

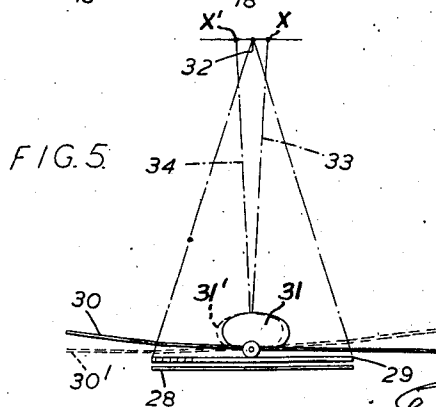
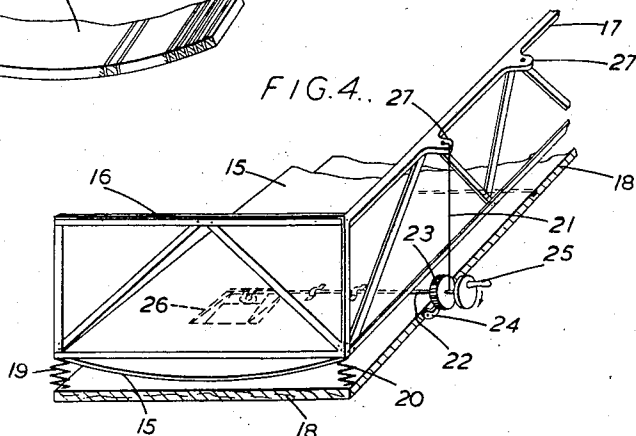
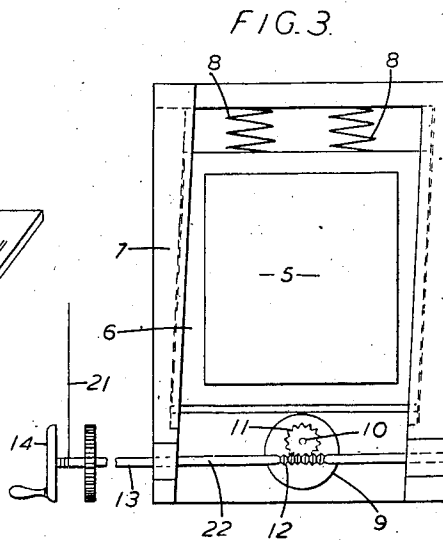
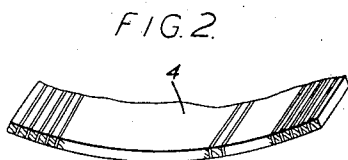
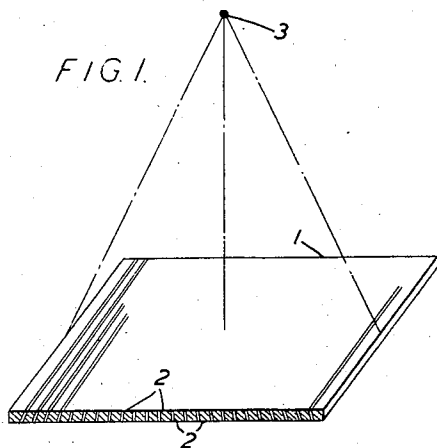
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L. P. C. J. DUDLEY
METHOD OF AND MEANS FOR MAKING STEREOSCOPIC
X-RAY PHOTOGRAPHS

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2 Sheets-Sheet 1



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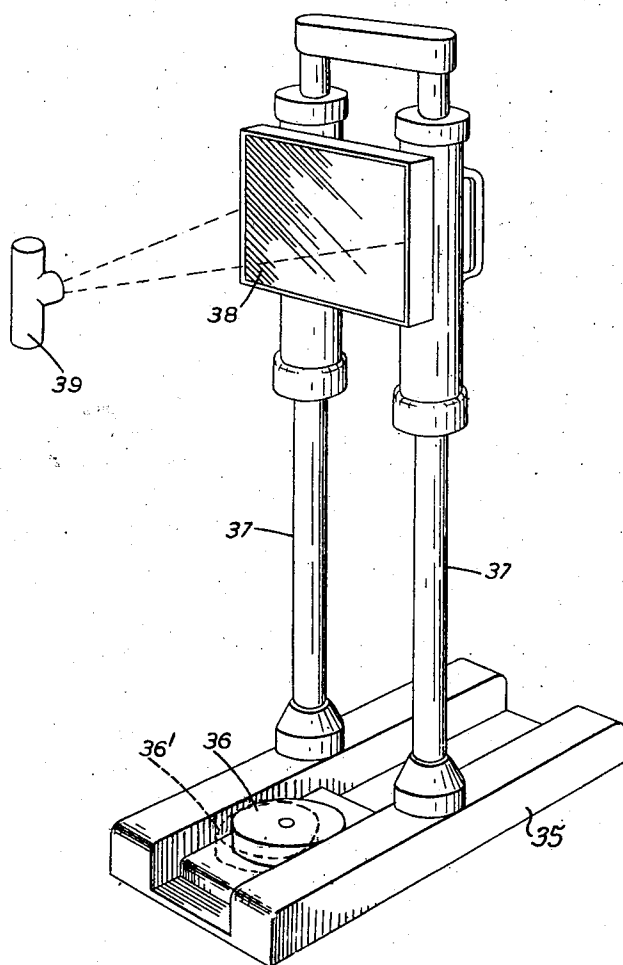
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FIG. 6.



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METHOD OF AND MEANS FOR MAKING
STEREOSCOPIC X-RAY PHOTOGRAPHS

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This invention relates to improvements in or relating to methods of and means for making stereoscopic X-ray photographs, known in the art as stereoscopic radiographs, of the integral or parallax panoramagram type and of the parallax stereogram type.

In previously suggested methods of making stereoscopic radiographs a grid is interposed between the body being subjected to X-radiation and a sensitized film or plate and the source of X-radiation is caused to move during the exposure or between two separate exposures, the said grid being moved in a direction at right angles to the direction of the grid strips and substantially parallel to the sensitized surface. The grid consists essentially of a number of narrow, substantially parallel strips of material having a high degree of opacity to X-radiation, each pair of adjacent strips being separated by a space or medium of high transparency to X-radiation. The thickness of the aforesaid grid is necessarily considerable in comparison with the width of the strips of which it is composed and in an endeavor to ensure that the masking effect of each strip will be substantially uniform notwithstanding the different position which each strip occupies with respect to the source of X-radiation it is desirable to use a grid which is slightly curved in a sense resulting in all points on an imaginary line bisecting the surface of the grid at right-angles to the grid strips lying substantially on the circumference of a circle of which the source of X-radiation is the centre or to employ a grid which is flat but in which the grid strips or some of them are inclined about their transverse axes, the strips near the central axis of the grid being normal to the surface of said grid and the remaining strips being inclined towards the said central axis to an extent which increases progressively towards the edges of the grid. These grids however can only work efficiently when the source of X-radiation is disposed in one particular position with respect thereto and there have therefore been difficulties in carrying out the suggested methods of making stereoscopic radiographs wherein, as above stated, exposures have to be made with the source of X-radiation in at least two different positions.

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to provide a method whereby the aforesaid difficulties may be entirely avoided and a further object is to provide simple and efficient apparatus with the aid of which such method can be carried out.

According to one feature of the present invention there is provided a method of making stereoscopic radiographs wherein a suitable grid is interposed between the body being subjected to X-radiation and the sensitized film or plate and the relative movement necessary between the source of X-radiation and the said body for the purpose of presenting different aspects of the said body to said X-radiation is achieved by moving said body during the exposure or between two or more separate exposures.

According to another feature of the present invention there is provided apparatus for making stereoscopic radiographs comprising a carrier for the body to be subjected to X-radiation, a support for a sensitized film or plate, a grid located between said carrier and said support, a source of X-radiation, means for moving said carrier and so presenting different aspects of the said body to the X-radiation and means for causing relative movement between said grid and said support for the film or plate in a direction at right angles to the longitudinal axis of the grid strips.

It is desirable that the planes of the film or plate and of the grid should be parallel or substantially parallel to one another and it is preferred therefore to employ a curved support for the film or plate in cases where the grid itself is of the curved kind. Such film or plate may be enclosed in a cassette although in some cases it is preferable to dispense with a cassette so as to enable the said film or plate to be disposed closer to the grid, it being desirable to reduce this distance as much as possible and in any event to make such distance small in comparison with that between the X-ray tube and the grid.

In the application of the present invention to the making of radiographs of the parallax panoramagram type the transparent or translucent spaces of the grid are preferably narrower than the opaque strips but in the case of radiographs of the parallax stereogram type the said transparent or translucent spaces and opaque strips are preferably of equal width.

One of the objects of the present invention is

The aforesaid movement of the carrier for the body to be subjected to X-radiation is preferably of an angular nature. Thus for instance a carrier in the form of a cradle or platform may be caused to rock or pivot about an axis parallel to the grid strips, the resultant angular movement of the body carried thereby then presenting different aspects of said body to the X-radiation.

The aforesaid relative movement between the film or plate and the grid may be attained by moving either or both of these parts but in general it is preferable to provide for movement being imparted only to the grid.

The aforesaid movement of the carrier and the movement of the grid or the film or plate support are of course coordinated or synchronised in the appropriate manner. Thus in the making of a radiographic parallax panoramagram the exposure may be a continuous one commencing and terminating respectively with the commencement and termination of the movement of the support or carrier for the body to be subjected to radiation or alternatively a number of separate exposures may be given each with said support or carrier in a different position, in both cases the grid or the plate or film being caused to move through a distance equal to the width of one opaque strip of the grid while the body is being caused to move between its two extreme positions. In this way the whole of the sensitized surface of the film or plate is exposed and an image or succession of images of the parallax panoramagram type will be formed. After development the picture is viewed through an optical lined grid having the same pitch as the radiographic grid and a stereoscopic view is obtained.

The procedure in the production of a radiographic parallax stereogram is similar to that above described but only two exposures are necessary, spaced strips constituting one half of the sensitized surface of the film or plate being exposed during one exposure and the intervening strips constituting the other half of the sensitized surface being exposed during the second exposure. The two exposures are in such cases made whilst the object being subjected to X-radiation is stationary and providing the second exposure is not made until the necessary movement of the object and of the grid or of the plate or film has been completed there is no necessity to synchronize the movements.

In order that the present invention may be well understood certain embodiments thereof will now be described, by way of examples only, and with reference to the accompanying drawings in which:

Figure 1 is a perspective view of one form of grid,

Figure 2 is a broken perspective view of another form of grid,

Figure 3 is a plan view of one form of grid mounting showing one mode of imparting movement to the grid,

Figure 4 shows in broken perspective view one form of carrier for a body to be subjected to X-radiation and one mode of associating the grid therewith.

Figure 5 is a diagrammatic view indicating the principles of the operation of the apparatus shown in Figure 4, and

Figure 6 is a perspective view of another form of apparatus according to the present invention.

Referring to Figure 1 of the drawings, the grid 1 is composed of a number of strips 2 of lead or other material which is opaque to X-radiation

with intervening strips of any suitable material such as a plastic which is transparent to X-radiation. The grid is of plane form and the sides of the opaque strips are so disposed that the angles which such sides make with the plane of the grid are equal to or substantially equal to the angles of incidence of the X-rays falling thereon, the source of radiation being designated 3 in Figure 1. In this way variations in the masking effect at different parts of the grid are avoided.

Figure 2 shows another form of grid and in this embodiment uniform masking is attained by imparting to the grid 4 a curvature which results in a line bisecting the grid strips lying on the circumference of a circle struck about the source of radiation as its centre.

The opaque strips of the grids shown in Figures 1 and 2 may be about four times as wide as the intervening transparent strips if the grid is intended for use in making radiographs of the parallax panoramagram type but for use in making radiographs of the parallax stereogram type the said opaque and transparent strips are preferably of equal width.

Referring now to Figure 3, a grid 5 is mounted in a frame 6 and the sides of such frame which extend longitudinally with respect to the grid strips are parallel to one another but inclined with respect to such strips. The frame 6 is slidably supported in an outer frame 7 and those sides of said frame 7 which are adjacent to the aforesaid inclined sides of the frame 6 are correspondingly inclined with the result that as said inner frame 6 is moved along the outer one in a direction parallel to the grid strips a movement transversely with respect to said strips is also generated.

Springs 8, 8 are interposed between the end members of the frames 6 and 7 for urging the frame 6 towards the base of the frame 7 as viewed in Figure 3 and the means for urging said inner frame in the opposite direction consist of a cam or eccentric 9 mounted on a shaft 10, the said shaft being driven by the worm wheel 11 and worm 12 so that fine control can be exerted over the movement of the grid. The said worm 12 may be cut in or mounted on a control shaft 13 provided with any suitable hand wheel or the like 14.

The range of sliding movement of the frame 6 and the inclination of the relevant parts of its supporting frame 7 are so chosen that the full range of movement will result in a transverse movement at least equal to the width of one opaque strip of the grid and stops may be provided in order to ensure that the range of movement will always be of the correct amount.

Figure 4 shows one form of apparatus including means for supporting a person in a horizontal position whilst being subjected to X-radiation. In this construction the apparatus includes a cradle-like structure comprising a curved carrier 15 capable of being rocked about a longitudinal axis. Said carrier is made of a plastic or other suitable material which is transparent to X-radiation. If desired frameworks such as those designated 16 and 17 may extend from said carrier, such frameworks being made for example from a strong aluminum alloy. In general it is preferable to leave one side of the platform unobstructed but frameworks of the above mentioned kind may be located on the other three sides.

The carrier 15 is supported for example resiliently by means of springs or the equivalent. In the example shown in Figure 4 springs are located between the carrier and the supporting

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base 18, one of the springs on one side being designated 19 and the corresponding spring on the opposite side being designated 20. Positive stops are provided for limiting the extent to which the carrier 15 can rock in both directions and the springs on one side are stronger than the springs on the other side so that the carrier normally tends to rock to its limiting position in one direction.

Means are provided for positively rocking the aforesaid carrier in a direction opposite to that in which it is rocked by the stronger springs, said means consisting in this example of a wire 21 which can be wound to a variable extent on a control shaft 22, said control shaft being provided with a ratchet wheel 23 with which a pawl 24 cooperates so as normally to prevent reverse movement of the carrier. The shaft 22 is provided with a hand wheel or the like 25 and it will be understood that by winding said handle in a direction drawing the wire downwardly the carrier 15 can be rocked to its limiting position in a direction opposite to that in which it tends to move under the influence of its spring mounting and during this time the pawl and ratchet mechanism prevents any inadvertent return movement of the carrier although at the end of the desired movement the pawl 24 can be released whereupon movement of the carrier back to its initial limiting position will be effected automatically under the influence of the above mentioned springs.

A grid assembly shown diagrammatically in Figure 4 and designated 26 is mounted on the base 18, such assembly being for instance similar to that described with reference to Figure 3 of the drawings and the control shaft of such assembly preferably being formed by the abovementioned control shaft 22 of the carrier operating mechanism.

It is desirable that the grid of the aforesaid assembly 26 be flush or substantially flush with the upper surface of the base 18 and for this purpose an opening is provided in the base for receiving such assembly.

In order to enable radiographs to be taken at various points longitudinally along the carrier 15 a plurality of grid assemblies and their associated control gear may be located at intervals along the base and may be operated simultaneously. In cases however where it is only desired to take one radiograph at a time but at various positions along the carrier the said grid assembly and control gear may be readily detachable from the base 18 and applicable thereto at various points. Thus for instance a series of openings may be provided in the base for receiving the grid assembly and the wire 21 of the control gear may selectively engage one of a series of lugs such as the lugs 27 on the rocking part of the apparatus.

The rocking movement of the carrier 15 is so coordinated with the movement of the grid in a direction at right angles to the grid strips that during the time taken for such grid to move through a distance equal to the width of one opaque strip the platform completes the rocking movement between its limiting positions assuming that radiographs of the parallax panoramagram type are being made. If however radiographs of the parallax stereogram type are being made synchronisation of these movements is not essential it being only necessary to ensure that each of the two exposures is made when the cradle and grid are in their appropriate limit positions.

Figure 5 indicates diagrammatically the prin-

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ciple involved in using the apparatus illustrated in Figure 4. As will be seen from such figure the sensitized film or plate 28 is located close to the grid 29. The carrier 30 which is the equivalent of the carrier 15 of Figure 4 is also located as close as possible to the grid. The carrier 30 which in this example has upwardly inclined side portions is rockable from the position shown in full lines to the position shown in dotted lines and designated 30'. The body 31 to be subjected to X-radiation is located at the centre of the carrier 30 and the source 32 of X-rays is also located in alignment with the centre of the carrier.

When the carrier 30 is in the position shown in full lines the body 31 is in the position also shown in full lines and a line drawn normal to the central axis of the carrier extends in the direction of the line 33. When however the carrier is in the position 30' the body 31 is in the dotted line position designed 31' and a line normal to the central axis of the carrier extends in the direction of the line 34. Two different aspects or a series of different aspects of the body 31 are accordingly presented to the X-radiation.

It will thus be appreciated that the effect obtained is similar to that which would result from moving the source of X-radiation from X to X' while the body remains stationary, but as the source of X-radiation is not in fact moved the angles of incidence of the rays remain in coincidence with the angles of inclination of the grid strips throughout the exposure in the case of a parallax panoramagram or for each of the separate exposures in the case of a parallax stereogram.

Figure 6 shows a modified form of apparatus suitable for instance for subjecting a person in a standing position to X-radiation. In this embodiment the apparatus includes a base 35 on which is mounted a rotary platform 36 and pillars 37 extend upwardly from said base and carry a grid assembly 38 which may for instance be similar to the grid assembly shown in Figure 3. The grid assembly 38 is preferably adjustable vertically along the pillars 37 and the rotary platform is preferably adjustable horizontally e. g. between the position shown in full lines and the position shown in dotted lines and designated 36'.

When the apparatus shown in Figure 6 is in use the person to be X-rayed stands on the platform 36, and the grid assembly 38 and the source of X-radiation 39 are adjusted to the appropriate positions dependent upon the position of the part to be subjected to radiation. As in the earlier described examples the grid is movable in a direction at right angles to the direction of the grid strips and the exposure is started with the platform and grid in one limiting position and terminated when such parts reach their other limiting position or alternatively separate exposures are made with the parts in their limiting positions or in a series of positions dependent upon the type of radiograph required.

In both of the above examples the means for moving the grid and the carrier or platform for the body to be subjected to X-radiation may be operated manually but in general it is desirable for these to be operated by means of a motor, e. g. an electric motor.

Whilst some embodiments of the present invention have been hereinbefore described it is to be understood that there may be various modifications without departing from the scope of such invention. Thus for example the carrier

or platform for the body to be subjected to X-radiation may be adapted to rotate or rock about an axis extending in any desired direction, there may be provision for making radiographs simultaneously of various parts of the body and the grid and support may be caused to undergo the desired movements by various forms of mechanism other than those specifically described.

I claim:

1. A method of making stereoscopic radiographs wherein a grid is interposed between the body to be subjected to X-radiation and a sensitized surface on which the radiograph is to be made, said grid having a plurality of substantially parallel laterally spaced strips of high opacity to X-radiation and a strip of high transparency in the space between each pair of adjacent opaque strips, the said opaque strips being at least as wide as the transparent strips, comprising moving the grid with respect to the sensitized surface in a direction transversely with respect to the grid strips and through a distance equal to the width of one of the opaque strips of the grid, the source of X-radiation being maintained in a stationary condition, and angularly moving the body as a whole about an axis parallel to the longitudinal axes of the grid strips so as to present different aspects of such body to radiation emanating from said source.

2. Apparatus for making stereoscopic radiographs comprising an angularly movable carrier for supporting the body to be subjected to X-radiation, a support for a sensitized coating, a grid having a plurality of substantially parallel laterally spaced strips of high opacity to X-radiation and a strip of high transparency to X-radiation in the space between each pair of adjacent opaque strips, the said opaque strips being at least as wide as the transparent strips, a stationary source of X-radiation, means for moving the grid with respect to the sensitized coating in a plane parallel thereto through a distance equal to the width of one opaque strip of the grid and in a direction transversely with respect to the grid strips, and means for moving said carrier and thereby positively moving a body located thereon in a direction substantially at right-angles to the longitudinal axes of the grid strips so as to present different aspects of such body to radiation emanating from said source.

3. Apparatus as claimed in claim 2, wherein the sides of the grid strips are inclined at angles substantially equal to the angles of incidence of the X-rays falling adjacent thereto.

4. Apparatus as claimed in claim 2 wherein the grid is curved in a sense resulting in a line bisecting the grid at right angles to the grid strips being substantially coincident with the arc of a circle struck about the source of X-radiation as a center.

5. Apparatus as claimed in claim 2 wherein the carrier comprises a cradle mounted for rocking movement about an axis parallel to the longitudinal axes of the grid strips.

6. Apparatus as claimed in claim 2 wherein the carrier comprises a rotary turntable mounted for rotation about an axis parallel to the longitudinal axes of the grid strips.

7. Apparatus for making stereoscopic radiographs comprising a movable carrier for the body to be subjected to X-radiation, a support for a sensitized coating, a grid having a plurality of substantially parallel laterally spaced strips of high opacity to X-radiation and a strip of high transparency to X-radiation in the space be-

tween each pair of adjacent opaque strips, said opaque strips being at least as wide as the transparent strips, a stationary source of X-radiation, means for moving the grid with respect to the sensitized coating in a plane parallel thereto and through a distance equal to the width of one opaque strip in a direction transversely with respect to the grid strips, and means for moving said carrier and thereby moving a body located thereon in a direction substantially at right-angles to the longitudinal axes of said grid strips so as to present different aspects of such body to radiation emanating from said source, wherein said carrier is in the form of a rockable cradle having spring suspension means disposed along its two sides, the suspension means on one side being stronger than those on the other side so that said cradle is normally rocked to one of its limiting positions.

8. Apparatus as claimed in claim 7 wherein movement of the cradle in a direction opposite to that in which it is biased by the spring suspension means and movement of the grid are effected by common driving mechanism.

9. Apparatus as claimed in claim 2 wherein movement of the carrier and movement of the grid are effected by common driving mechanism.

10. Apparatus for making stereoscopic radiographs comprising an angularly movable cradle for supporting the body to be subjected to X-radiation, a support for a sensitized coating, a grid having a plurality of substantially parallel laterally spaced strips of high opacity to X-radiation and a strip of high transparency to X-radiation in the space between each pair of adjacent opaque strips, the said opaque strips being at least as wide as the transparent strips, a stationary source of X-radiation, means for moving the grid with respect to the sensitized coating in a plane parallel thereto through a distance equal to the width of one opaque strip of the grid and in a direction transversely with respect to the grid strips, and means for rocking said cradle about an axis parallel to the longitudinal axes of the grid strips.

11. Apparatus for making stereoscopic radiographs comprising a rotary turntable for supporting the body to be subjected to X-radiation, a support for a sensitized coating, a grid having a plurality of substantially parallel laterally spaced strips of high opacity to X-radiation and a strip of high transparency to X-radiation in the space between each pair of adjacent opaque strips, the said opaque strips being at least as wide as the transparent strips, a stationary source of X-radiation, means for moving the grid with respect to the sensitized coating in a plane parallel thereto through a distance equal to the width of one opaque strip of the grid and in a direction transversely with respect to the grid strips, and means for rotating said turntable about an axis parallel to the longitudinal axes of the grid strips.

12. Apparatus for making stereoscopic radiographs comprising a movable carrier for the body to be subjected to X-radiation, a support for a sensitized coating, a grid having a plurality of substantially parallel laterally spaced strips of high opacity to X-radiation and a strip of high transparency to X-radiation in the space between each pair of adjacent opaque strips, the said opaque strips being at least as wide as the transparent strips, a stationary source of X-radiation, means for moving the grid with respect to the sensitized coating in a plane parallel there-

to through a distance equal to the width of one opaque strip of the grid and in a direction transversely with respect to the grid strips, and means for moving said carrier and thereby positively moving a body located thereon in a direction substantially at right-angles to the longitudinal axes of the grid strips so as to present different aspects of such body to radiation emanating from said source, the said movement of the carrier and the said movement of the grid being effected by common driving mechanism.

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