Dec. 17, 1946. W. WATSON 2,412,662

X-RAY APPARATUS

Filed Aug. 23, 1944

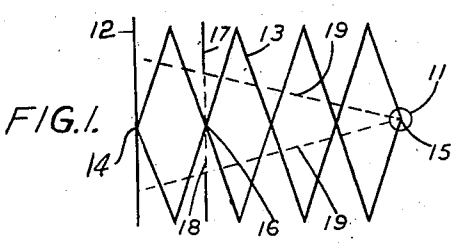


FIG. 1.

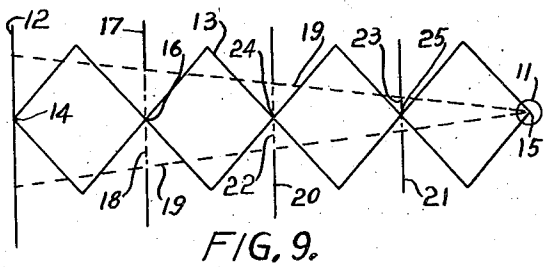


FIG. 9.

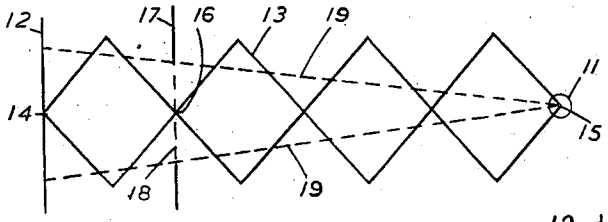


FIG. 2.

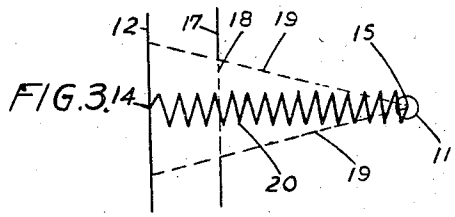


FIG. 3.

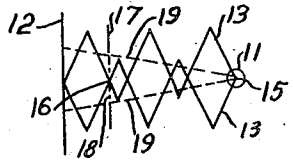


FIG. 10.

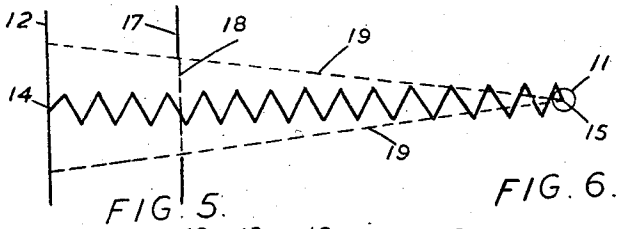


FIG. 4.

FIG. 5.

FIG. 6.

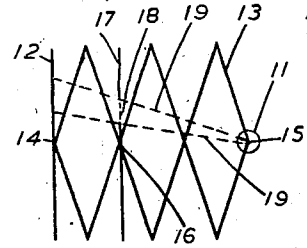


FIG. 7.

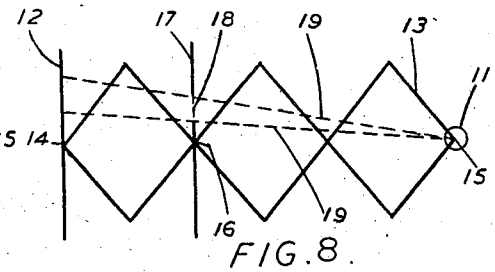
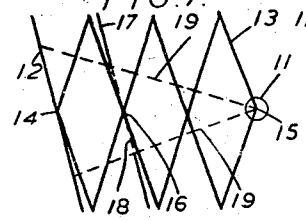
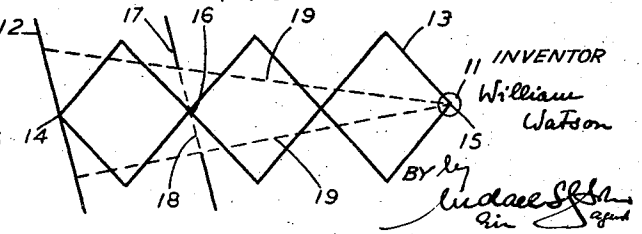


FIG. 8.





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X-RAY APPARATUS

William Watson, Ilford, England

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11 Claims. (Cl. 250—105)

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This invention relates to apparatus for defining the cross-sectional area of a beam of radiation which may be visible light, infra-red, ultra violet, X-rays or gamma rays, or other radiation. The invention is particularly concerned with arrangements for defining the cross-sectional area of a beam of X-rays incident on a fluorescent screen, photographic film, paper, or plate or other element, and will be described with particular reference to that application.

Optimum conditions for radiological observations on a fluorescent screen usually involve the adjustment of the apparatus so that there is only a short distance between the X-ray tube and the fluorescent screen. By keeping the distance short the electrical power energising the X-ray tube may be kept to a minimum and this is desirable where the observation of the fluorescent image on the screen takes some time, as in the observation of movement in medical radiology. On the other hand for optimum conditions for radiography it is usually desirable to adjust the apparatus so that there is a relatively long distance between the X-ray tube and the fluorescent screen since this increases the sharpness of the image.

The cross-sectional area of the beam of X-rays employed is normally defined by inserting a diaphragm of adjustable aperture in the path of the rays. It will be appreciated therefore, that the actual size of the image on the fluorescent screen will vary with the distance of the screen from the X-ray tube, assuming a constant size of aperture in a fixed position relative to the X-ray tube, and it is frequently the case that on increasing the distance between the fluorescent screen and the X-ray tube to that most suitable for radiography, the size of the image on the screen becomes too great and has to be reduced by manually adjusting the aperture to a smaller area.

According to the present invention in apparatus comprising a substantially point shaped source of rays, a substantially plane element on which a beam of said rays is desired to fall, and a diaphragm substantially parallel to said plane element and located between said element and said source of rays, the aperture in said diaphragm serving to define the cross-sectional area of a beam of said rays emitted by said source, there is provided a longitudinally extensible member extending between and joining the said source and the said plane element, the said extensible member having one or more points in its length which move as the said member is extended or retracted a distance which is a constant fraction of the amount by which the said member is extended or retracted, the said diaphragm being

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mounted on the said extensible member at one of such points.

More particularly, according to this invention, the source of rays is an X-ray tube and the plane element is a fluorescent screen or photographic plate, film or paper.

In one form of the invention the extensible member consists of a symmetrical system of crossed levers of the type known as a "lazy-tongs." The pivotal points along the centre line of such a system, where the levers cross one another, and also the other points where the levers are pivotally connected, are points within the meaning defined above. By securing one end of the lazy-tongs to the X-ray tube and the other to the fluorescent screen and by mounting the diaphragm on one of the said pivotal points an increase or decrease in the tube-screen distance, effected by extending or retracting the lazy-tongs, causes a proportional movement of the diaphragm. Thus the cross sectional area of the beam of X-rays falling on the screen remains constant irrespective of the tube-screen distance.

The lazy-tongs system may be of the type in which the levers cross one another at the midpoints of their length, but they may be arranged to cross at some other point along their length, the system necessarily being symmetrical along its longitudinal axis.

In another form of the invention the extensible member consists of a uniform spring. This may be in the form of a coiled metal spring or may be a length of elastic material such as rubber cord. It is the property of a uniform spring that all points along its length move, when the spring is extended or retracted, a distance which is a constant fraction of the distance by which the spring is extended or retracted. The diaphragm may, therefore, be mounted at any convenient point along the length of the spring. By securing one end of the spring to the X-ray tube and the other end to the fluorescent screen and by mounting the diaphragm at some convenient point along the length of the spring, it is ensured that the cross-sectional area of beam of X-rays falling on the screen is constant irrespective of the tube-screen distance.

It will be apparent that any other form of extensible member satisfying the conditions stated above may be similarly employed.

It is sometimes considered desirable to employ a plurality of diaphragms of successively increasing aperture from X-ray tube to screen since it is considered that this reduces penumbral shadow. It is to be understood that several such diaphragms may be used in the present invention

by mounting them at successive pivotal points on the lazy-tongs linkage or by mounting them at intervals along the length of a spring linkage as described above.

As indicated above it is essential that the diaphragm be arranged so as to be substantially parallel to the fluorescent screen or other element. However, the axis of the X-ray beam need not be normal to the fluorescent screen nor need the aperture in the diaphragm be centrally disposed in relation to the axis of the beam; an eccentric aperture will give an image of constant size and position on the screen when mounted in accordance with this invention.

It will be appreciated that the actual construction of the device must take into account the weight of the parts involved; the X-ray tube, diaphragm and screen or any of them may conveniently be mounted in guides or runners to take their weight, the extensible member serving only to control their relative positions.

The aperture in the diaphragm is preferably adjustable but once set will, as indicated above, give the same size image for any tube-screen distance.

The invention will now be described with reference to the accompanying diagrammatic drawing in which Figures 1 and 2 show one form of the apparatus, employing a "lazy-tongs" connection, in different degrees of extension. Figures 3 and 4 show an alternative form of the apparatus, employing a spring connection, in different degrees of extension. Figures 5 and 6 show a form of apparatus similar to that of Figures 1 and 2, employing an eccentrically apertured diaphragm, in different degrees of extension. Figures 7 and 8 show a form of apparatus similar to that of Figures 1 and 2 where the screen is not normal to the X-ray source, in different degrees of extension. Figs. 9 and 10 show two modifications of the apparatus shown in Fig. 1.

Referring to Figure 1, there is provided a source of X-rays 11 and a screen 12. The screen 12 is linked through a lazy-tongs connection 13 to the source of X-rays so that one mid-point end 14 of the lazy-tongs system is located at the screen 12, and the other mid-point end 15 is connected to a point on the X-ray tube (not shown) corresponding with the source of the X-rays 11. At another mid-point 16 of the lazy tongs system is located a diaphragm 17 having an aperture 18. The path of the X-rays from the source 11 to the screen 12 is shown by the limiting lines 19.

In Figure 2 the apparatus of Figure 1 is shown in extended form. It will be noted that, although no change has been made in the dimensions of the aperture 18, the limiting lines 19 meet the screen 12 in the same position as in Figure 1. In other words, the screen 12 and the source of X-rays 11 have been moved further apart without any change in the dimensions of the area of the screen 12 reached by the X-rays.

Figure 3 illustrates similar apparatus in which there is employed a spring 20 instead of the lazy-tongs system 13. One end of the spring 14 is anchored at the screen 12 and the other end 15 at the source of X-rays 11. The diaphragm 17 is located at a point along the length of the spring. In Figure 4 this system is shown extended, and it will be seen that as in the case of Figures 1 and 2, the area of the screen reached by the X-rays is not affected by increasing the distance between the screen and the source of X-rays.

Figure 5 illustrates apparatus of the type of Figure 1 wherein the diaphragm 17 has an eccentrically located aperture 18. This apparatus is shown extended in Figure 6 and it will be seen that, although the aperture is eccentric, the area of the screen reached by the X-rays is not affected by increasing the distance between the screen and the source of X-rays.

Figure 7 illustrates apparatus of the type of Figure 1 wherein the screen is mounted at an angle to the position normal to the source of X-rays, and the diaphragm 17 is mounted at the same angle. This apparatus is shown extended in Figure 8, and it will be seen that, although the screen 12 and diaphragm 17 are at an angle to the normal, the same conditions hold as in the other examples.

Fig. 9 illustrates an apparatus of the type shown in Fig. 1 wherein a plurality of diaphragms 17, 20 and 21 are arranged substantially parallel to screen 12 and located between this screen and the X-ray tube 15. These diaphragms 17, 20 and 21 are provided with apertures 18, 22 and 23, respectively, adjusted so as to define the cross sectional area of the beam of X-rays emitted by the X-ray tube 11. Of course, in accordance with the present invention, these diaphragms are each mounted at a point where the levers are pivotally connected, namely diaphragm 17 at point 16, diaphragm 20 at point 24 and diaphragm 21 at point 25.

Fig. 10 illustrates an apparatus of the type shown in Fig. 1 wherein the levers 13 cross at some other points than the midpoints of their lengths. Of course, in order to obtain proper operation of such a system, it is necessary that the same is symmetrical along its longitudinal axis.

Although in the drawing the element 12 has been designated as a screen, it will be clear that it may alternatively be a photographic film, plate, paper or other substantially plane element on which the X-ray beam is intended to fall. If desired, other diaphragms of appropriate size may be located at other mid-points or any other pivotal point of the lazy-tongs systems of Figures 1, 2, 5, 6, 7 and 8 or at other points along the length of the spring 20 in Figures 3 and 4 for the purpose, for example, of reducing penumbral shadow. Only one diaphragm has been shown in the drawing for the sake of simplicity.

Whilst the foregoing description relates particularly to the case where the source of rays is an X-ray tube, it is to be clearly understood that it may, instead, be a substantially point source of other radiation, e. g. visible light, infrared, ultra-violet or gamma rays. Similarly the fluorescent screen or photographic element may be replaced by any other plane surface.

What I claim is:

1. Apparatus comprising a substantially point shaped source of rays, a substantially plane element on which a beam of said rays is desired to fall, a diaphragm substantially parallel to said plane element and located between said element and said source of rays, the aperture in said diaphragm serving to define the cross-sectional area of a beam of said rays emitted by said source, and a longitudinally extensible member extending between said source and said plane element and joining the same, the said extensible member having at least one point in its length which moves as the said member is extended or retracted a distance which is a constant fraction of the amount by which the said member is extended or retracted, the said diaphragm being

mounted on the said extensible member at one such point.

2. X-ray apparatus comprising a substantially point shaped source of X-rays, a substantially plane element on which a beam of X-rays from said source is desired to fall, a diaphragm substantially parallel to said plane element and located between said element and said X-ray source, the aperture in said diaphragm serving to define the cross-sectional area of a beam of X-rays emitted by said source, and a longitudinally extensible member extending between said source and said plane element and joining the same, the said extensible member having at least one point in its length which moves as the said member is extended or retracted a distance which is a constant fraction of the amount by which the said member is extended or retracted, the said diaphragm being mounted on the said extensible member at one such point.

3. X-ray apparatus comprising a substantially point shaped source of X-rays, a substantially plane element on which a beam of X-rays from said X-ray source is desired to fall, a diaphragm substantially parallel to said plane element and located between said element and said X-ray source, the aperture in said diaphragm serving to define the cross-sectional area of a beam of X-rays emitted by said X-ray source, and a crossed lever lazy-tongs connection extending between said X-ray source and said plane element and joining the same, the said diaphragm being mounted at a point on such connection where the levers are pivotally connected.

4. X-ray apparatus comprising a substantially point shaped source of X-rays, a substantially plane element on which a beam of X-rays from said X-ray source is desired to fall, a diaphragm substantially parallel to said plane element and located between said element and said X-ray source, the aperture in said diaphragm serving to define the cross-sectional area of a beam of X-rays emitted by said X-ray source, and a crossed lever lazy-tongs connection extending between said X-ray source and said plane element and joining the same, the said diaphragm being mounted at a point on such connection where the levers cross one another.

5. X-ray apparatus comprising a substantially point shaped X-ray source, a substantially plane element on which a beam of X-rays from said X-ray source is desired to fall, a diaphragm substantially parallel to said plane element and located between said element and said X-ray source, the aperture in said diaphragm serving to define the cross-sectional area of a beam of X-rays emitted by said X-ray source, and a uniform spring extending between and connecting said X-ray source and said plane element, the said diaphargm being mounted at a point along the length of said spring.

6. X-ray apparatus comprising a substantially point shaped X-ray source, a substantially plane X-ray sensitive element on which a beam of X-rays from said X-ray source is desired to fall, a diaphragm substantially parallel to said plane X-ray sensitive element and located between said X-ray sensitive element and said X-ray source, the aperture in said diaphragm serving to define the cross-sectional area of a beam of X-rays emitted by said X-ray source, and a crossed lever lazy-tongs extending between and connecting said X-ray source and said plane X-ray sensitive element, the said diaphragm being mounted at a point on such connection where the levers are pivotally connected.

7. X-ray apparatus comprising a substantially point shaped X-ray source, a substantially plane X-ray sensitive element on which a beam of X-rays from said X-ray source is desired to fall, a diaphragm substantially parallel to said plane X-ray sensitive element and located between said X-ray sensitive element and said X-ray source, the aperture in said diaphragm serving to define the cross-sectional area of a beam of X-rays emitted by said X-ray source, and a crossed lever lazy-tongs extending between and connecting said X-ray source and said plane X-ray sensitive element, the said diaphragm being mounted at a point on such connection where the levers cross one another.

8. X-ray apparatus comprising a substantially point shaped X-ray source, a substantially plane X-ray sensitive element on which a beam of X-rays from said X-ray source is desired to fall, a diaphragm substantially parallel to said plane X-ray sensitive element and located between said X-ray sensitive element and said X-ray source, the aperture in said diaphragm serving to define the cross-sectional area of a beam of X-rays emitted by said X-ray source, and a uniform spring extending between and connecting said X-ray source and said plane X-ray sensitive element, the said diaphragm being mounted at a point along the length of said spring.

9. X-ray apparatus comprising a substantially point shaped X-ray source, a substantially plane element on which a beam of X-rays from said X-ray source is desired to fall, a plurality of diaphragms substantially parallel to said plane element and located between said element and said X-ray source, the apertures in said diaphragms being adjusted to define the cross-sectional area of a beam of X-rays emitted by said X-ray source, and a crossed lever lazy-tongs connection extending between said X-ray source and said plane element and joining the same, the said diaphragms each being mounted at a point on such connection where the levers are pivotally connected.

10. X-ray apparatus comprising a substantially point shaped X-ray source, a substantially plane element on which a beam of X-rays from said X-ray source is desired to fall, a plurality of diaphragms substantially parallel to said plane element and located between said element and said X-ray source, the apertures in said diaphragms being adjusted to define the cross-sectional area of a beam of X-rays emitted by said X-ray source, and a crossed lever lazy-tongs connection extending between and joining said X-ray source and said plane element, the said diaphragms each being mounted at a point on such connection where the levers cross one another.

11. X-ray apparatus comprising a substantially point shaped X-ray source, a substantially plane element on which a beam of X-rays from said X-ray source is desired to fall, a plurality of diaphragms substantially parallel to said plane element and located between said element and said X-ray source, the apertures in said diaphragms being adjusted to define the cross-sectional area of a beam of X-rays emitted by said X-ray source, and a uniform spring extending between and connecting said X-ray source and said plane element, the said diaphragms being mounted at different points along the length of said spring.

WILLIAM WATSON.