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Hozumi

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[54] **APPARATUS FOR RADIOGRAPHING THE JOINTS OF THE JAWS**

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[52] **U.S. Cl.** **250/320**, 250/446, 250/491, 250/323

[51] **Int. Cl.** **G03b 41/16**

[58] **Field of Search** 250/446, 456, 491, 320, 250/323

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[57] **ABSTRACT**

An apparatus for radiographing the joints of the jaws, wherein a film is supported at one lateral side of a patient's face and an X-ray source is provided at the opposite lateral side thereof. As the X-ray source projectes X-rays onto the film, it is moved relative to the film, so that a substantially stationary and consequently clear image of that one of the joints at the side of the film is formed thereon against a much more blurred image formed thereon of the other joint at the side of the X-ray source.

19 Claims, 6 Drawing Figures

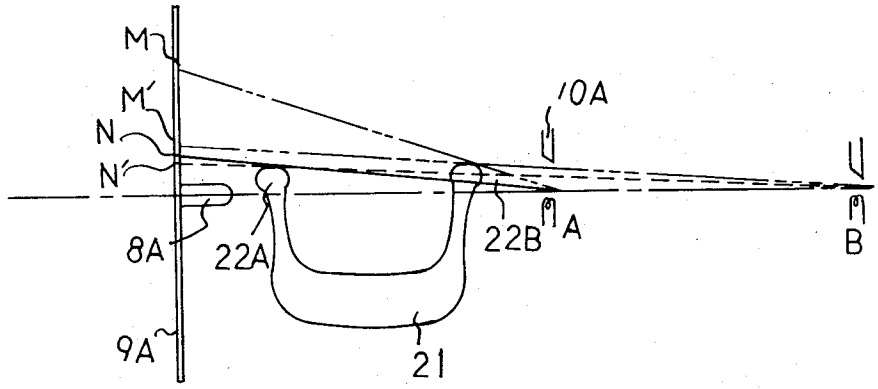
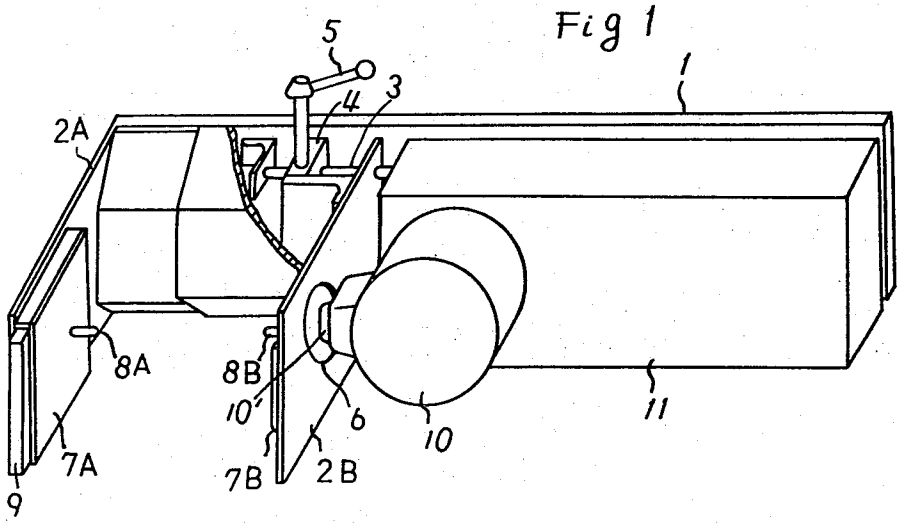


Fig 1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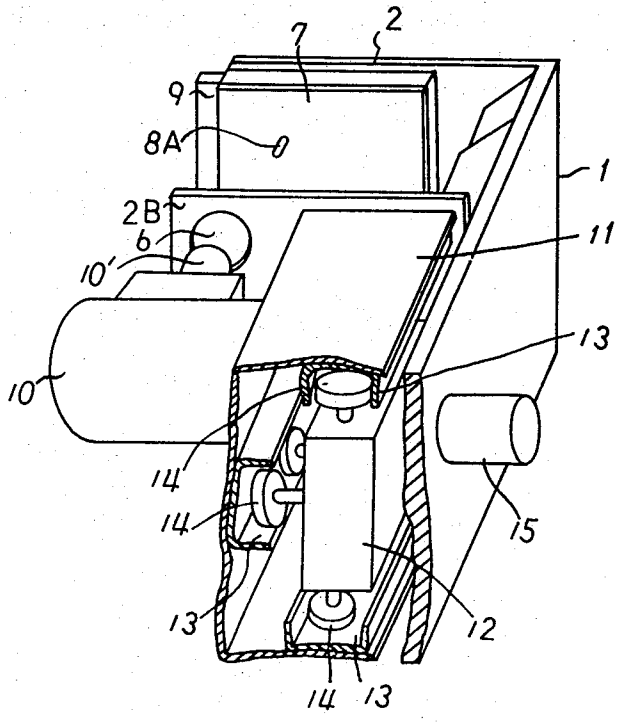
3
4
1
2A
8A
8B
10'
6
10
11
7A
7B
2B
9

Fig3


7
2
9
8A
0
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2B
6
11
10'
13
10
14
14
15
13
12
14
13

Fig 2

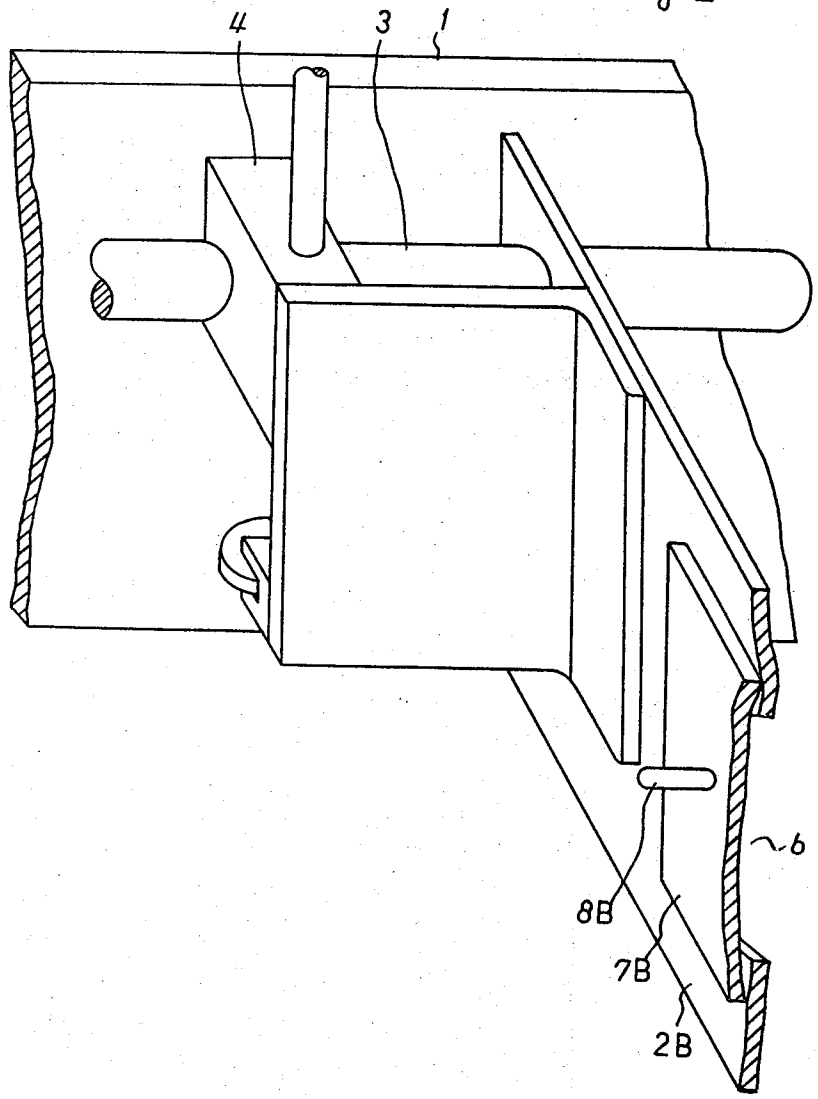


Fig 5

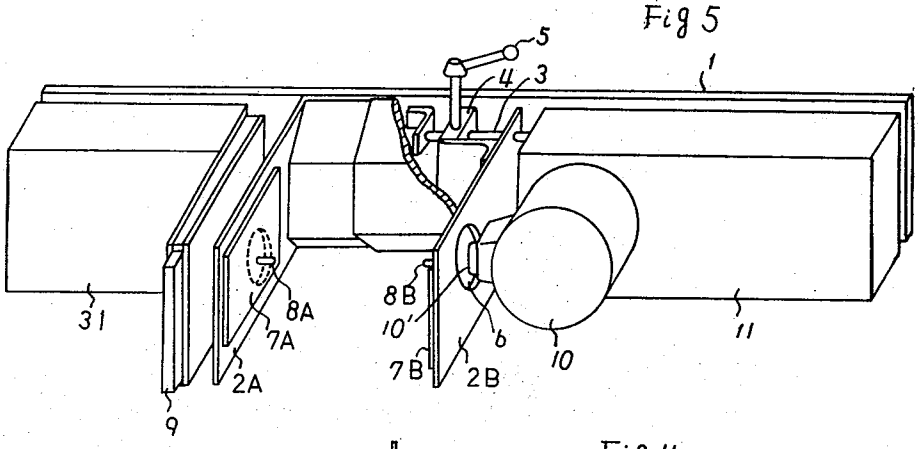


Fig 4

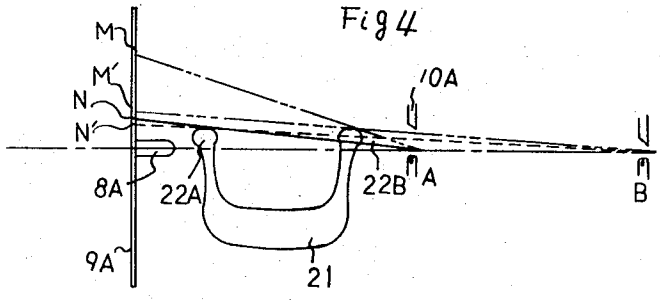
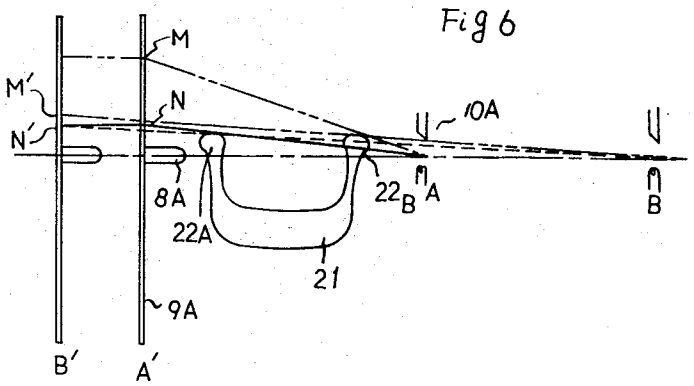


Fig 6



APPARATUS FOR RADIOGRAPHING THE JOINTS OF THE JAWS

This invention relates to an apparatus for radiographing the jaws of a human being, and more particularly, the joints of the upper and lower jaws below each ear of a human being.

In treating teeth or putting in an artificial tooth, it often is necessary to take an X-ray picture of the joints of the upper and lower jaws in order to know the state of occlusion of the teeth before and after the treatment or putting in the artifical tooth. If an X-ray is projected for radiographing in the direction of a straight line connecting the right and left joints of the upper and lower jaws, the images of the two joints overlap on the film so that they appear obscure or blurred. Moreover, near the jaws there are various bones which obstruct taking a clear picture of the jaw joints.

One way to avoid this may be to project X-rays in a direction aslant to the straight line connecting the right and left joints of the jaws so that the X-rays pass only one of the joints and not the other. With this arrangement, however, the picture taken does not clearly show the state of occlusion of the upper and lower jaws so that it does not well serve the clinical purpose. If the directions in which the pictures are taken before and after the treatment do not coincide, it will be impossible to decide the proper state of occlusion after the treatment. Obviously, if the direction in which the pictures of the same object are taken changes every time each picture is taken, it will pose a serious problem whether the direction is a aslant to the line connecting the two joints or not.

To solve the above problem it has recently been proposed to take a picture of the joints of the jaws by placing an X-ray source adjacent to one of the joints and a film adjacent to the other joint, so that the image of the joint near the X-ray source appears on the film more blurred than the image of the joint near the film. However, the former image is not sufficiently blurred so that it overlaps a clearer image of the latter joint, with more or less blurred images of the neighboring bones overlapping the images of the joints.

Accordingly, the primary object of the invention is to provide an apparatus for radiographing the joints of the upper and lower jaws of a human being, which is capable of obtaining a clear X-ray picture of the required one of the joints by making the image of the other joint sufficiently blurred to produce a clear image of the required joint.

Another object of the invention is to provide such an apparatus as aforesaid, wherein the X-rays are always projected in the same direction even when X-ray pictures are repeatedly taken.

As previously mentioned, in order to take a proper X-ray picture of the joints of the jaws it is necessary to project X-rays in a direction parallel to the straight line connecting the right and left joints. To this end the apparatus of the invention is provided with a pair of ear rods or plugs adapted to be fitted into the holes of the opposite ears of a patient whose jaws are to be radiographed thereby to place the patient's head at the proper position.

An X-ray source is placed at one side of the patient's head and on the extension of the straight line connecting the two ear rods or joints of the jaws or a line adjacent to and parallel with the straight line so that the X-ray from the source is projected onto the portion to be radiographed. At the side of the patient's head opposite to the X-ray source there is placed a film.

In one embodiment of the invention, the X-ray source is movable along the straight line without changing the direction of projection of the X-ray so that the distance between the X-ray source and the film may be changed thereby to cause the image of the joint at the side of the X-ray source to become more blurred than that of the joint at the side of the film. In other words, the image of the joint of the jaw at the side of the film is clearer than the images of other portions of the jaw.

In another embodiment of the invention, both of the X-ray source and the film are simultaneously movable without changing the direction of projection of the X-ray. If the source and the film are moved while keeping constant the ratio between the distance between the X-ray source and the joint at the side of the film and the distance between the film and the joint at the side of the film, the image of the joint is kept stationary and clear on the film while the image of the other joint is blurred thereon.

The invention will be described in detail with reference to the attached drawings, wherein:

FIG. 1 is a partially cut-away perspective view of one embodiment of the invention;

FIG. 2 is an enlarged perspective view of a portion of FIG. 1;

FIG. 3 is a partially cut-away perspective view of another portion of FIG. 1;

FIG. 4 is a view for explanation of the operation of the apparatus of FIG. 1;

FIG. 5 is a view similar to FIG. 1 but showing another embodiment of the invention; and

FIG. 6 is a view for explanation of the operation of the apparatus of FIG. 5.

Referring in detail to the drawings, there is shown in FIG. 1 a frame 1 having an opposed pair of protective plates 2A and 2B made of, say, lead which does not pass X-rays.

The plate 2A is rigidly fixed to the frame while the plate 2B is movable relative to and parallel with the plate 2A. To this end the plate 2B is slidably carried by a pair of guide rods 3 (only one of which is shown in FIG. 1) fixed to the frame. A locking device 4 having a handle 5 is fixed to the palte 2B and slidably carried by the rods 3 so that by means of the handle 5 the device 4 is operated to clamp the rods thereby locking the plate 2B at a desired position. The plate 2B is formed with a hole 6 through which X-rays pass.

On the mutually facing sides of the plates 2A and 2B there are provided a pair of plates 7A and 7B made of, for example, synthetic resin which is highly permeable to radioactive rays. A pair of ear rods or plugs 8A and 8B are planted on the mutually facing sides of the plates 7A and 7B in such a manner that they oppose each other in axial alignment. Between the plates 2A and 7A there is formed a space into which a film magazine 9 can be removably put. The ear rods 8A and 8B are preferably aligned with a line passing the center of the hole 6 in the plate 2B.

When a picture is to be taken, the patient's head is positioned between the protective plates 2A and 2B, with his or her face directed toward the frame 1 or oppositely. The plate 2B is adjusted so that the plates 2A and 2B sandwich the patient's head laterally, with the ear rods 8A and 8B inserted into the opposite ears of

the patient. Then the handle **5** is turned to fix the plate **2B** at the position. The patient's jaws to be radiographed have now been set at a proper position between the protective plates **2A** and **2B**.

An X-ray source **10** contains an X-ray tube which emits X-rays to be projected through a projector **10'** directed toward the aperture **6** in the protective plate **2B**. The source **10** is movable along the straight axial line connecting the ear rods **8A** and **8B**. To this end, the X-ray source **10** is mounted on a carriage **11**. As shown in FIG. **3**, a guide block **12** is secured to the frame **1**, and on the inner surface of the upper and lower walls of the carriage **11** there are provided a pair of upper and lower rails **13** which are engaged by rollers **14** mounted on the guide block **12**. A motor **15** provided on the frame drives one or more of the rollers **14** through a suitable gear train not shown thereby moving the carriage **11** and consequently the X-ray source longitudinally of the rails **13** at a constant speed. The direction of the movement is parallel with the axial line connecting the ear rods **8A** and **8B**. The movement of the X-ray source is effected in the course of the radiographing operation.

Referring to FIG. **4**, suppose that a jaw **21** has left and right joints **22A** and **22B** which former is positioned near a film **9A** with the latter **22B** being positioned near the X-ray tube **10A**. Initially the X-ray tube **10A** is at a start point A where the tube starts emitting X-rays for radiographing and continues the emission as it is moved away from the film **9A** as far as a point B. When the tube **10A** is at point A, the image of the joint **22B** is formed at a point M on the film **9A**. However, when the tube **10A** has been moved to the point B, the image of the joint **22B** is formed at a point M' on the film **9A**. On the other hand, the image of the other joint **22A** is formed at points N and N' respectively when the X-ray tube is at points A and B. As is clearly shown, the distance between M and M' is far greater than the distance between N and N'. This means that as the X-ray source is moved the image of the joint **22B** is more blurred on the film than the image of the joint **22A**. In other words, the picture taken shows a clear image of the joint **22A** against a sufficiently blurred image of the joint **22B**.

In the above explanation, the X-ray source is moved away from the film. As can be easily understood, the same result will be obtained when the X-ray tube is moved toward the film.

Experiments performed by the present inventor have disclosed that with the distance between the right and left joints being 170 mm, it is possible to take a clear picture of the joint **22A** by moving the X-ray source a distance of 200 mm.

The X-ray source may be moved manually as well as by means of the motor **15**.

In the above example, the film is kept stationary while a picture is being taken. As previously mentioned, the image of the joint **22A** to be radiographed is moved from N to N'. The smaller the distance between N and N', the clearer the image obtained. To decrease the distance between N and N' the film **9A** may be moved simultaneously with the movement of the X-ray source, and by properly setting the distance the film is to be moved it is possible to keep the image of the joint **22A** stationary on the film. To accomplish this the X-ray source and the film may simultaneously be moved in such a manner that the ratio of the distance between the X-ray source and the joint **22A** and the distance between the film and the joint **22A** will always be kept constant.

FIG. **5** shows an arrangement wherein the X-ray source and the film are simultaneously moved while keeping the above-mentioned ratio constant. In this embodiment, the film magazine **9** is separated from the protective plate **2A** and attached to a carriage **31**. The carriage **31** contains a mechanism similar to that contained in the carriage **11**. The carriage **31** is slidable along the line connecting the two joints but in the direction opposite to that in which the carriage **11** is moved.

The operation of the arrangement of FIG. **5** will now be explained with reference to FIG. **6**. While the X-ray tube **10A** is moved at a constant speed from the point A to the point B, the film **9A** is also moved at a constant speed from a point A' to a point B'. Then the image of the joint **22B** on the film at A' is moved from M to a point M' on the film that has been moved to the point B', while the image of the other joint **22A** is moved from N to N'. However, by maintaining the previously mentioned ratio constant it is possible to keep the line connecting N and N' substantially parallel with the direction of movement of the film, so that the image of the joint **22A** remains substantially stationary on the film **9A** and consequently becomes sharper and clearer than with the arrangement of FIG. **1**. On the other hand, the image of the joint **22B** which moves from M to M' becomes more blurred and obscure thereby relatively increasing the clarity of the image of the joint **22A**.

As mentioned above, the apparatus of the invention is capable of taking a clear picture of the desired one of the right and left joints of the jaws by making the image of the other joint sufficiently blurred so that the picture clearly shows the state of occlusion of the upper and lower jaws and serves well for the purpose of diagnosis and treatment.

What I claim is:

1. Apparatus for radiographing the joints of the jaws of a patient's head along a straight line connecting said joints so as to form a relatively clear image of one joint and a relatively blurred image of the other joint, said apparatus comprising:

head support means for supporting the head of a patient in a fixed position;

film support means located on one side of said head support means for supporting a film in a position such that said film will intersect an extension of the straight line connecting the joints of the jaws of a patient's head when a patient's head is held by said head support means;

an X-ray source;

X-ray source means for supporting said X-ray source on the other side of said head support means in a position such that the X-rays emitted by said X-ray source will travel along the straight line connecting the joints of the jaws of a patient's head when a patient's head is held in said head support means; and

X-ray moving means operatively connected to said X-ray support means for moving said X-ray support means and said X-ray source along a path defined by an extension of the straight line connecting the joints of the jaws of a patient's head when a patient's head is held by said head support means as said X-ray source projects X-rays toward said film

whereby a relatively clear image of the joint of the jaws nearest to said film and a relatively blurred image of the joint of the jaws nearest to said X-ray source are formed on said film.

2. Apparatus for radiographing the joints of the jaws of a patient's head as claimed in claim **1** wherein said head support means comprises:

a first protective plate located between said film support means and said patient's head when a patient's head is held by said head support means; and

a second protective plate located between said X-ray source and said patient's head when a patient's head is held by said head support means, said first and second protective plates sandwiching the lateral sides of the patient's head when a patient's head is held by said head support means so as to support and maintain the patient's head in a fixed position.

3. Apparatus for radiographing the joints of the jaws of a patient's head as claimed in claim **2** wherein one of said first and second protective plates is movable toward and away from the other of said first and second protective plates.

4. Apparatus for radiographing the joints of the jaws of a patient's head as claimed in claim **3** including locking means for locking said one of said first and second protective plates at a desired position relative to the other of said first and second protective plates.

5. Apparatus for radiographing the joints of the jaws of a patient's head as claimed in claim **3** wherein said one of said first and second protective plates is movable along a path defined by an extension of the straight line connecting the joints of the jaws of a patient's head when a patient's head is located between said first and second protective plates.

6. Apparatus for radiographing the joints of the jaws of a patient's head as claimed in claim **5** including locking means for locking said one of said first and second protective plates at a desired position relative to the other of said first and second protective plates.

7. Apparatus for radiographing the joints of the jaws of a patient's head as claimed in claim **2** wherein said X-ray support means comprises:

a pair of guide rails spaced from one another and lying along axes that are parallel to one another and the straight line connecting the joints of the jaws of a patient's head when a patient's head is held between said first and second protective plates; and

a carriage mounted on said guide rails so as to be slidable along said guide rails, said carriage supporting said X-ray source.

8. Apparatus for radiographing the joints of the jaws of a patient's head as claimed in claim **7** wherein said X-ray moving means includes:

at least one roller mounted so as to engage one of said guide rails and affixed to said carriage; and

drive means for rotating said at least one roller in a manner such that the rotation of said roller moves said carriage along said guide rails.

9. Apparatus for radiographing the joints of the jaws of a patient's head as claimed in claim **2** including first and second ear rods, said first ear rod being affixed to said first protective plate and said second ear rod being affixed to said second protective plate, said ear rods projecting toward one another and lying on a common axis, said ear rods adapted to fit into the ear holes of a patient's head so as to properly position said patient's head between said first and second protective plates.

10. Apparatus for radiographing the joints of the jaws of a patient's head as claimed in claim **9** wherein said common axis is coaxial with the straight line connecting the joints of the jaws of a patient's head when a patient's head is held between said first and second protective plates.

11. Apparatus for radiographing the joints of the jaws of a patient's head as claimed in claim **2** wherein said X-ray moving means moves said X-ray support and said X-ray source away from said film support means as said X-ray source projects X-rays toward the film supported by said film support means.

12. Apparatus for radiographing the joints of the jaws of a patient's head as claimed in claim **2** wherein said X-ray moving means moves said X-ray support and said X-ray source toward said film support means as said X-ray source projects X-rays toward the film supported by said film support means.

13. Apparatus for radiographing the joints of the jaws of a patient's head as claimed in claim **2** including film support moving means for supporting said film support means and for moving said film support means along a path defined by an extension of the straight line connecting the joints of the jaws of a patient's head held between said first and second protective plates.

14. Apparatus for radiographing the joints of the jaws of a patient's head as claimed in claim **13** wherein said X-ray moving means moves said X-ray support and said X-ray source, and said film support moving means moves said film support means simultaneously in a manner such that the ratio of the distance between the joint nearest said film support means and said film support means, and the distance between the joint nearest said X-ray source and said X-ray source, is maintained constant.

15. A method of radiographing the joints of the jaws of a patient's head so as to form a relatively clear image of one joint and a relatively blurred image of the other joint, said method comprising the steps of:

supporting said patient's head in a fixed position;

locating a film on one side of said patient's head along an extension of the straight line connecting the joints of the jaws of said patient's head;

locating an X-ray source on the other side of said patient's head in a position such that the X-rays emitted by said X-ray source travel along said straight line connecting the joints of the jaws of said patient's head; and

moving said X-ray source along an extension of said straight line connecting the joints of the jaws of said patient's head while projecting X-rays along said straight line connecting the joints of the jaws of said patient's head toward said film.

16. A method of radiographing the joints of the jaws of a patient's head as claimed in claim **15** wherein said X-ray source is moved away from said patient's head while said X-rays are being projected toward said film.

17. A method of radiographing the joints of the jaws of a patient's head as claimed in claim **15** wherein said X-ray source is moved toward said film while said X-rays are being projected toward said film.

18. A method of radiographing the joints of the jaws of a patient's head as claimed in claim **15** including the further step of moving said film along a path defined by an extension of said straight line connecting the joints

of the jaws of said patient's head as said X-ray source is moved.

19. A method of radiographing the joints of the jaws of a patient's head as claimed in claim **18** wherein the ratio of the distance between the joint of the jaws of said patient's head nearest said film and said film, and the distance between the joint of the jaws of said patient's head nearest said X-ray source and said X-ray source, is maintained constant as said film and said X-ray source are moved.

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