which is a self contained unit requiring no installation or wall supports.

A still further object of the present invention is to provide an *x–y* drive for a dental x-ray having an automatic apex adjustment which shifts the x-ray axis of rotation as the size of the pattern traversed by the x-ray source and film is changed.

These and other objects, advantages and characterizing feature of the present invention will become more apparent upon consideration of the following detailed description thereof when taken in connection with the accompanying drawings depicting the same.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevation view showing the dental x-ray apparatus of the present invention;

FIG. **2** is a front elevation view of the apparatus base, partly away and in section, showing the X–Y drive on an enlarged scale;

FIG. **3** is a plan view of the X–Y drive with portions removed for clarity;

FIG. 4 is an elevation view on an enlarged scale of a portion of the Y-reaction arm of the drive;

FIG. 5 is a view similar to FIG. 3 with still further portions removed for clarity to show the X-reaction arm and apex adjustment mechanism;

FIG. 6 is an elevation on an enlarged scale of an apex compensating mechanism associated with the X-reaction arm; and

FIG. 7 is a plot showing the X–Y drive path of travel and the net movement generated by the apparatus when taking an x-ray of a large and a small detal arch.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, FIG. 1 shows the x-ray apparatus of the present invention generally indicated at **0.** The apparatus includes a supporting base **12,** a patient chair **14** carried by the base, and a column **16** upstanding from the base and supported for rotation about a vertical axis passing generally through the seat of the patient chair. Column **16** is generally L-shaped wherein the horizontally deposed leg **17** passes beneath the seat of the chair. At the top of column **16** is an x-ray source **18** and an x-ray film cassette **20.** The cassette is supported on a curved outwardly extending horizontal arm **22,** so that the patient to be x-rayed can be positioned between the x-ray source and the film cassette. The upright structure indicated at **24** at the front of the dental chair and the chin and forehead rests **26, 28** respectively are used for properly positioning the patient. It should be appreciated, that the chin and forehead rests define a fixed reference point for properly positioning the head of the patient for the x-ray procedure. In order to bring patients of different sizes to this reference point, chair **14** can be raised or lowered and the backrest **30** moved on ways **32** front-to-back of the chair.

A transformer **13** and other electrical components for activating the x-ray source are located within base **2** at any convenient location, preferably at a rear portion thereof. A flexible electrical cable **15** extends from the transformer and passes up through column **16** (including leg **17**) for connecting the power supply to the x-ray source.

Disposed within base **12** is the means for rotating the column about its vertical axis and for moving the axis of rotation through a closed path of travel in the X–Y plane. As shown in FIG. **2,** base **12** is generally U-shaped in cross-section having a horizontal base leg **34** and upstanding sides **36** *a* and *b*. The base or horizontal leg **34** is adapted to rest on a floor surface and is provided with a pair of spaced parallel ways **38** which are oriented along the X axis of the base, that is, front-to-back. Slidably carried on these ways is a carriage **40.** Carriage **40** is also U-shaped in cross-section having base **42** and upstanding front and rear wall members **44,** only the rear one of which is shown in FIG. **2.** The carriage in turn, carries adjacent the upper end of each wall **44** a pair of parallel ways **46.** Ways **46** are oriented normal to ways **38** and are aligned generally along the Y-axis of base **12** or side-to-side. Slidably carried on ways **46** is a platform **48.** Due to the orientation of ways **38** and **46,** it should be apparent that platform **48** can be moved along both the X and Y axis of base **12.** Suspended from platform **48** are a plurality of columns **50** which in turn support a plate **52** in spaced relationship from platform **48.** Disposed between the platform and the plate and carried in part by the plate are the various mechanisms for driving the platform through a closed path of travel in the X–Y plane.

As shown in FIG. **2,** an upright shaft **54** is supported by and is journaled to platform **48** and plate **52** by means of bearings **51, 53** respectively. With this arrangement, the shaft is free to rotate about its vertical axis while the axis is being transported through a closed path of travel in the X–Y plane. It should be appreciated that the horizontal leg **17** of column **16** is fixed at one end to the portion **56** of the shaft located above platform **48.** The portion **58** of the shaft located between platform **48** and plate **52** is fixed to a cam member **60.**

The cam is generally disc-shaped having endless grooves **62** and **64** cut into the top and bottom surfaces respectively of the disc. These grooves comprise the cam surfaces for programming the motions of the platform as further set out herein below.

A drive motor **66** fixed to plate **52** rotates the cam and therefore, shaft **54** by means of a drive belt **68** which engages around the periphery of the cam.

In order to translate the movement of cam surfaces **62, 64** into motion of platform **48** through a closed path of travel in the X–Y plane, a cam follower is associated with each of the cam grooves. In this respect, cam groove **62** and its associated cam follower cooperate to move platform **48** through the Y component of travel (side-to-side) whereas cam groove **64** and its associated cam follower cooperate to move platform **48** through the X component of travel (front-to-back). The net result is movement of platform **48** through a closed path of travel in the X–Y plane.

CONTROL OF Y COMPONENT

Referring to FIGS. **2, 3** and **4** the cam follower associated with groove **62** includes a horizontal pick-off arm **70,** which is journaled at one end **72** to platform **48** by means of a vertical shaft **74** extending between the platform and plate **52** (FIG. **2**). Fixed to pick-off arm **70** at a given point along the arm is a cam follower **76,** best seen in FIG. **4,** which rides in cam groove **62.** The distance between cam follower **76** and shaft **74** is a fixed dimension and as the cam rotates under the fixed cam follower, the pick-off arm rocks about its journaled end **72** depending upon the radial distance of the cam groove from shaft **54.**

As shown in FIGS. **3** and **4,** pick-off arm **70** is provided with a lead screw **78** which drives a nut **80** along the arm to increase or decrease respectively the linear distance of the nut from shaft **74.** Upstanding from nut **80** is a pin **82** which is in turn, journaled to one end of a rigid reaction arm **84.** The other end of reaction arm **84** is slidably mounted on a way **86** carried at the top of upstanding base side **36***a*, way **86** being alligned generally parallel to ways **38** (FIGS. **2** and **3**).

With this arrangement, reaction arm **84** is free to move along the X-axis of the base, but is fixed against movement in the Y direction. Thus, as cam disc **60** is rotated and the radial distance of cam groove **62** changes with respect to shaft **54,** the reaction arm will force platform **48** to move to the left or the right as viewed in FIGS. **2** and **3.** For example, as the radial distance of cam groove **62** from shaft **54** increases, the entire mechanism supported by platform **48** will shift to the left as viewed in FIG. **3** and conversely, will shift to

the right as viewed in FIG. 3 when the radial distance decreases. Moreover, as described more fully hereinbelow the effect of the throw of the cam groove **62** can be increased or decreased proportionally by moving nut **80** respectively away from or towards, shaft **74** in order to change the overall size of platform movement in the Y direction.

CONTROL OF X COMPONENT

A somewhat similar arrangement is provided for translating the rotational movement of cam groove **64** into movement of platform **48** along the X axis of base **12.** In this respect, FIG. **5** is a plan view of the X–Y mechanism similar to FIG. **3** only with some parts removed for clarity, such as pick-off arm **70,** reaction arm **84** and portions of cam disc **60.**

FIG. **5** shows a second, generally L-shaped pick-off arm **88** having legs **90** and **92.** At one end of the pick-off arm (leg **90**) is a cam follower **94** which extends up into cam groove **64** cut into the bottom surface of cam disc **60.** Pick-off arm **88** is also journaled intermediate its ends to vertical shaft **74** so that the distance from the shaft to cam follower **94** is a fixed distance. The other leg **92** of the L-shaped pick-off arm carries a lead screw **96** which in turn drives a nut **98** (FIG. **3**). The adjustment of this nut along leg **92** accomplishes a result similar to the adjustment of nut **80** along pick-off arm **70.** In other words, such movement will either scale up or down the effect of a throw of cam groove **64** depending upon whether the nut is moved respectively away from or towards shaft **74.**

Extending horizontally from upstanding side **36***b* of the base is a fixed member **100** only a portion of which is shown in FIG. **5.** Since this member is fixed to side **36***b*, it represents a ground station. A way **102** is carried on member **100,** the way being oriented generally parallel to ways **46** and normal to ways **38** (FIGS. **2** and **3**). Slidably carried on way **102** is an apex adjustment means generally indicated at **104.** While this means will be described more fully herein below, it is sufficient for the present merely to say that the apex adjustment means **104** is also pinned to nut **98** so that it is similar in one aspect to reaction arm **84.** That is, means **104** is free to slide with the X–Y drive mechanism in either direction along the Y axis of base **12,** but it is fixed by member **100** against movement in the X direction. Thus, any variation in the radial distance of cam groove **64** from shaft **54** is translated into movement of platform **48** in the X direction. For example, as the radial distance decreases, the L-shaped pick-off arm **88** will rock clockwise about shaft **74** causing the platform **48** to shift toward the top of the Figure as view in FIGS. **3** and **5** which is towards the back of the apparatus. Conversely, any increase in the radial distance of the cam groove **64** from shaft **54** will cause the L-shaped arm to rock counter-clockwise about shaft **74** causing the platform to shift direction towards the bottom of the Figure as view FIGS. **3** and **5** which is toward the front of the apparatus.

Thus, the mechanism described herein above cooperates in response to rotation of cam disc **60** to move platform **48** and therefore, the axis of rotation of column **16** in a closed path of travel in the X–Y plane. As column **16** is connected to shaft **54,** rotation of cam **60** will likewise, rotate the column. For example, the path of travel generated by the X–Y drive is shown in FIG. **7** at **130.** Only one half the curve is shown and it should be understood that the missing portion is a mirror image of that shown. It should be appreciated that reference **130** represents the path of travel of shaft **54** and therefore, the axis of rotation of column **16.** The curve **132** in heavy solid line represents a locus of points within the depth of focus and includes both the mandibular joints and the dental arch. Points **1–8** represent various positions of the x-ray film during the x-ray procedure and are along a path generally parallel to the dental arch. The position of the x-ray source, while not shown is understood to be on the far side of the axis of rotation from points **1–8.** From FIG. **7,** it should be apparent that the rotational movement of the column, when associated with the movement in the X–Y plane of platform **48** from which the column upstands, produces a net movement of the x-ray source **18** and film cassette **20** along a path of travel which parallels the dental arch. As shown by heavy solid line **132** in FIG. **7,** the x-ray is taken starting at the left mantibular joint L_1. It then moves inward to x-ray the last molar L_4 on the left side and then along the dental arch to the last molar R_4 on the right side of the mouth and then outward to x-ray the right mandibular joint R_1.

CHANGE OF X–Y PATTERN SIZE

As previously stated, the size of the pattern traveled by the platform can be changed by moving the points of the pick-offs defined by nuts **80** and **98.** This is accomplished by the simultaneous rotation of lead screws **78** and **96** to move the nuts toward or away from shaft **74.** For this purpose, a second drive motor **106** is mounted on plate **52** (FIGS. **3** and **5**). When actuated, this motor drives both lead screws through a system of bevel gears **108.** Actuation of the motor can be accomplished by any suitable means (not shown) such as a hand controller. It should be appreciated that such an arrangement allows an infinite adjustment of the pattern size within the full limits of the adjustment range.

As the pattern size is adjusted, it is important that a common reference point be maintained for all pattern sizes. Preferably, this common point is located at the front of the dental arch, as defined, for example, by the chin and head rests **26, 28** respectfully, at the front of the dental chair which are used for properly positioning the patient. For example, FIG. **7** shows at **130** a path of travel as may be generated by the mechanism for making a full mouth dental x-ray of the dental arch of an adult. Reference **130***a* line shows a smaller, symmetrical, pattern of the path generated for making an x-ray of a younger person whose dental arch is included in the light solid line curve shown at **132A.** The point indicated at A is common to both patterns and is located at the front or apex of the dental arch. Thus, when the size of the pattern is changed, it is necessary to provide an adjustment which maintains the position of point A. This is accomplished by an apex adjuster which shifts the X–Y path of travel towards point A when a child is in the chair and away from point A when a adult is in the chair.

APEX ADJUSTMENT

The apex adjuster generally indicated at **104** can be seen in plan view in FIGS. **3** and **5,** and in elevation view in FIGS. **2** and **6.** As described hereinabove, there is a way **102** mounted on member **100,** which in turn is attached to the ground of the apparatus. Also as previous stated, way **102** is oriented parallel to ways **46**

d normal to way **38** (FIG. **3**). Slidably mounted on ıy **102** is a block **110.** The ends **112** of the block IG. **6**) are mitered and slidably fit into a pair of hori-ntal side supports **114.** Supports **114** extend in canti-/er fashion from a mounting bracket **116** which pnds from platform **48** (FIGS. **2** and **3**). With the ar-ngement described thus far, it should be appreciated at block **110** is free to slide with platform **48** in the direction of the chair, but that the block, being on ıy **102,** is fixed from sliding in the X direction. How-er, due to the sliding relationship between block **110** d side supports **114,** the supports and platform **48** n slide with respect to the block in the X direction. To accomplish the apex adjustment, which requires ɔvement in the X direction or front-to-back, FIGS. **5** d **6** show that block **110** contains a diagonal cam ɔove **118** which slidably retains a follower **120.** The llower depends from nut **98** and is therefore tied, via ; **92** and shaft **74,** to platform **48** with the screw per-tting an adjustment of the nut with respect to the ıtform. Cam groove **118** is oriented generally on the ıgonal of block **110** to accomplish the apex adjust-ɛnt as set out hereinbelow.

As previously stated, rotating screw **96** to move nut with respect to platform **48** to the left or the right viewed in the Figures, will respectively increase or crease the size of the X component at the pattern. ovement of the nut will in turn drive follower **120** ainst one side or the other of inclined slot **118.** The essure of follower **120** against the side of slot **118** nnot be relieved by a corresponding movement of ıtform **48** in the Y direction as movement in the Y rection is prevented by reaction arm **84.** Conse-ently, such pressure is relieved by follower **120** rid-ɛ up or down the inclined slot as viewed in FIGS. **3** d **5.** As follower **120** is tied to platform **48,** move-ɛnt of the follower in the X direction produces a like ɔvement of platform **48,** wherein the platform, acket **116** and side supports **114** slide over block **110** the X direction.

By way of example, if nut **98** is moved to the left, as ɛwed in the Figures, to increase the size of the pat-ɛn, follower **120** will be forced up the inclined slot **8** (FIGS. **3** and **5**) moving platform **48** towards the ck of the apparatus and away from the reference de-ed by chin and head rests **26, 28** respectfully. If the t moves in the opposite direction to decrease the pat-ɛn size, follower **120** will be forced down the inclined ıt moving platform **48** towards the reference point fined by the chin and headrests. Such movement ɯards and away from the chin and headrests main-ns the key position of the apex of the pattern at point (FIG. **7**) as the pattern size is changed.

Thus, it should be appreciated that the present inven-n accomplishes its present objects in providing a ntal x-ray apparatus for taking full mouth x-rays ıich is a self-contained unit requiring no installation wall support. The apparatus has the capability of ıking an infinite adjustment of the size of the pattern lowed by the x-ray source and the film holder about ɛ head of the patient. Such change in the pattern size ıccomplished quickly and easily while maintaining a mmon reference point with respect to all of the pat-ɛn sizes. The majority of the weight of the apparatus, ıde up by the transformer and other electrical com-nents and the X–Y drive mechanism, is located in ɛ base of the apparatus, so the apparatus can be made free standing and there is no need to wall supports for mounting the apparatus.

Since the present invention concerns primarily the general arrangement of the x-ray apparatus together with X–Y drive and apex adjustment as described herein, no mention is made of other features well-known in the art which are essential to the operation of a pantographic dental x-ray machine of the type described. For example, it is well-known that as column **16** is rotated about a patient, means must be provided to accomplish an independent rotation of x-ray film cassette **20** in order to achieve proper exposure of the x-ray film. The rotation must be in a particular time sequence with the movement of arm **16,** but as such a mechanism forms no part of the present invention, none has been described herein and the apparatus to accomplish this has been omitted from the drawing for purposes of simplification.

Having thus, described the invention in detail, what is claimed as new, is:

1. Dental X-ray apparatus of the type for taking a full mouth X-ray comprising:

a. a base adapted to rest on a floor surface;

b. a patient chair on said base and means for holding the head of the patient at a defined reference point;

c. platform supported for movement relative to said base in a X–Y plane beneath the seat of said patient chair:

d. a generally L-shaped column having a horizontal leg extending beneath said seat with one end of said leg being mounted to said platform for rotation about a vertical axis passing generally through the seat of said patient chair, the upstanding portion of said column extending to a point above said patient chair;

e. a horizontal arm extending outward from said column over said patient chair;

f. an X-ray source in said column and an X-ray film holder on the outward end of said horizontal arm in line with said X-ray source;

g. a power supply in said base connected to said X-ray source by flexible cable means extending through said column;

h. first drive means carried by said platform for rotating said column and therefore said X-ray source and film holder about said vertical axis, whereby said X-ray source and film holder orbit the head of a patient positioned at said reference point; and

i. second X–Y drive means carried by said platform and cooperating with said base for moving said platform uninterruptedly along a closed curved path of travel in an X–Y plane, which movement when associated with the rotation of said column produces a net orbital movement of said X-ray source and film holder along a path of travel which parallels the dental arch.

2. X-ray apparatus as in claim **1** comprising a carriage mounted for movement along a first axis of said base, said platform being mounted on said carriage for movement along a second axis of said base.

3. X-ray apparatus as in claim **1** wherein said second X–Y drive means comprises:

a. a rotatable cam member journaled to said platform;

b. first force transmitting means engaging said cam freely movable along a first axis of said base and fixed with respect to a second axis of said base for

moving said platform along said second axis of said base responsive to the rotation of said cam; and

c. second force transmitting means engaging said cam freely movable along said second axis and fixed with respect to said first axis of said base for moving said platform along said first axis of said base responsive to the rotation of said cam.

4. X-ray apparatus as in claim **3** wherein said cam is disc-shaped having a cam surface in each face thereof, each of said force transmitting means including a cam follower engaging one of said cam surfaces.

5. X-ray apparatus as in claim **4** wherein said cam surfaces are formed by an endless groove in each face of said cam, each groove defining a motion component along a axis of said base.

6. X-ray apparatus as in claim **3** including a vertical shaft journaled to and extending through said platform, the portion of said shaft above said platform being connected to and forming the vertical axis of rotation of said column and the portion of said shaft below said platform mounting and forming the axis of rotation of said cam.

7. X-ray apparatus as in claim **3** wherein said first and second force transmitting means are simultaneously adjustable for changing the size but not the shape of said closed curved path of travel through which said platform is moved.

8. Apparatus as set forth in claim **7** including apex adjustment means for shifting the axis of rotation of said shaft towards or away from said defined reference point as the shape of said closed path of travel is respectively decreased and increased.

9. X-ray apparatus as in claim **3** wherein said first force transmitting means comprises:

a. a shaft depending from said platform;

b. a first pick-off arm having one end journaled to said shaft;

c. a cam follower on said pick-off arm engaged with said cam;

d. a rigid reaction arm connected to said pick-off arm, said reaction arm being freely movable along an X axis of said base and fixed against movement along a Y axis of said base.

10. X-ray apparatus as in claim **9** wherein said second force transmitting means comprises:

a. a L-shaped pick-off arm journaled intermediate its ends to said shaft;

b. a second cam follower on one leg of said L-shaped pick-off arm engaged with said cam; and

c. a second reaction arm connected to the second leg of said L-shaped pick-off arm, said second reaction arm being freely movable along a Y axis of said base and fixed against movement along an X axis of said base.

11. X-ray apparatus as in claim **10** including:

a. a lead screw on said first pick-off arm and on the second leg of said L-shaped pick-off arm;

b. a nut driven by each screw along said arms towards and away from said shaft;

c. said reaction arms being connected to the nut on their respective pick-off arms; and

d. means for simultaneously rotating said screws to drive said nuts in concert toward or away from said shaft to vary the nut-cam follower distance and change the effect of the throw of said cam.

12. X-ray apparatus as in claim **11** including:

a. a way oriented parallel to the second leg of said L-shaped pick-off arm;

b. a block slidably mounted on said way;

c. a mounting bracket depending from said platform;

d. a pair of side supports extending from said bracket and slidably engaging said block, said side supports permitting movement of said platfrom over said block in a direction normal to said way and said way permitting movement of said block and platform in a direction parallel to said way; and

e. means connecting said block and the nut on the second leg of said L-shaped pick-off arm for moving said platform over said block as said nut is moved to change the throw of said cam.

13. X-ray apparatus as in claim **12** wherein said block has a generally diagonal cam groove therein and said means connecting said block and nut includes a follower connected to said nut and riding in said cam groove.

14. Dental X-ray apparatus of the type for taking a full mouth X-ray by orbiting an X-ray source and X-ray film holder about the head of a patient along an orbital path which follows the shape of the patient's dental arch, and apparatus comprising:

a. a fixed base supporting a patient chair;

b. a platform movable with respect to said base and chair through a closed path of travel in an X–Y plane beneath said chair;

c. a column upstanding from said platform supporting said X-ray source and X-ray film holder, said column being rotatable about a vertical axis of rotation while being transported through said closed path of travel by said platform such that said X-ray source and X-ray film holder are orbited about the head of a patient through an orbital path which parallels the shape of the dental arch; and

d. X–Y drive means carried by said platform and cooperating with said base for moving said platform with respect to said base through said closed path of travel, said X–Y drive means including a rotatable cam carried by said platform and a pair of reaction arms extending between said cam and base, each of said reaction arms being freely movable with respect to said base along one axis thereof and fixed with respect to said base along another axis thereof, the throw of said cam during the rotation thereof forcing said reaction arms to move said cam and therefore said platform with respect to said base through said closed path of travel.

15. X-ray apparatus as set forth in claim **14** wherein said cam is disc-shaped having an endless cam groove in both the top and bottom surfaces thereof defining respectively the X and Y components of motion of said platform, and each of said reaction arms being associated with a cam follower engaged in one of said cam grooves.

16. X-ray apparatus as in claim **15** including a vertical shaft depending from said platform, said X–Y drive means including:

a. a pick-off arm having one end journaled to said shaft, one of said cam followers being fixed to said arm;

b. a lead screw and nut on said pick-off arm, said screw being rotated for driving said nut along said pick-off arm towards and away from said shaft; and

c. one of said reaction arms being journaled at one end of said nut, the movement of said nut towards

and away from said shaft acting to decrease and increase respectively the throw of said cam.

17. X-ray apparatus as in claim **15** including a vertical shaft depending from said platform, said X–Y drive means including:

a. an L-shaped pick-off arm journaled intermediate its ends to said shaft, one of said cam followers being fixed on one leg of said L-shaped pick-off arm;

b. a led screw and nut on said second leg of said L-shaped pick-off arm, the rotation of said led screw driving said nut along said leg towards and away from said shaft;

c. a pin on said nut; and

d. means including one of said reaction arms journaled to said pin, the movement of said nut towards and away from said shaft acting to decrease and increase respectively the throw of said cam.

18. Dental X-ray apparatus of the type for taking a full mouth X-ray comprising:

a. a base adapted to rest on a floor surface;

b. a patient support means on said base including means for holding the head of a patient at a reference point;

c. a platform supported on said base for movement relative to said base through a closed path of travel in an X–Y plane beneath said patient support means;

d. an X-ray source and film holder, said source and film holder being spaced and in line and rotatable about a vertical axis upstanding from said platform so as to orbit the head of a patient held at said reference point;

e. means for moving said platform through said closed path of travel while rotating said X-ray source and film holder about said vertical axis, the rotational movement of said X-ray source and film holder together with the movement of said vertical axis producing a net movement of said X-ray source and film holder along a path of travel which parallels the dental arch of a patient's head held at said reference point;

f. means for symmetrically changing the size of said closed path of travel; and

g. means for translating said platform towards and away from said reference point as the size of said path of travel is respectively decrease and increased.

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