March 15, 1938. G. GROSSMANN 2,110,953

METHOD OF AND APPARATUS FOR MAKING RADIOGRAPHS MORE PARTICULARLY OF BODY SECTIONS

Filed April 21, 1934 2 Sheets-Sheet 1

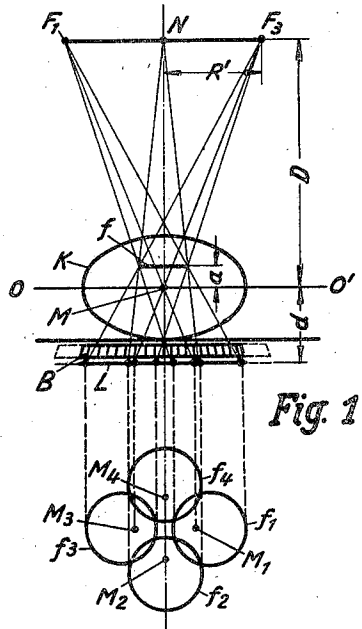


Fig. 1

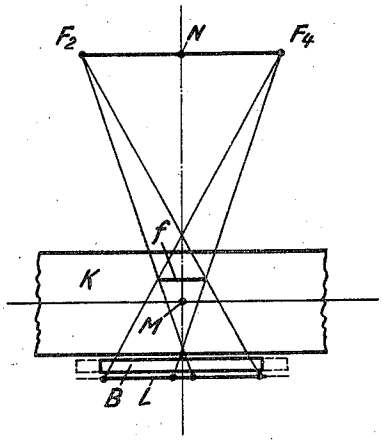


Fig. 1a

Fig. 1b



Fig. 1c

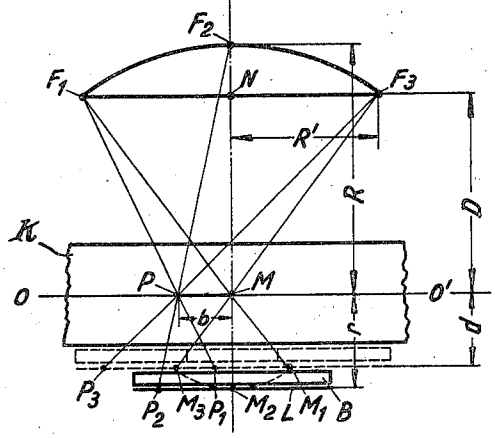


Fig. 2

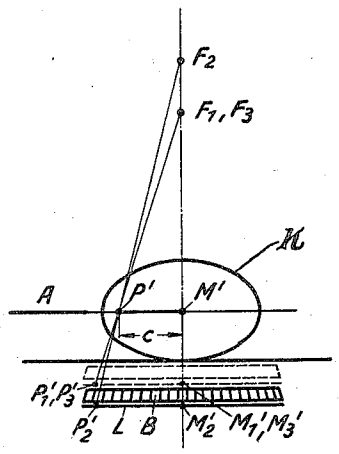


Fig. 2a

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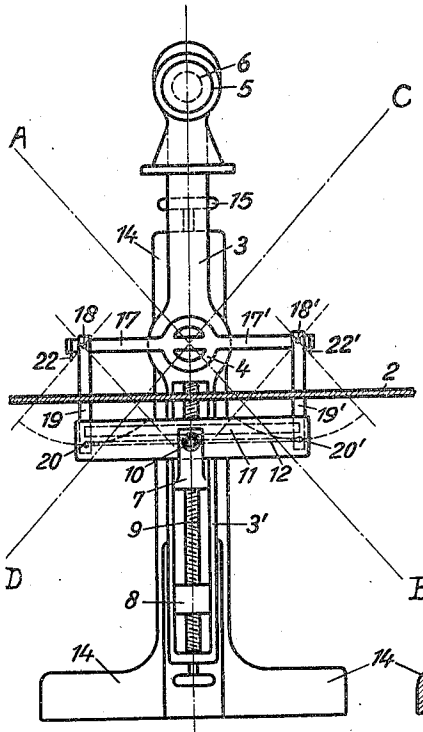


Fig. 3

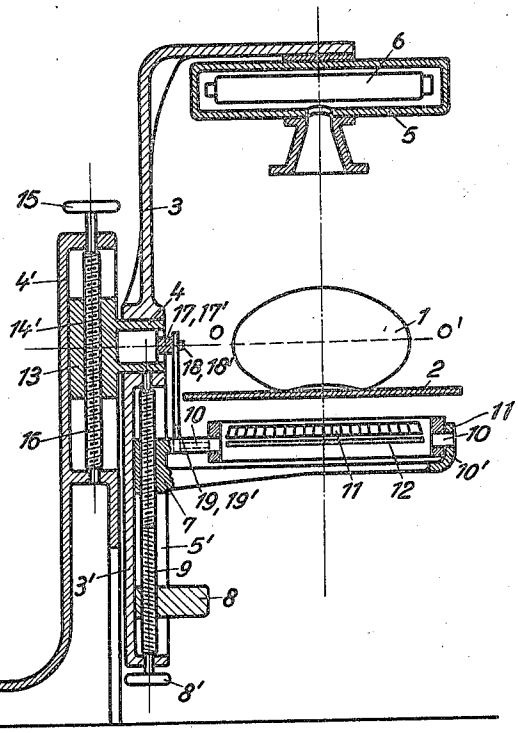


Fig. 3a

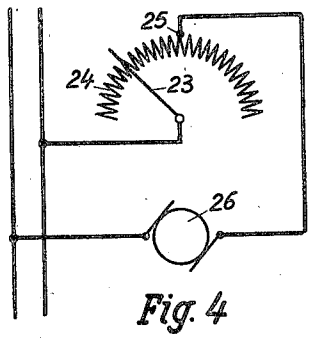


Fig. 4

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2,110,953

UNITED STATES PATENT OFFICE

2,110,953

METHOD OF AND APPARATUS FOR MAKING RADIOGRAPHS MORE PARTICULARLY OF BODY SECTIONS

Gustav Grossmann, Berlin-Zehlendorf-West, Germany

Application April 21, 1934, Serial No. 721,794
In Germany April 21, 1933

12 Claims. (Cl. 250—34)

This invention relates to a method of and apparatus for making radiographs of body sections.

The invention and its aims and objects will be readily understood from the following description of a preferred mode and manner of carrying out my method and of an illustrative embodiment of apparatus for practicing said method when considered in connection with the accompanying drawings wherein:

Figs. 1, 1*a*, 1*b*, 1*c* illustrate diagrammatically a mode and manner of making body sections;

Figs. 2 and 2*a* illustrate diagrammatically my improved method;

Fig. 3 is a front elevation, partly in section, of one illustrative embodiment of apparatus for practicing my novel method;

Fig. 3*a* is a sectional side view of the apparatus shown in Fig. 3;

Fig. 4 is a detail of the contact lever and co-operating resistance;

Methods for making radiographs of body sections as heretofore practiced are based upon the idea of moving the Roentgen-ray tube focus within a plane parallel to the body section to be reproduced and along a curve of two dimensions, while moving the surface or layer upon which the picture of said body section is to be received, and which is parallel to said section, within its own plane and continuously in the opposite direction to that of the movement of said focus, in such manner that a Roentgen-ray passing through any point of said body section will always fall on the same point of the surface or layer upon which the picture of said body section is received. A surface section, for example a quadrangular surface section located without the body section to be reproduced and in a plane parallel to said body section will then be pictured in the form of a band having its median line in the form of a curve like that of the path described by the Roentgen-ray tube focus, the width of said band equaling the central projection of the length of one side of the square that is pictured. If the Roentgen-ray tube focus describes a circular movement, the quadrangular surface section located outside of said body section will be represented in the form of a circular ring. Other conditions being equal, the greater the distance separating said quadrangular surface section from the body section to be reproduced and the greater the diameter of said circle described by said focus, the greater will be the diameter of the median line of said circular ring. Therefore, other conditions being equal, the longer the path described by the Roentgen-ray tube focus during the making of the radiograph is, the more effectively can the Roentgen-ray shadow of a small part of the body located without the body section to be reproduced be effaced or obliterated. It has therefore always been aimed to cause the Roentgen-ray tube focus to describe a curve of two dimensions having as great a total length as possible, for example a spiral, a sinical line and the like, or in general a curve that fills out a circular surface area as much as possible.

In practice it is of the greatest importance thus to obliterate or efface Roentgen shadows of solid parts of the body located without the particular body section which it is desired to reproduce, that is to say of such solid body portions which will produce a Roentgen shadow of relatively large surface area upon an immovable picture receiving layer.

In the case of methods heretofore used, the Roentgen shadow produced by such a solid part of the body will always be the same irrespective of whether the Roentgen-ray tube focus describes a circle or a spiral of Archimedes which fills in as much as possible the surface area enclosed by the circular path. This will be perfectly clear from Figs. 1 and 1*a*, wherein O, O′ indicates the body section K to be reproduced upon the picture receiving layer L. The Roentgen-ray tube focus F describes a circle having as center the point N and the radius R′, while the picture-receiving layer L effects, within its own plane a circular movement in the opposite direction to that of said focus, so that the Roentgen projection of the center M of the body section O, O′ always falls upon the same point of the picture-receiving layer L. An infinitely thin homogeneous body portion situated parallel to said plane O, O′ and at a distance *a* above the same, is indicated at *f*. In Fig. 1*b* the four Roentgen shadows f^1, f^2, f^3, and f^4, of said infinitely thin layer *f*, which are produced upon the supposedly stationary picture-receiving surface L when in describing the circle of the radius R′, the movable focus F of the Roentgen-ray tube is in the positions F_1 and F_2, F_3, and F_4, are shown. Of these four positions F_1 and F_3 are located in the plane L of the picture l, while F_2, F_4 are the momentary positions of F on the diameter of the circle which is perpendicular to the plane of said picture. The four projections of the point M, namely M_1, M_2, M_3, M_4 are included within the four projections of *f*.

As a matter of fact, however, the picture-receiving layer L is not stationary but is moved in such manner that M_1, M_2, M_3 and M_4 coincide,

so that the resulting Roentgen shadow of *f* forms a circular area, as shown in Fig. 1c, the density of the shadow diminishing from the center toward the periphery. If the focus F be not moved in a circle having the radius R' but describes a spiral of Archimedes enclosed within said circle and reaching the same, the layer *f* will be projected just the same in the form of a circular area of the same diameter, the only difference being that the shadow density decreases more markedly than in the former case as the radius vector increases. In making a radiograph of a section of the thorax parallel to the back thereof, it is also impossible to attenuate the disturbing shadow of the spinal column located without said section, by prolonging the path traversed by said focus.

Furthermore, movement of said focus through a curve of two dimensions parallel to the plane of the picture-receiving layer, and the corresponding but opposed movement of the picture-receiving layer entail two further disadvantages. One is due to the fact that the support for the Roentgen tube and the support for the picture-receiving layer must at least be connected by a single rigid link which executes oscillatory movements about a point in the plane of the body section to be reproduced. Such a joint, a universal joint, for example, always has some play even when most carefully constructed. This is all the more difficult to avoid as the masses to be moved (high tension and radiation proof container for the Roentgen tube, the secondary ray diaphragm, the film holder etc.) are quite considerable while the movement of these parts, in order to make short exposures, must be effected at great speed and the excursions of the focus must be long in order effectively to efface or obliterate the Roentgen shadows of the parts of the body located outside the body section to be reproduced. This entails an exceedingly accurate mechanical construction of the device which in turn entails a high cost of production.

Whereas heretofore the movement of the focus is along a curve of two dimensions, that is to say, in the same direction as the blades of a grid diaphragm B as well as in a direction perpendicular to said blades, then the excursions of the focus in this second direction must be relatively small, because if a certain limit be exceeded, the production of radiographs of the body becomes impossible by reason of the action of the diaphragm blades in producing Roentgen shadows. The maximum value of R' possible cannot exceed 11.6 cm. when using a secondary diaphragm centered for a spacing of 70 cm. and in which the height of the blades relative to the spacing of two blades is as 5:1, where D=40 cm. and d=20 cm. (see Fig. 1).

In the latest Roentgen tubes (ray-proof tubes) the effective rays are projected out through a diaphragm opening. The angle of the effective ray cone in the case of round focus tubes is at most 55°. In the case of Goetz tubes it is substantially less. If the Roentgen tube be moved parallel to itself, so that the focus moves in a plane parallel to the body sections to be reproduced, then said tube can be permitted to make only short excursions as otherwise the marginal portions of the body to be reproduced will be outside the range of the effective ray cone, or only a small central portion of the body can be reproduced. In view of the limitation of the effective ray cone the possible excursion Rm is only 1.04 cm. assuming the angle of the effective ray cone to be 55° and the width of the body section to be reproduced to be 40 cm., D being equal to 40 cm. and d being equal to 20 cm. The possible excursion is therefore so small that the desired result is absolutely impossible to obtain when using modern tubes, unless the movement of the focus be coupled with a rotation of the tube about said focus such that the axis of the effective ray cone is always directed upon the center M of the body section to be reproduced.

It has already been proposed, when using a tube which is not ray-proof, to mount the tube diaphragm for movement in such manner that the axis of the diaphragm tube shall always be directed toward the center M of the body section to be reproduced. The introduction of such a movement of the tube diaphragm or of the Roentgen tubes themselves entails, however, a considerable increase in the cost of the device. In the present state of the art it is impossible to make use of a Roentgen-ray tube that is not high tension proof, as the distance D must be short in the interest of securing as strong obliteration as possible of undesirable Roentgen shadows.

The present invention avoids all the disadvantages and objections above referred to while securing the greatest possible obliteration of undesired Roentgen shadows.

One of the main distinctions of applicant's invention as compared with the methods heretofore used resides in the fact that the Roentgen tube focus is moved within a plane at right angles to the body section to be reproduced and along the arc of a circle, and when a secondary grid diaphragm is used, the plane in which the Roentgen tube focus is moved is parallel to the grid elements of said diaphragm. As the central ray from the Roentgen tube remains always directed at the center of the body section to be reproduced, and as the movement of the Roentgen tube focus takes place only in the direction of the grid elements of the diaphragm, the excursions of said focus can be very great. As a result the undesirable Roentgen shadows of body portions of large cross section can be more effectively effaced or obliterated than is possible when the Roentgen tube focus is moved along a curve of two dimensions within a plane that is parallel to the body section to be reproduced. Furthermore the invention makes it possible to transmit the movement of the Roentgen-ray tube to the carrier or support of the picture receiving layer, by means of a preferably rigid member for example, and thus, by eliminating universal joints, secure the required coupled movement of the Roentgen tube focus and the picture-receiving layer by simple means which can be readily produced at low cost. Another feature of the invention resides in the fact that by rigidly connecting the Roentgen-ray tube and the Roentgen tube casing with its carrying or supporting arm, it is possible to use Roentgen-ray tubes in which the angle of the effective ray cone is small, that is to say Roentgen-ray and high tension proof Roentgen-ray tubes.

In the illustrative embodiment of apparatus for practicing my invention herein shown, the Roentgen tube, which may preferably be enclosed in a high tension and ray-proof casing, and a suitable carrier for the picture-receiving layer are secured to the opposite ends, respectively, of a two-armed lever rotatable about an axis which is in the same plane as that of the body section to be reproduced. Said Roentgen tube and carrier will preferably be secured against rotation

upon said lever. If a secondary grid diaphragm be used, the latter will be so disposed that the grid elements are directed perpendicularly to the axis of rotation of said lever. Said carrier for the picture-receiving layer may be rod-shaped and the picture-receiving layer and, in certain cases, the secondary grid diaphragm with it are rotatable about said carrier and guided by a joint, conveniently a Watt parallelogram, in such manner that the plane of the picture-receiving layer remains at all times parallel to the body section to be reproduced. In accordance with the invention also the axis about which the Roentgen tube and the picture-receiving layer are rotatable will preferably be mounted at an angle, preferably an angle of 45° to the longitudinal axis of the body section to be reproduced. The object of this is to efface or obliterate in so far as it is possible to do so disturbing or interfering Roentgen shadows of transverse and longitudinally directed parts of the body exterior to the body section to be reproduced, such as the longitudinally extending spinal column and the transversely directed ribs.

Figs. 2 and 2*a* are two projections at right angles to each other and show the relative positions of the body to be reproduced, the path followed by the Roentgen-ray tube focus F, the picture-receiving layer L and the secondary grid diaphragm B when the latter is used. The Roentgen-ray tube focus F is caused to travel along the arc of a circle F_1, F_2, F_3 located in a plane at right angles to O, O', which indicates the plane of the body section to be radiographed and co-axial with M (see Fig. 2). The picture-receiving layer L swings with the Bucky diaphragm B about an axis in Fig. 2 which is perpendicular to the plane of the picture and passes through M, the direction of rotation being the same as that of F and with the same angular speed as the latter, said picture-receiving layer remaining at all times parallel to itself. Every point of the picture-receiving layer therefore moves along the arc of a circle which is parallel to the plane of the picture in Fig. 2 and perpendicular to the plane of the picture in Fig. 2*a*. Projections M_1, M_2, M_3 of M corresponding to positions F_1, F_2, F_3 of the focal point fall always upon the same point of the picture-receiving layer. But it will be noted also that the projection of any point P in the body section O, O' to be reproduced always falls upon the same point of L. Assuming *b* and *c* to be the abscissa and ordinate, respectively, relative to the rectangular coordinate system having M as center and accepted as parallel to the two planes of Figs. 2 and 2*a*, then as clearly appears from Figs. 2 and 2*a*, we have

$$\frac{P_1M_1}{PM}=\frac{D+d}{D};\ \frac{P_1'M_1'}{P'M'}=\frac{D+d}{D},$$

$$\frac{P_2M_2}{PM}=\frac{R+r}{R};\ \frac{P_2'M_2'}{P'M'}=\frac{R+r}{R}$$

but as

$$\frac{D}{d}=\frac{R}{r},$$

therefore $P_1M_1=P_2M_2$ and also $P_1'M_1'=P_2'M_2'$.

The grid elements of the secondary grid diaphragm, shown in section in Fig. 2*a*, extend parallel to the plane of Fig. 2. Consequently the excursion of the focus relative to the axis N . . . M can be of any size desired, more particularly as the body section to be reproduced will be pictured throughout its entire extent in every position of the Roentgen tube focus. Assuming D=40 cm. and *d*=20 cm. and R'=30 cm., then a body layer *f* at a distance *a*=5 cm. from the plane O, O' and extending parallel to the latter, will produce a shadow of approximately elliptical form, having a superficial area somewhat larger than that of the circular shadow, which, other things being equal, would be obtained if the Roentgen tube focus were moved along a circular path parallel to the plane O, O' having the maximum radius R'=11.6 cm. permitted by the secondary grid diaphragm, as previously explained. The fact that the shadow is herein extended or drawn out longitudinally (its longitudinal axis in the plane of Fig. 2 is approximately 2.25 times its transverse axis) makes it possible, by correspondingly choosing the direction of movement relative to the body, to obliterate or efface the undesirable shadow in the most favorable direction for the reproduction of the picture. As R' may be greater than 30 cm., it is possible by using the method forming the object of the present invention to distribute the Roentgen shadow of the body layer *f* over a much larger surface or area than has heretofore been possible.

In the illustrative embodiment of the invention, the Roentgen tube and the carrier for the picture-receiving layer are carried adjacent the opposite ends respectively of a rigid double arm lever which is rotatable about its axis A lying in the plane O, O' in the picture plane of Fig. 2*a*. The transmission of the movement of the Roentgen-ray tube to the carrier of the picture-receiving layer thus is effected with the complete elimination of transmission means which execute oscillation in space about a point. As the rotation here is about a stationary axis, the desired and required movement of the Roentgen tube focus and the carrier of the picture plane as a unit is secured without difficulty. Preferably the stud shaft about which said lever rotates will be of relatively large diameter in order to avoid any possible play. Means are provided for maintaining the picture-receiving layer in constant parallelism with the body section to be reproduced. Any suitable means may be provided for this purpose without departing from the spirit of the invention, said means herein comprising a rectilinear guide including links that are rotatable about axes that are parallel to the axis of rotation of said lever and which therefore also move each one in a plane that is perpendicular to said axis of rotation. In this case, therefore, also oscillatory or pendulating movements about a point are avoided.

In order to be able to make a series of different parallel body sections it is necessary that the axis of rotation of said two-arm lever and the supporting surface for the body the sections of which are to be reproduced shall be relatively adjustable, so that the axis of rotation of said lever may always be brought into the same plane as that of each body section to be reproduced. This may be accomplished by making it possible to raise and lower said lever axis or said body supporting surface or both. In each case it will be preferable to adjust the secondary grid diaphragm with the light sensitive layer so that it may always remain as close as possible to the body to be reproduced.

Referring now more particularly to Figs. 3 and 3*a* showing an illustrative construction for practicing my method, the body 1 to be reproduced, see more particularly Fig. 3*a*, is supported or rests upon a supporting table 2. In order not to complicate the drawings this table has been shown

only diagrammatically in Figs. 3 and 3a. It may be of any suitable and conventional construction, such as is commonly used in hospitals for example, in which the patient lies upon a vertically adjustable surface which is carried by a frame supported upon rollers so as to enable the patient to be rolled into the desired position between the Roentgen-ray tube 6 and the picture-receiving layer 12, see Fig. 3a in which the patient is diagrammatically indicated by 1. The double arm lever 3, 3' is rotatable about a horizontal stud shaft 4 carried by a rigid support comprising a base 14 and a standard 4' integral therewith. The arm 3 of said lever carries the Roentgen-ray tube 6 secured in the tube housing 5 which will preferably be high tension proof. The other arm 3' of said lever is provided with a longitudinal guiding slot 5' in which are slidably mounted a carriage 7 and a weight 8. A spindle 9 is mounted for rotary movement in said lever arm 3' and is provided with right and left screw threaded portions which are in screw threaded engagement with correspondingly screw threaded bores in said carriage and weight, respectively. Said spindle may be provided at its lower end with a wheel 9' for rotating the same vertically to adjust said carriage and weight, movement of said carriage and weight being always in opposite directions as will readily be understood. The weight 8 and the carriage 7 with the parts carried by the latter are equal in weight, so that the center of gravity of the lever arm 3' including all the parts carried thereby is always at the same distance from the axis of rotation 4. The lever arm 3 and 3' and masses carried thereby are so chosen that this entire structure is in balanced condition in its rotation about the axis 4. The secondary grid diaphragm 11 and the light sensitive layer 12 in its holder are rotatable about trunnions 10, 10, one of which is journaled in said carriage 7 and the other in a bracket 10' projecting from said carriage. The stud shaft 4 is preferably carried by a carriage 13 slidable vertically in a guide slot in the standard 4' and provided with a screw threaded bore 14' in screw threaded engagement with a screw threaded spindle 15 provided at its upper end preferably with a wheel 15 by rotation of which said carriage 13 and parts carried thereby may be raised and lowered as desired. Said carriage 13 (see Fig. 3) is provided with brackets 17, 17' rigidly secured thereto and carrying pivots 18, 18' upon which the upper ends of links 19, 19' are pivoted. The upper ends of these telescoping or otherwise extensible links 19, 19' are pivotally connected by pivots 20, 20', respectively carried by the opposite ends of the holder or frame 11' containing the picture-receiving surface and carrying the diaphragm frame 11. As in the swinging movement of the lever 3 the sensitive layer holder 11' and consequently pivots 20, 20' will swing with said lever, while pivots 18, 18' on the stationary brackets 17, 17' do not swing with said lever, it would be apparent that said links 19, 19' will swing in parallelism about said pivots 18, 18', thus causing said holder 11' to move parallel to itself. Said holder 11' will thus be kept parallel to itself and to the body section O, O' to be radiographed during the movement of said holder in the opposite direction to the movement of the X-ray tube, as will also the picture receiving layer contained in said holder. Means is thus provided assuring that the secondary grid diaphragm 11 and with it the picture-receiving layer 12 shall always remain horizontal. As will clearly appear from the description of Figs. 2 and 2a, the body section diagrammatically indicated by the dotted line O, O', Fig. 3a, which coincides with the geometrical axis of the shaft 4, will be radiographed upon the Roentgen-ray sensitive layer 12 in making the exposure with the moving Roentgen-ray tube 6. By rotating the hand wheel 15, the stud shaft 4 can always be adjusted so as to be in the plane of the body section to be radiographed. For example if said stud shaft has been lowered a distance of 2 cm., the carriage 7 will be raised 2 cm. by rotating the spindle 9, so that said secondary diaphragm 11 and with it the layer 12 for receiving the picture are once more adjusted in normal position relative to the supporting plate 2 and to the body 1 to be radiographed. It will be apparent to those skilled in the art that the screw-threaded spindle 9, when the lever 3, 3' is in vertical position, could be suitably connected with the screw threaded spindle 16, so that, by rotating the hand wheel 15, adjustment of the carriage 7 and carriage 13 could be simultaneously effected and in the same degree. The carriage 13 may be provided with adjustable stop arms (22, 22') by which the angle through which the lever 3, 3' may be swung in either direction about the stud shaft 4, may be limited.

If that body section which is at the height of the axis of rotation 4, is to be radiographed, the double lever 3, 3' will be brought into one of its end positions for example that determined by a stop 22. These end positions are indicated approximately by broken lines A—B and C—D, respectively in Fig. 3. Simultaneously with the throwing of the Roentgen tube into circuit said double lever 3, 3' will be put in motion and swung slowly into its other end position. At the moment said lever reaches said other end position or shortly before, the Roentgen-ray tube will be thrown out of circuit. Movement of said lever 3, 3' could also be effected by an electro-motor. In such case, electrical contacts would be provided on the stop levers of which one would be actuated a short time after said lever 3, 3' had been set in motion by the motor and the other would be actuated shortly before said lever 3, 3' reaches its other end position. The first contact would serve to throw the Roentgen apparatus into operation and the other to throw it out of operation. Preferably a transmission element will be inserted between the electro-motor and the double lever 3, 3', or, by means of a resistance or voltage regulator controlled by said lever 3, 3', the number of revolutions of the electro-motor will be so controlled that the angular speed of movement of the lever 3, 3' would increase until it reached its vertical position and then diminish. Any suitable means may be provided for this purpose without departing from the spirit of the invention, a convenient arrangement being the following:

A contact lever 23 (Fig. 4) swings above the stud shaft 4 with said lever 3, 3', its free end cooperating with a semi-circular resistance 24. The median point of said resistance is connected at 25 to a conductor leading to one terminal of an electro-motor 26. The other terminal of said motor and said contact lever 23 are connected respectively by suitable conductors with the two energy supplying mains. That part of the resistance 24 between the contact point of said contact lever 23 and the connecting point 25 is always included in the circuit of said motor 26 and serves to throttle the operation of said motor. It will be apparent from what was said above that during

the swinging movement of said lever 3, 3' and consequently of said contact lever 23, said portion of said resistance that is in circuit will first be diminished and thereafter increased, so that the number of revolutions of said electromotor will first be gradually increased and thereafter decreased.

When it is desired to radiograph sections of a body, whether it be a human or animal body or a section of a piece of work or other article, which contain massive or solid body elements possessing two preferred directions at right angles to each other, parallel to the body sections to be radiographed, it is preferable to efface or obliterate the disturbing or interfering shadows resulting from such body elements in a direction inclined at an angle to the said preferred direction, for example at an angle of 45°. Thus, for example, in making radiographs of sections of the trunk, it is preferable to adjust the plane in which the Roentgen-ray tube is to be swung in accordance with the invention, at an angle of 45° to the longitudinal axis of the table or supporting surface upon which the patient is positioned.

I am aware that my present invention may be embodied in other specific forms from that herein described without departing from the spirit or essential attributes thereof, and I therefore desire the present embodiment and example of said invention to be considered in all respects as illustrative and not restrictive, reference being had to the appended claims rather than to the foregoing description to indicate the scope of the invention.

I claim:

1. Method of making radiographs of body sections which comprises moving the X-ray tube focus and the film as a unit in opposite directions in respect to the body to be radiographed and in a plane perpendicular to the body section to be radiographed, in making the exposure; throughout said movement of the X-ray tube focus and the film directing the central ray from the X-ray tube always substantially upon the same point of the body section to be radiographed; and throughout said movement of the X-ray tube focus and the film maintaining the film parallel with itself, in such manner that each ray passing through any point of the body section to be radiographed will always fall upon the same point of the film.

2. Method of making radiographs of body sections which comprises moving the X-ray tube focus and the median line of the film as a unit in opposite directions in making the exposure, about an axis lying in the plane of the body section to be radiographed and in a plane at right angles to the body section to be radiographed; and maintaining the film parallel with itself during said movement.

3. Method of making radiographs of body sections which comprises moving the tube focus and the middle point of the film in opposite directions in making the exposure, said movement being in a plane that is perpendicular to the body section to be radiographed and parallel to the edges of a scattered ray grid diaphragm; maintaining said grid diaphragm parallel to said film during said movement; and throughout said movement directing the central ray from the tube always toward the same point of said body section while maintaining the film parallel with itself during the movement thereof.

4. Apparatus for making radiographs of body sections comprising, in combination, a lever adapted to swing in a plane perpendicular to the body section to be radiographed about a fulcrum having its axis in the plane of the body section to be radiographed; an X-ray tube, a film box support mounted for rocking movement about an axis perpendicular to the plane in which said lever swings, said X-ray tube and said support being carried by said lever at opposite sides of its fulcrum; and a link system pivotally connecting said support to said lever to maintain said support always parallel to itself during the swinging movement of said lever.

5. Apparatus for making radiographs of body sections, comprising a rigid support; an X-ray tube holder; a film holder; a two-armed lever mounted to swing in a plane perpendicular to the body section to be radiographed about a shaft carried by said support, one arm of said lever being connected to said tube holder and its other arm being connected to a shaft about which said film holder is rotatable; and a link system connecting said support and said film holder to maintain said film holder always parallel to itself.

6. Apparatus for making radiographs of body sections, comprising a rigid support; an X-ray tube holder; a film holder; a two-armed lever mounted to swing in a plane perpendicular to the body section to be radiographed about a shaft carried by said support, one arm of said lever carrying said tube holder and the other arm of said lever carrying a shaft about which said film holder is rotatable; means to adjust said first-named shaft about which said two-armed lever is adapted to swing, lengthwise of said support; and means to maintain said film holder always parallel to itself, during the swinging movement of said two-armed lever.

7. Apparatus for making radiographs of body sections, comprising a rigid support; an X-ray tube holder; a film holder; a two-armed lever mounted to swing in a vertical plane about a shaft carried by said support, one arm of said lever carrying said tube holder and the other arm of said lever carrying a shaft about which said film holder is rotatable, said film holder being pivotally connected to said support by a link system to maintain said film holder always parallel to itself.

8. Apparatus for making radiographs of body sections, comprising a rigid support; an X-ray tube holder; a film holder; a two-armed lever adapted to swing about a shaft carried by said support, one arm of said lever being connected to said tube holder which is secured against rotation relatively to said lever, and the other arm of said lever being connected to a shaft about which said film holder is rotatable, said film holder being pivotally connected to said support by a link system to maintain said film holder always parallel to itself.

9. Apparatus for making radiographs of body sections, comprising a rigid support; an X-ray tube holder; a film holder; a scattered X-ray grid diaphragm connected to said film holder; a two-armed lever adapted to swing about a shaft carried by said support, one arm of said lever being connected to said tube holder and its other arm being connected to a shaft about which said film holder is rotatable, said film holder being pivotally connected to said support by a link system to maintain said film holder always parallel to itself, the edges of the grids of said diaphragm being parallel to the plane in which said lever is adapted to swing.

10. Apparatus for making radiographs of body sections, comprising a rigid support; an X-ray

tube holder; a film holder; a two-armed lever adapted to swing about a shaft carried by said support, one arm of said lever being connected to said tube holder and its other arm being connected to a shaft about which said film holder is rotatable, said shaft being adjustable lengthwise of said lever, said film holder being pivotally connected to said support by an extensible link sytem to maintain said film holder always parallel to itself

11. Apparatus for making radiographs of body sections, comprising a rigid support; an X-ray tube holder; a film holder; a two-armed lever adapted to swing about a fulcrum upon said support, one arm of said lever being connected to said tube holder and its other arm being connected to a shaft movable lengthwise of said lever and about which said firm holder is rotatable, said film holder being pivotally connected to said support by an extensible link system to maintain said film holder always parallel to itself; means to adjust the fulcrum of said lever lengthwise of said support perpendicularly to the plane of said film holder and simultaneously to move the shaft of said film holder lengthwise of said lever the same distance in the opposite direction.

12. Apparatus for making radiographs of body sections, comprising a rigid support; an X-ray tube holder; a film holder; a two-armed lever adapted to swing about a fulcrum on said support; a counterweight movable lengthwise of said lever, one arm of said lever being connected to said tube holder and its other arm being connected to a shaft about which said film holder is rotatable, said film holder being pivotally connected to said support by an extensible link system to maintain said film holder always parallel to itself; means to adjust the shaft of said film holder lengthwise of said lever and simultaneously to move said counterweight in the opposite direction.

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