Dec. 19, 1939. H. C. BERTRAM 2,184,174

X-RAY APPARATUS

Filed March 11, 1938 2 Sheets-Sheet 1

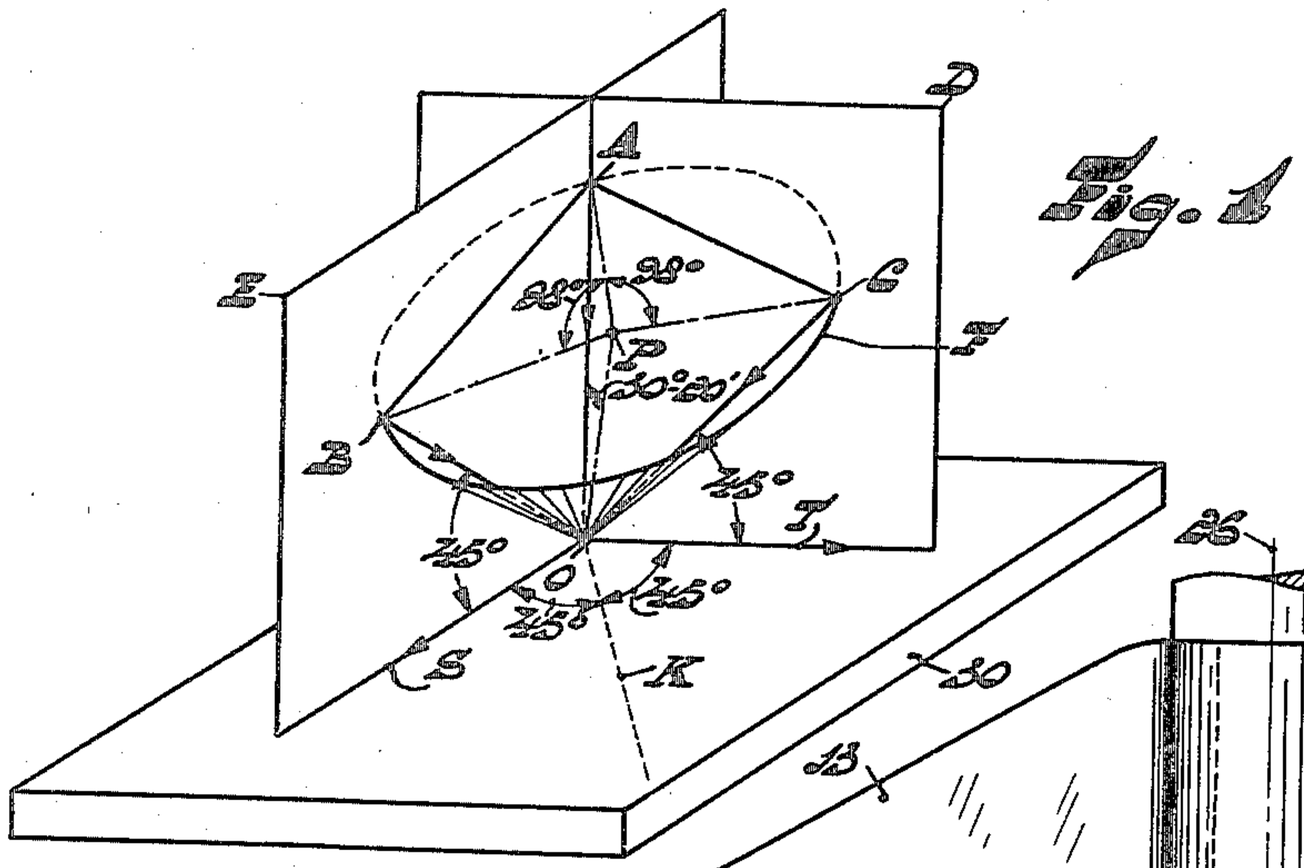

Fig. 1

Fig. 2

Fig. 3

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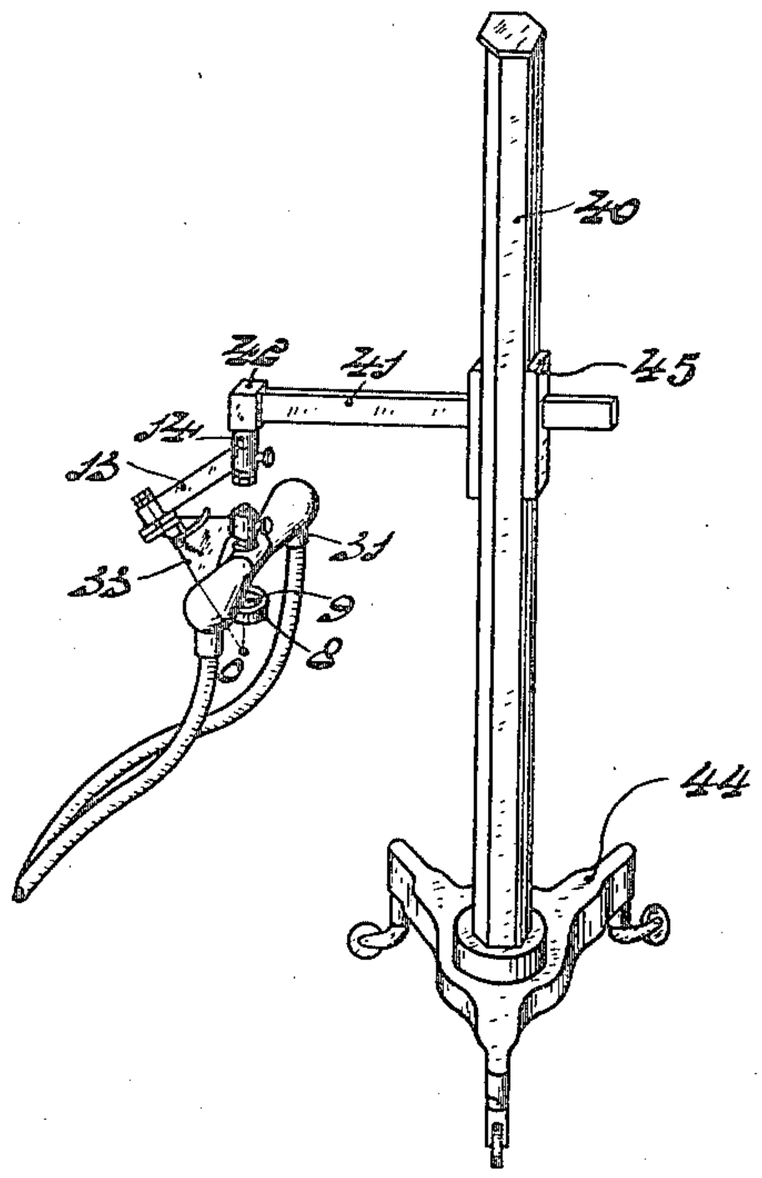
Fig. 4



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Patented Dec. 19, 1939 2,184,174

UNITED STATES PATENT OFFICE

2,184,174

X-RAY APPARATUS

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Application March 11, 1938, Serial No. 195,409
In Germany March 17, 1937

5 Claims. (Cl. 250—65)

My invention relates to X-ray apparatus, and particularly to a supporting device for an X-ray tube for investigating stresses in materials.

For this purpose, it is common practice to make three radiographs from the surface of the body to be examined, which may be a work-piece or a machine part, by causing the X-rays reflected and dissipated from the surface to act upon a photographic layer. In making these radiographs, a narrow X-ray beam is caused to impinge in three different directions upon the same point of the surface of the body. For one of these radiographs, the X-ray beam extends normal to the surface; for the second radiograph it makes an angle of 45° with the surface of the body and lies in a plane which is normal to the surface of the body and passes through the direction of the stress to be measured; and for the third exposure it forms an angle of 45° with the surface of the body and lies in a plane which is normal to the first plane and to the surface of the body.

With existing apparatus it is very difficult to accurately adjust the X-ray tube together with the diaphragm and exposure device into each of these three directions of exposure, and the operation of such apparatus is very time-consuming.

The object of my invention is to overcome the above difficulties and to provide an X-ray apparatus with which the X-ray beam can be quickly placed in any of the above positions.

Another object of the invention is to provide an apparatus in which the X-ray beam is accurately located in these positions.

Still further objects and advantages attaching to my apparatus and to its use and operation will be apparent to those skilled in the art from the following particular description.

In accordance with the invention, I so support the portion of the apparatus carrying the X-ray tube together with the aperture-diaphragm which serves for the obtainment of the narrow ray beam and in some cases the film-holder, that it can be rotated about the axis of a conical surface of which the three directions of exposure are generatices, and the directrix is a circle. During the three exposures this axis forms an angle of about 30° with the X-ray beam defined by the aperture-diaphragm, and intersects this beam on the side of the apertured diaphragm remote from the X-ray tube so that it is possible to bring the vertex of the conical surface into the surface of the material whose stresses are to be investigated.

I also provide means for accurately locating and holding the apparatus in each of the three positions.

In order that the invention may be clearly understood and readily carried into effect, I shall describe the same in more detail with reference to the accompanying drawings, in which:

Figure 1 is a perspective diagram illustrating the principle of the invention.

Figure 2 is a sectionized side view of one form of construction of a device according to the invention.

Figure 3 is a sectionized view along line X—X of Fig. 2, and

Figure 4 is a perspective view of the apparatus mounted upon a stand.

In Fig. 1, the reference numeral **30** indicates a plate of a material in which stresses indicated by lines S and T are to be determined at a point **0** on the surface thereof. Perpendicular to the surface of plate **30** and passing through lines S and T respectively, are two planes D and E intersecting in a line AO which is also perpendicular to the surface of the plate **30**. One of the three exposures, which as mentioned above are usually made for determining the stress in the plate 30, is taken along line AO in the direction indicated by the arrow. Lying within plane E and making an angle BOS of 45° with the line OS is a line BO which represents the direction in which a second exposure is taken. Lying within plane D and making an angle COT of 45° with the line OT is a line CO, which represents the direction in which the third exposure is taken.

Assuming that AO, BO and CO are of equal length, a circle F drawn through the points A, B and C will have its center at a point P. A line PO can then be considered as the axis of a cone and forms an angle of 30° 20′ with each of the lines AO, BO and CO. Thus, lines AO, BO and CO are generatrices of a conical surface of revolution whose axis of rotation is the line PO and whose directrix is the circle F.

According to the invention, the X-ray tube, together with the apertured diaphragm, is adapted to rotate about an axis of rotation which coincides with the cone-axis OP. Thus it is only necessary to rotate the tube about the axis of rotation to bring the X-ray beam into either of the directions AO, CO and BO.

Preferably, I provide means for quickly locating the X-ray beam at either of the positions indicated by lines AO, CO and BO, for instance by a set of adjusting marks, or a braking or locking device by which the desired angular displacements about the axis of rotation of the

meridian plane through the ray beam are rendered readable or perceptible. As both the angles APB and APC have a value of about 98° and the normal adjustment, i. e., when the X-ray beam lies in the direction AO, can of course be readily found, by rotating the X-ray tube around the axis OP by 98° to the left and to the right of the normal position the ray directions BO and CO are determined. The adjusting marks, or the like, may be so formed that two of the meridian planes in which the X-ray beam is located for the adjustments determined by them form with each other an angle of about 200°, preferably of 196°, and the third one, i. e., corresponding to line AO, divides this angle into two equal parts.

One construction of my apparatus according to the invention is illustrated in Fig. 2 in which reference numeral 31 designates an X-ray tube having an envelope 1 provided with an X-ray window 23, and an anode 2 provided with a target 32 upon which a focal spot 3 is formed during operation.

The X-ray tube is supported by a suitable clamping ring 4 provided with a trunnion 5 rotatably mounted on an arm 6 of a supporting member 33. A screw 7 serves to hold trunnion 5 in the desired position. Member 33 has a flange portion 17, and an annular portion 8 carrying a diaphragm 9 of X-ray absorbent material, such as copper or lead, and provided with an aperture 10. Aperture 10 serves to form the X-rays leaving tube 31 through window 23 into a narrow beam, and a film holder 27 carried by portion 8 serves to hold the films for receiving the X-rays reflected from the body 30.

Secured to portion 17 of member 33 is a pivot 11 which is rotatably mounted in a cylindrical member 12. The axis 24 of the pivot (which corresponds to the line PO in Fig. 1) forms an angle of 30° 20′ with the line 25 which is the axis of the X-ray beam leaving aperture 10. With the apparatus in the position shown, line 25 is also the normal direction and corresponds to line AO of Fig. 1. Thus, by rotating member 33 about the axis 24 the X-ray beam may be placed in positions corresponding to lines BO and CO of Fig. 1.

Rotatably mounted on a member 14 forming part of a supporting device, is an arm 13 having a cylindrical portion 12. The pivot 11 is rotatably mounted in the portion 12 and secured thereto by means of nuts 34 and a collar 48. A screw 15 serves to secure arm 13 in the proper position on member 14.

The cylindrical portion 12 has a flange 16 which engages the flange 17 of the supporting member 33. It is, as shown in Fig. 3, provided with three notches 35, 36 and 37, notches 37 and 35 being located 98° from notch 36. Pivoted on member 33 at a point 18 (see Fig. 2) is a lever 38 having a latch portion 20 adapted to engage one of the notches 35, 36 and 37, a handle portion 19 and an arm 21. A tension spring 22 having one end connected to arm 21 and its other end fixed to member 33 at a point 39 serves to hold portion 20 in engagement with one of the notches. The latch portion 20 can be lifted from the notches by exerting pressure on the handle portion 19 and then the supporting device 33 is permitted to rotate about the axis 24.

In operating the apparatus, the arm 33 is rotated around axis 24 until portion 20 engages notch 36 and the X-ray tube is in the central position. Member 14 is then moved until its axis 26—and thus the axis 25 of the X-ray beam—is perpendicular to the surface of plate 30 at the point O.

The distance between the diaphragm 9 and the surface of the body 30 under examination may be adjusted by means of a supporting device with a vertically slidable carrier for example a supporting device as described in United States patent specification 2,051,508 of Wildeboer. A device of this kind is shown in Fig. 4. It has a pedestal 44 and a carrier 45. The carrier can be displaced along the vertically arranged tubular portion 40 of the stand. The carrier 45 has a horizontally slidable arm 41, provided with an end portion 42. The member 14 forms part of the end portion 42.

The distance between the diaphragm 9 and the surface of body 30 is such that the axis 24 passes through the point O. This distance remains the same in all cases and is for example about 50 mms.

Arm 13 is then rotated about the member 14 until the projection of this arm upon the surface of body 30 intersects the right angle between the two stresses to be investigated, i. e., in Fig. 1 it lies in a plane normal to the surface of the body 30 and passing through line OK. The arm 13 is then secured in this position by tightening screw 15.

The X-ray beam is shown in the normal or central position, i. e., in the direction of line AO in Fig. 1. After taking a radiograph with the beam in this position, member 33 is rotated around axis 24 into positions corresponding to notches 35 and 37 where the second and third radiographs are taken.

I prefer to make the axis 26 coincide with the axis 25 of the X-ray beam because in this case rotation of the arm 13 about axis 26 can be effected without displacing the point at which the X-ray beam impinges upon the surface of the plate.

The angles need not be exactly the values given above, but may vary slightly, for instance may vary about ± 5%. However, the best results are obtained when the axis of rotation makes an angle of 30° 20′ with the normal of the surface to be investigated, and when the notches 35, 36 and 37 are spaced apart at angles of 98°.

While I have described my invention in connection with specific examples, I do not wish to be limited thereto but desire the appended claims to be construed as broadly as permissible in view of the prior art.

What I claim is:

1. An apparatus for investigating stresses in material comprising means for producing a narrow X-ray beam including an X-ray tube and a diaphragm having an aperture, a supporting member and a second member, carrying said X-ray tube and diaphragm said members being rotatably connected to each other by means of a pivot, the axis of said pivot forming an angle of about 30° with the axis of said X-ray beam and intersecting the same on the side of the diaphragm remote from the X-ray tube, and means associated with said members to indicate when said X-ray beam is in each of three predetermined positions, the planes through said axis and the axis of the X-ray beam when in two of said positions forming an angle lying between 180° and 208° and the plane through said axis and the axis of said X-ray beam when in its third position forming equal angles with said first two planes.

2. An apparatus for investigating stresses in

material comprising means for producing a narrow X-ray beam including an X-ray tube and a diaphragm having an aperture, a supporting member and a second member rotatably connected to said supporting member by means of a pivot and carrying said X-ray tube and diaphragm, the axis of said pivot forming an angle of about 30° with the axis of said X-ray beam and intersecting the same on the side of the diaphragm remote from the X-ray tube, and means to indicate the position of the X-ray beam comprising a disc associated with said first member and concentric with the axis of said pivot, said disc being provided with three notches spaced apart at equal angles of about 98°, and a member associated with said second member and adapted to selectively engage the notches.

3. An apparatus for investigating stresses in material comprising means for producing a narrow X-ray beam including an X-ray tube and diaphragm having an aperture, a supporting arm, a member pivotally connected with said arm and a second member pivotally connected with said first member, the axis of pivoting between said first and second member lying in a plane with the axis of pivoting between said first member and said arm and forming an angle of about 30° therewith and with the axis of said X-ray beam and intersecting the latter on the side of the diaphragm remote from the X-ray tube, said second member carrying said X-ray tube and diaphragm.

4. An apparatus for investigating stresses in material comprising means for producing an X-ray beam of small cross section including an X-ray tube and a diaphragm provided with a small aperture, a supporting arm, a member pivotally connected with said arm, a second member pivotally connected with said first member and carrying said X-ray tube and diaphragm, the axis of pivoting between said two members lying in a plane with the axis of pivoting of said first member and said arm and forming an angle of about 30° therewith and with the axis of the X-ray beam and intersecting the beam on the side of the diaphragm remote from the X-ray tube, and means to support a photographic film transverse the axis of the X-ray beam at a point between said diaphragm and the point of intersection of said two axes of pivoing.

5. An X-ray apparatus comprising means for producing a narrow X-ray beam including an X-ray tube and a diaphragm provided with an aperture, a supporting arm and a member pivotally connected therewith and a second member pivotally connected with said first member, the axis of pivoting between said first and said second member lying in a plane with the axis of pivoting between said first member and said arm and forming an angle of about 30° with said latter axis and with the axis of said X-ray beam and intersecting the axis of said beam on the side of the diaphragm remote from said X-ray tube, said second member carrying said X-ray tube and diaphragm, the axis of said X-ray beam coinciding with the axis of pivoting between said first member and said arm when in the plane of said axes of pivoting.

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