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Holstrom

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[54] **X-RAY DEVICE FOR INVESTIGATION OF SKULLS**

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[51] **Int. Cl.** **G01n 23/00**

[58] **Field of Search** 250/53, 50, 91, 57, 58, 250/444, 446, 320, 490, 491

[56] **References Cited**

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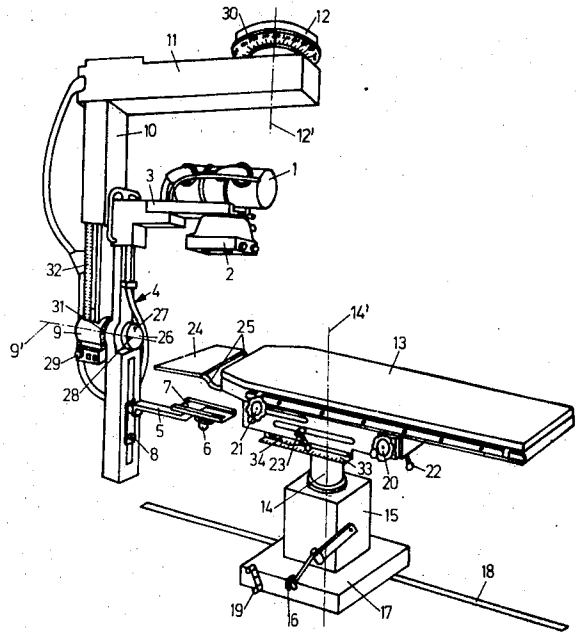
[57] **ABSTRACT**

An X-ray device for investigation of skulls has a support for the patient and an X-ray tube - image layer unit which is movable relatively thereto in such manner that the object being examined, namely a skull, can be introduced into the ray flow and fixed. The unit consists, on the one hand, of a U-shaped swingable arm having one arm portion carrying an X-ray tube with a light sight provided with indicating markings extending in the longitudinal direction of the support and transversely thereto, which pass through the central ray and can be projected upon the object being examined. The other arm portion has an image layer carrier. The units carried by the two arm portions are so directed toward each other that the central ray of the X-ray tube lies in the middle perpendiculars of the image layer. The unit includes, on the other hand, a U-shaped stand having one leg carrying the swingable arm which is mounted substantially in its center of gravity for rotation about a horizontal axis. The horizontal leg is swingably connected with a pivot bearing for rotation about a vertical bearing axis. These connections are such that the focus of the X-ray tube and the center of the image layer move upon outer surfaces of imaginary concentrical spheres. The present invention is particularly characterized by the provision of a light sight mounted in the rotary axis of the swingable arm and directed toward the object being examined for fixing permanent initial positions of the object being examined to the device (zero position) and for the linear projection of vertical and horizontal sections extending through the center of imaginary spheres upon the outer surface of the object being examined. The present invention also includes the provision of an X-ray tube - image layer unit and indicating means combined with the patient support for setting quantitatively fixable changes of setting positions relatively to the zero position.

12 Claims, 2 Drawing Figures



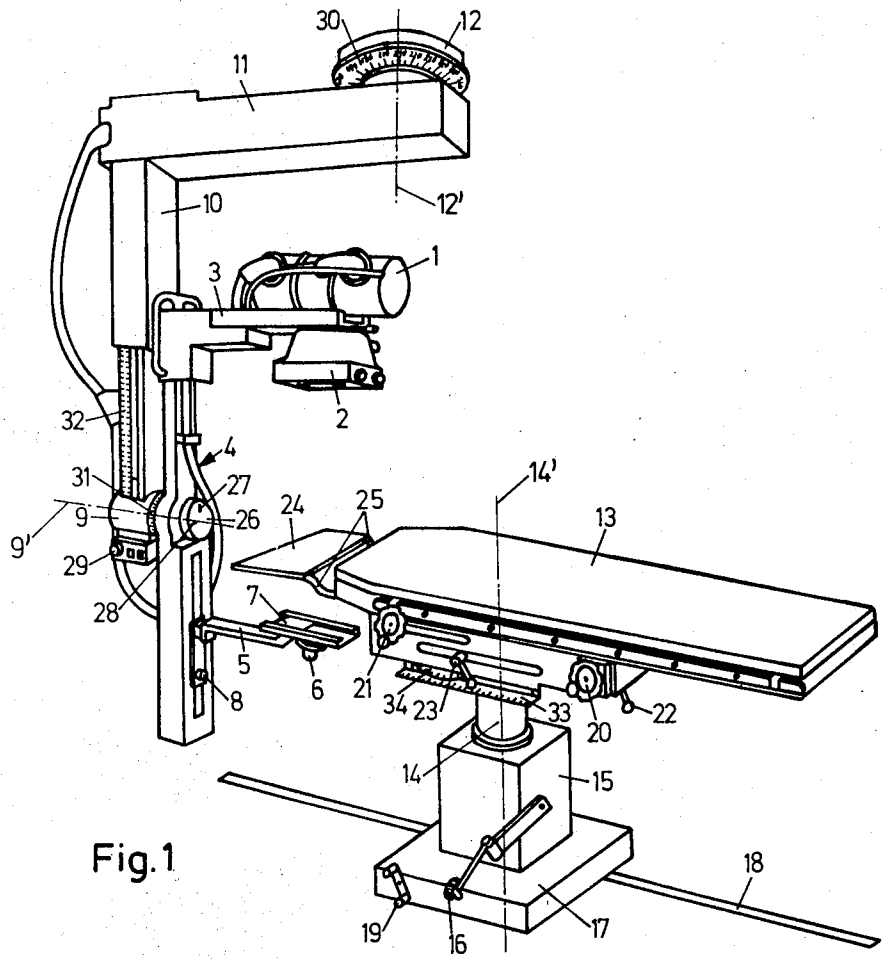

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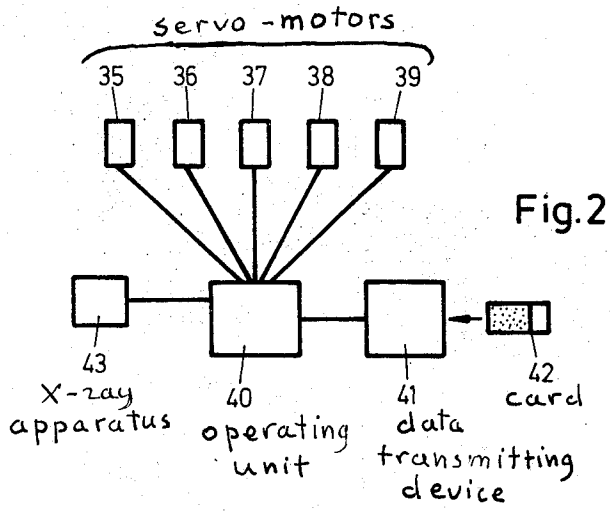
Fig.1


servo-motors
35
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X-ray apparatus
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operating unit
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data transmitting device
42
card

Fig.2

X-RAY DEVICE FOR INVESTIGATION OF SKULLS

This invention relates to an X-ray device for investigation of skulls. The invention is particularly concerned with a device of this nature having a support for the patient and an X-ray tube-image layer unit which is movable relatively thereto in such manner that the object being examined, namely a skull, can be introduced into the ray flow and fixed. The unit consists on the one hand of a U-shaped swingable arm having an arm portion carrying the X-ray tube with a light sight provided with indicating markings extending in the longitudinal direction of the support and transversely thereto, which pass through the central ray and can be projected upon the object being examined. The other arm portion has an image layer carrier. The elements carried by the two arm portions are so directed toward each other that the central ray of the X-ray tube lies in the middle perpendiculars of the image layer. The unit includes, on the other hand, a U-shaped stand having a leg carrying the swingable arm which is mounted substantially in its center of gravity for rotation about a horizontal axis. The other leg is swingably connected with a pivot bearing for rotation about a vertical bearing axis. These connections are such that the focus of the X-ray tube and the center of the image layer move upon outer surfaces of imaginary concentrical spheres.

The diagnosis of skulls by X-rays requires to a much greater extent than that of other body parts a ray flow in all different directions. This is caused by the fact that the soft part structures of the brain and the mucous membranes of the nasal and throat passages are embedded in the bone structure of the skull. The result is that the soft part structures which are to be reproduced can be superposed by bone structures and the bone structures of opposed skull parts can be superposed to provide false information. To avoid these superpositions it is necessary to maintain certain projection requirements which often require very complicated settings.

These settings can be carried out only with difficulty by the usual X-ray diagnosing devices. This drawback resulted in the development of a number of special devices which have all produced certain improvements in the setting art but did not provide a completely satisfactory solution. Finally a break through was achieved by the idea of combining the X-ray tube and the image layer into a unit which is movable relatively to the patient in such manner that the central ray of the X-ray tube and the center of the image layer are movable upon surfaces of imaginary concentrical semi-spheres around the object being examined as the center. In this manner it is possible to fix the patient in the lying position and to make exposures in each desired position by a corresponding positioning of the receiving unit. This skull examining device has means setting the directions of projection consisting of measuring means which permit to set a predetermined spatial location as the starting position for all desired projections.

An object of the present invention is to improve existing devices of the described nature by simplifying the setting of the initial position (zero position).

Other objects will become apparent in the course of the following specification.

In the accomplishment of the objectives of the present invention it was found desirable to mount on the rotary axis of a swinging arm a light sight directed toward the object being examined for the linear projection of

sectional surfaces passing through the center of the imaginary spheres upon the object being examined and to provide the X-ray tube - image layer unit as well as at the patient support indicating means for setting quantatively fixable changes of the setting positions relatively to the zero position.

This arrangement of the present invention greatly simplifies the setting of the zero position. After the patient has been fixed upon his support and his head has been placed in an approximate exposure position, the light sight at the X-ray tube and in the point of rotation of the swinging arm is used to cover three reference surfaces of the head extending perpendicularly to each other and passing through the center of the imaginary spheres, which are anatomically easily recognized and defined, such as, for example, the infraorbital, auricular and medialsagittal surfaces, these surfaces being covered by corresponding markings of the light sight. Starting with this zero position it is possible to set many exposure positions by reading from a chart the geometrical parameters corresponding to the individual types of exposures; they are then set purely mechanically at the corresponding setting means and are read at the indicating means. In this manner skull examinations which belong to the most complicated duties of medical auxiliary operators can be now carried out by persons who are not specially trained or experienced.

According to a further embodiment of the present invention it is possible to carry out the settings, for example, by an actuating device using programs embodied in perforated cards. Thus errors in settings are eliminated and the time required for operators to set a series of skull exposures is reduced to a minimum.

The invention will appear more clearly from the following detailed description when taken in connection with the accompanying drawing showing by way of example only, a preferred embodiment of the inventive idea.

In the drawing:

FIG. 1 is a perspective view illustrating a device constructed in accordance with the present invention.

FIG. 2 is a block circuit showing the automative actuation of the movements of the device.

FIG. 1 shows an X-ray device having an X-ray tube 1 with a diaphragm 2 adjustably connected thereto. The tube 1 is connected to an arm portion 3 of a U-shaped swingable arm 4. The arm portion 5 of the arm 4 carries a holder 6 for cassettes. An X-ray film cassette 7 can be slid into the holder 6. The X-ray tube and the holder are so arranged that the central ray of the X-ray tube coincides with the central vertical line of the cassette. The arm portion 5 is adjustable in the direction of the central ray by a device 8 in order to change the focus-image layer distance. The swingable arm 4 is mounted in its middle section between the X-ray tube and the cassette carrier located in its maximum focus-image layer distance upon an arm 9 shaped as a horizontal bearing and forming a part of a U-shaped stand having a vertical column 10 and a horizontal arm 11. The arm 4 is rotatable about the horizontal bearing axis 9' in such manner that the focus of the X-ray tube 1 and the center of the image layer of the cassette 7 move upon concentrical circular paths. The arm 11 of the stand is suspended upon a rotary bearing 12 so as to be rotatable about its vertical bearing axis 12'. The axis 12' of the bearing 12 extends through the center of imaginary concentrical circles upon the circumfer-

ences of which move the focus of the X-ray tube **1** and the center of the image layer of the cassette **7.** Due to this arrangement the focus of the X-ray tube and the center of the image layer move upon the outer surface of imaginary concentrical spheres.

The support for the patient consists of a table plate **13** mounted upon a column **14** which can be adjusted in height by a hydraulic raising device located in a casing **15** and operated by a pedal **16.** The column **15** is mounted upon a base **17** having rollers (not shown) two of which are guided in a rail **18,** so that the table can be moved relatively to the device in the same direction set by the rail **18.** A lever **19** is used to stop the movement of the support in the direction of the rail. The table plate **13** is adjustable in the longitudinal and transverse directions relatively to the column **14.** The longitudinal shifting takes place by the hand wheel **20** while the transverse movement is carried out by the hand wheel **21.** A lever **22** is used to stop the table in its longitudinal direction while the lever **23** stops the transverse movement of the table. The table has supporting means at its head end for introducing a head support **24** made of transparent material. The two carrying arms **25** of this head support are curved so that by placing the head support into the one or the other position the head of the patient can be supported in two different positions.

The device is placed in the following manner into its initial position (zero position) relatively to the object being examined (the skull):

After the patient has been placed on the table and fixed, the table is moved to such a position relatively to the X-ray tube - image layer unit, that the skull of the patient lies approximately in the direction of the rays. The light sight **26** is located in the point of rotation of the arm **4** for the precise setting of the object being examined. The light sight has a vertical slit **27** and a horizontal slit **28.** Two light markings can be projected upon the object being examined through these two slits, which represent a vertical and a horizontal sectional surface passing through the center of the imaginary concentric spheres. By the use of the adjusting means **20, 21** of the table the object being examined can be brought into a position wherein the vertical sectional surface will characterize a predetermined anatomically easily fixable position, for example, the so-called infraorbital plane. In order to fix a horizontal plane the light marking **28** can be moved to cover the so-called infraorbital plane by varying the vertical location of the object being examined to the device, with the help of the pedal **16** for the height moving of the table or with the help of the setting member **29** for shifting the telescopically movable supporting column **10.** There are two possibilities for moving the third plane required for a definite space position, to cover the light sight marking. Firstly, the column is swung about the axis **12'** of the bearing **12** to the extent of **90** degrees and the light marking **26** is brought to cover the socalled medial sagittal plane. Secondly, without carrying out the swinging movement of the stand, the light marking provided in the diaphragm **2** of the X-ray tube is used as a graticule extending in the longitudinal direction of the table and transversely thereto. For that purpose the central ray of the X-ray tube is placed vertically and then the marking of the light sight extending in the longitudinal direction of the table is brought to cover the medial-sagittal plane of the object being examined by the use of the setting means **21** of the table.

After the zero position has been set in this manner all the desired exposure positions can be set, for example, by means of a chart which prescribes the quantative deviations of individual positions from the zero position. For that purpose indicating means are provided for the individual setting members determining the relative positions of the object being examined and the X-ray tube - image layer unit. Thus the rotary bearing **12** is provided with the scale **30,** the horizontal rotary axle for the swinging movement of the arm **4** with the scale **31,** the telescopic guide of the column **18** with the scale **32,** the setting means **20** for the longitudinal movement of the table with the scale **33** and, finally, the setting means **21** for the transverse movement of the table with the scale **34.**

FIG. **2** illustrates diagrammatically the possibility of changing from a manual setting to a setting by means of servo-motors, the individual exposure positions being automatically fixed by a unit operated by a perforated card. The block circuit diagram of FIG. **2** shows five such servo-motors, namely, the motor **35** for the vertical movement of the column, the motor **36** for the angular adjustment of the swinging arm at the bearing **9,** the motor **37** for the angular adjustment of the column at the bearing **12,** the motor **38** for moving the table in the transverse direction of the table plate and finally the motor **39** for shifting the table plate in the longitudinal direction of the table. All these motors are operated by an operating unit **40** on the basis of information introduced into a data transmitting device **41,** for example, by means of a perforated card **42.** This actuation by means of a perforated card need not be limited to the mechanical setting movements of the device, but can be also used to carry out corresponding electrical settings of the X-ray tube voltage, X-ray tube current and the exposure duration at the X-ray apparatus **43,** so as to provide the correct condition for each exposure. The termination of the exposure can be also carried out automatically in the described manner, so that the entire exposure program can be developed automatically and the service of the operator will be limited only to the setting of the zero position.

I claim:

1. An X-ray device for investigation of skulls, comprising in combination with a patient support adapted to carry the object to be examined, a swingable U-shaped arm, an X-ray tube carried by a portion of said arm, a diaphragm adjustably connected with said X-ray tube, a film cassette adjustably mounted upon another portion of said arm, a bearing supporting said arm for movement about a horizontal axis between said X-ray tube and said cassette, a light sight connected with said bearing and directed toward said patient support, said diaphragm and said cassette being directed toward each other, the central ray of said X-ray tube passing through the center of said cassette, means supporting said arm for movement about a vertical axis, the focus of said X-ray tube and the center of said cassette being movable upon surfaces of imaginary concentrical spheres, said light sight having vertical and horizontal slits, whereby ray projections extending through said slits may form imaginary vertical and horizontal sectional surfaces extending through the center of said imaginary spheres and upon the surface of the object to be examined, and indicating means connected with

said X-ray tube, said cassette and said patient support for setting quantitatively fixable changes of setting positions relatively to a zero position.

2. A device in accordance with claim 1, wherein said light sight is a double line projecting light sight for linear projection of a vertical and horizontal projection plane upon the object to be examined.

3. A device in accordance with claim 1, wherein said patient support comprises a carrying table, means shifting said table longitudinally and transversely, and indicating means connected with the last-mentioned means.

4. A device in accordance with claim 3, comprising means adjusting the height of said table.

5. A device in accordance with claim 3, comprising a rail and means guiding said patient support upon said rail.

6. A device in accordance with claim 3, comprising a transparent head support extending beyond one end of said table and means connecting said head support with said end of the table and adjusting the height of said head support relatively to said table.

7. A device in accordance with claim 3, comprising a central column supporting said table, said table being swingable about the central axis of said column.

8. A device in accordance with claim 1, comprising means connected with said U-shaped arm for telescopic height adjustment of said portions of the U-shaped arm.

9. A device in accordance with claim 8, comprising means connected with said other portion of the arm for shifting it in the direction of the central ray.

10. A device in accordance with claim 1, comprising motors connected with said indicating means for carrying out said changes of setting positions and a programmed actuating device operatively connected with said motors.

11. A device in accordance with claim 10, wherein said programmed actuating device has means setting the X-ray tube voltage, X-ray tube current and exposure time on the basis of the programmed data.

12. An X-ray device for investigation of skulls, comprising in combination with a patient support adapted to carry the object to be examined, a swingable U-shaped arm, an X-ray tube carried by a portion of said arm, a diaphragm adjustably connected with said X-ray tube, a film cassette adjustably mounted upon another portion of said arm, a bearing supporting said arm for movement about a horizontal axis between said X-ray tube and said cassette, a light sight connected with said bearing and directed toward said patient support, said light sight being a double line projecting light sight for linear projection of a vertical and horizontal projection plane upon the object to be examined, said diaphragm and said cassette being directed toward each other, the central ray of said X-ray tube passing through the center of said cassette, means supporting said arm for movement about a vertical axis, the focus of said X-ray tube and the center of said cassette being movable upon surfaces of imaginary concentrical spheres, said light sight having vertical and horizontal slits, whereby ray projections extending through said slits may form imaginary vertical and horizontal sectional surfaces extending through the center of said imaginary spheres and upon the surface of the object to be examined, indicating means connected with said X-ray tube, said cassette and said patient support for setting quantitatively fixable changes of setting positions relatively to a zero position, motors connected with said indicating means for carrying out said changes of setting positions and a programmed actuating device operatively connected with said motors, said programmed actuating device having means setting the X-ray tube voltage, X-ray tube current and exposure time on the basis of the programmed data.

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