Nov. 3, 1959 C. B. LAND 2,911,537

X-RAY CONE ASSEMBLY

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FIG. 1

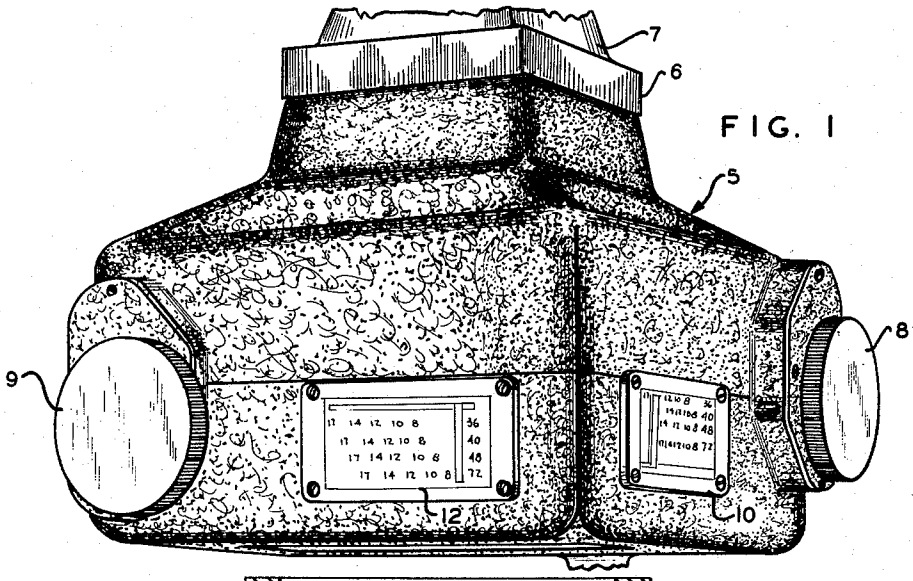
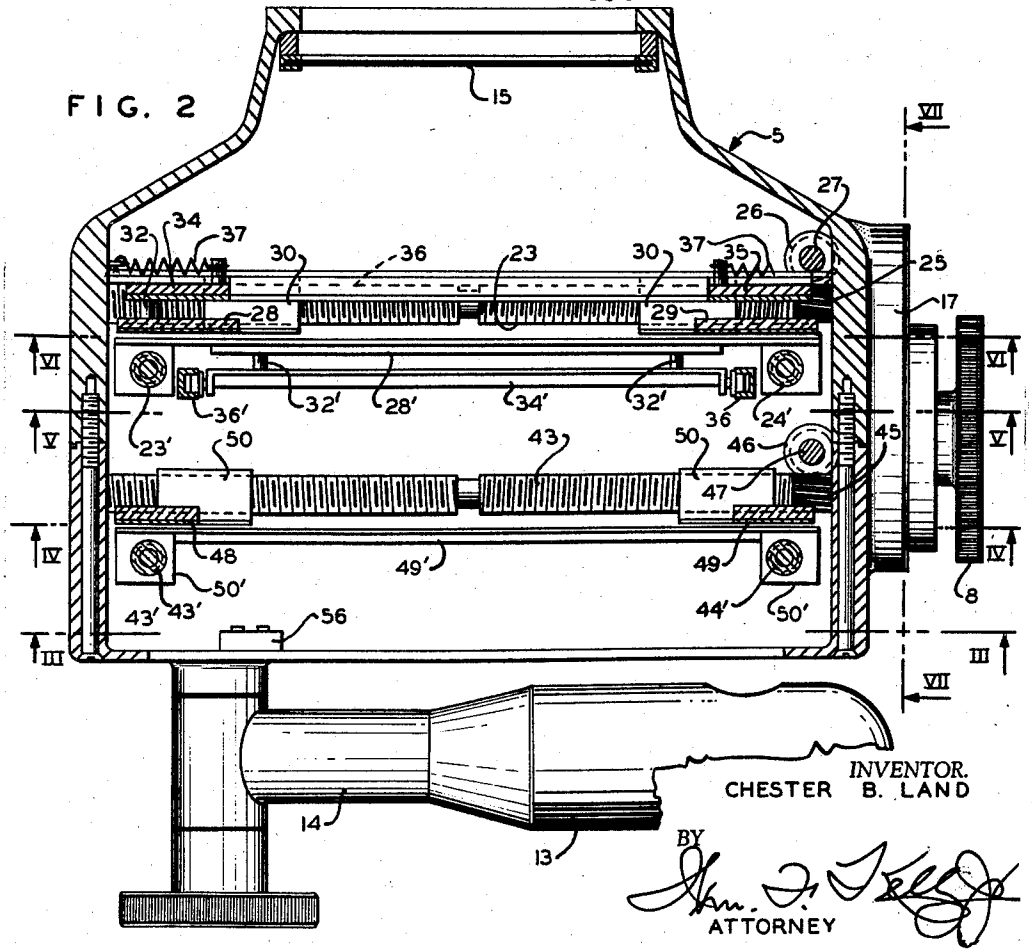


FIG. 2



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FIG. 3

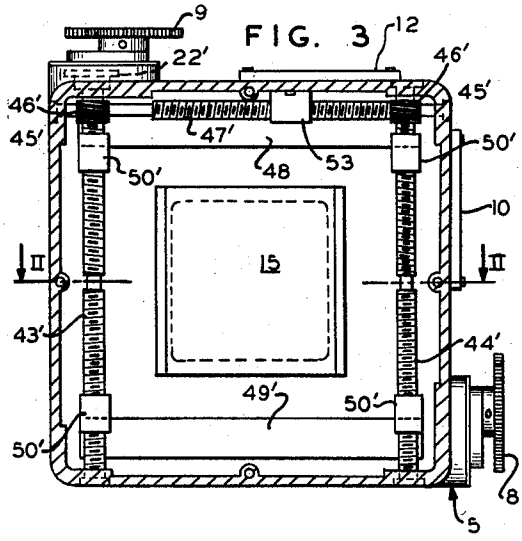


FIG. 4

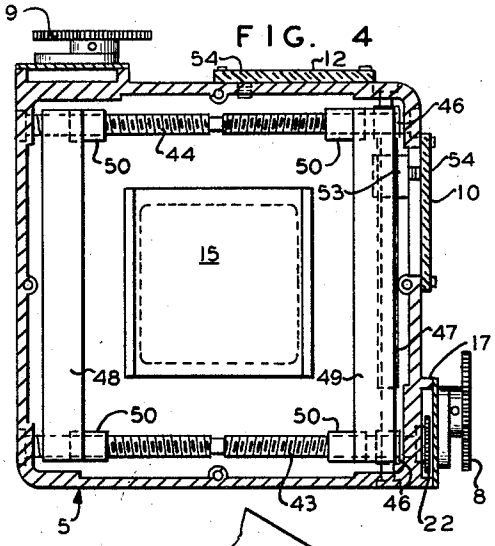


FIG. 5

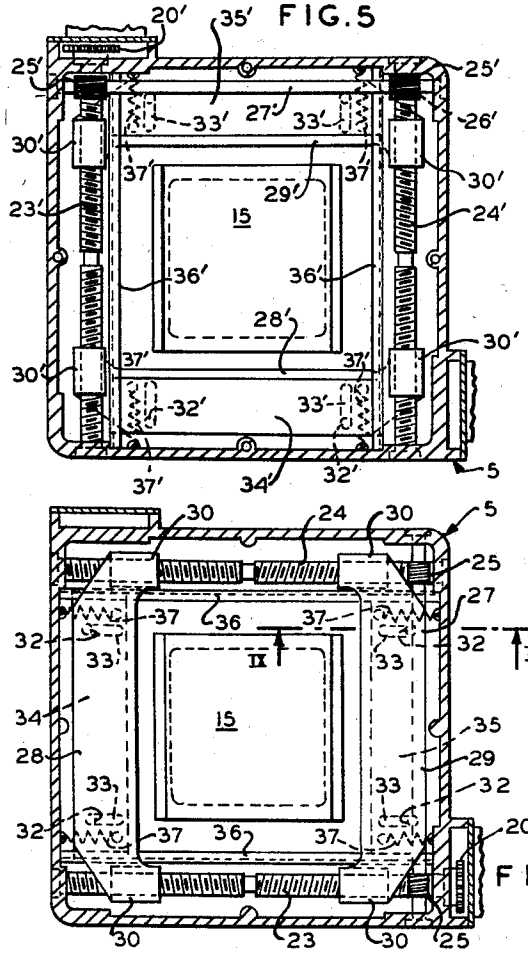


FIG. 7

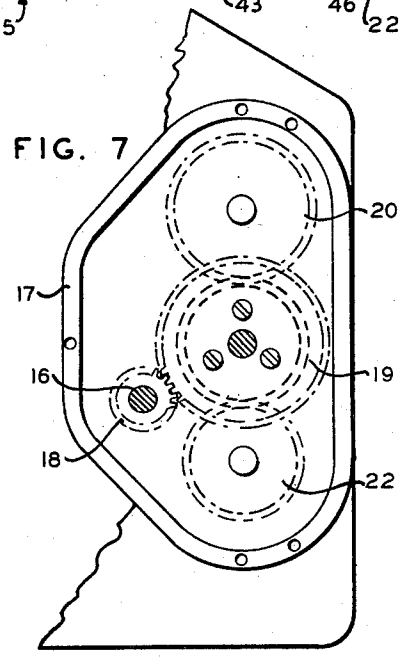


FIG. 6

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FIG. 8

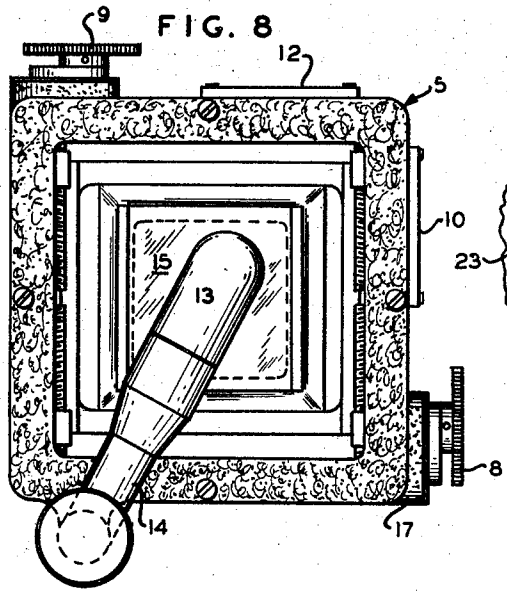


FIG. 9

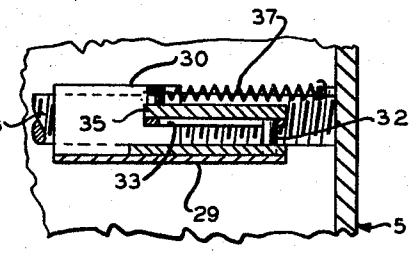


FIG. 10

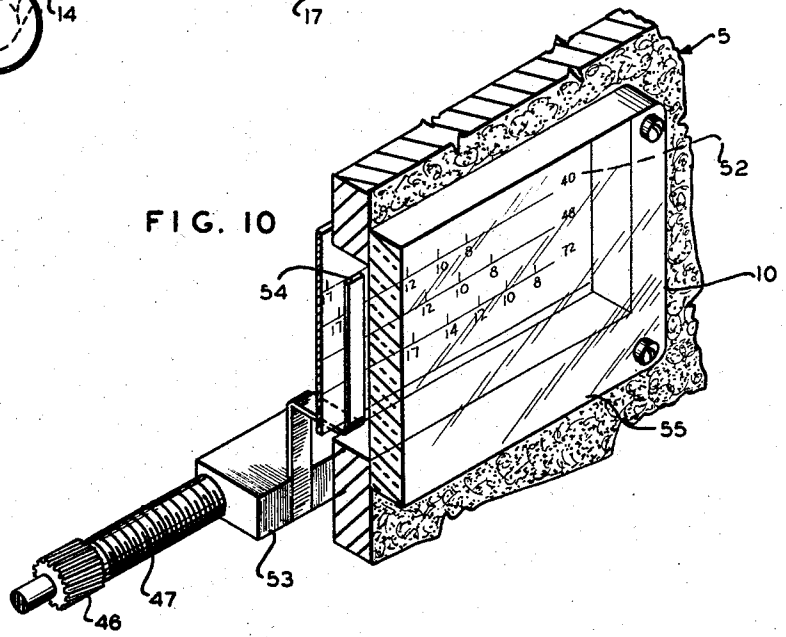
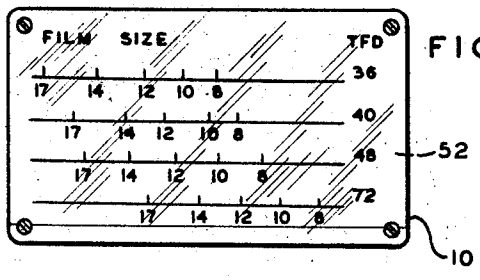


FIG. 11



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2,911,537

X-RAY CONE ASSEMBLY

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Application March 24, 1958, Serial No. 723,330

4 Claims. (Cl. 250—105)

The present invention relates to X-ray apparatus and more particularly to an X-ray cone used to control the area of the beam from an X-ray tube impinging upon a patient or film.

Devices of this type are well known to the art wherein an iris diaphragm or sliding shutter is employed as part of the cone assembly and positioned between the X-ray tube and the patient support at a preselected distance, so as to give a desired area of the X-ray beam at the level of a patient or film. The difficulty with such devices heretofore has been in their lack of accuracy or dependability in restricting the X-ray beam to a definite area even though the diaphragm or shutter seemed to indicate a definite cut-off thus restricting the beam at the patient level to a preselected area. At one time this was not considered too serious since a slightly larger field than necessary did not matter too much. However, with comparatively recent studies of radiation it has now been determined that there is a definite limit in the amount of X-radiation which the human body can tolerate even in a lifetime. Since this discovery, it has now become exceedingly imperative that X-ray dosage be exactly controlled and hence a definite and accurate restriction of the area of an X-ray beam to the minimum necessary for a radiograph or fluoroscopic examination is of paramount importance.

It is accordingly the primary object of the present invention to provide an X-ray cone assembly wherein control mechanism is provided which is preset to give an accurate and dependable selection of the definite size field area of the X-ray beam at the patient or film level.

Another object of the present invention is the provision of an X-ray cone assembly provided with an accurately adjustable shutter operable to give a preselected definite field area of the X-ray beam at the patient or film level with a sharp cut-off of such area.

Another object of the present invention is the provision of an X-ray cone assembly provided with a double diaphragm operable to accurately give a preselected definite field area of the X-ray beam at the patient or film level and wherein such double diaphragm is controllable to give a very sharp cut-off of such area over the entire field range.

A further object of the present invention is the provision of an X-ray cone assembly provided with an accurately adjustable double diaphragm operable to give a preselected definite field area with a dependable cut-off at the patient or film level and wherein such cone assembly is provided with a direct reading indicator which gives at a glance the definite field area at preselected distances of the patient or film from the X-ray tube.

Still further objects of the present invention will become obvious to those skilled in the art by reference to the accompanying drawings wherein:

Figure 1 is a perspective view of the X-ray cone assembly of the present invention with certain appendices broken away,

Fig. 2 is a cross-sectional view of the X-ray cone assembly as shown in Fig. 1 but on a slightly enlarged scale

and taken on the line II—II of Fig. 3 looking in direction of arrows,

Fig. 3 is a cross-sectional view taken on the line III—III of Fig. 2 and looking in the direction indicated by the arrows,

Fig. 4 is a cross-sectional view taken on the line IV—IV of Fig. 2 and looking in the direction indicated by the arrows,

Fig. 5 is a cross-sectional view taken on the line V—V of Fig. 2 and looking in the direction indicated by the arrows,

Fig. 6 is a cross-sectional view taken on the line VI—VI of Fig. 2 and looking in the direction indicated by the arrows,

Fig. 7 is a cross-sectional view taken on the line VII—VII of Fig. 2 looking in the direction of the arrows,

Fig. 8 is a bottom plan view of the X-ray cone assembly of the present invention as shown in Fig. 2,

Fig. 9 is a cross-sectional view taken on the line IX—IX of Fig. 6 and looking in the direction indicated by the arrows,

Fig. 10 is a perspective fragmentary cross-sectional view of the indicator carried exteriorly of the assembly housing,

Fig. 11 is an elevational view of the indicator plate with its direct reading indicia thereon.

Referring now to the drawings in detail the X-ray cone assembly of the present invention as therein shown comprises a substantially rectangular housing **5** tapering toward the top to a frame element **6** by which it is attached to the usual X-ray tube supporting housing so as to normally depend therefrom and be thus disposed between the X-ray tube and the patient and film positioned therebeneath. The housing **5** is provided with control knobs **8** and **9** which are rotatable by an operator to cause movement of a double diaphragm for the purpose of preselecting the actual field area of the X-ray beam at the level of the patient and film. Since the actual field area is accurately selectable over the entire range of film exposure area from an 8 inch by 8 inch to 17 inch by 17 inch at distances of 36, 40, 48 and 72 inches, the operator can readily determine his diaphragm setting for the desired field area by merely glancing at direct reading indicators **10** and **12** also disposed on the outside surface of the housing **5**.

However, as a further check as to the actual cross-sectional area impinging upon the table top on which the patient rests during an examination, the X-ray cone assembly is provided with an electric lamp encased in a reflector **13** carried by a pivoted arm **14** so that such lamp and reflector can be swung centrally of the bottom of the X-ray cone assembly **5**, as shown in Fig. 8. When in this position light from the lamp is projected upwardly interiorly of the housing **5** where it passes through the diaphragm, no matter what its setting, and such light beam is reflected back by a polished surface, such as a mirror or the like **15** (Fig. 2), on to the table top or other surface so that the operator can actually observe the area covered by the light beam and which will be the same for the X-ray beam when the latter comes through the mirror **15** during energization of the X-ray tube.

The control knobs **8** and **9** are each connected to a short shaft **16** projecting from a gear box **17**. Since the gears in the gear box **17** and which are operated by the respective control knobs **8** and **9** are identical, it is believed necessary to describe only one. Accordingly, by reference now more particularly to Fig. 7, it will be noted that the control-knob shaft **16**, which is rotated by the knob **8**, carries a small gear **18** meshing with an intermediate gear **19** which latter gear drives an upper larger gear **20** (approx. 36 teeth) and a lower

smaller gear 22 (approx. 30 teeth). As shown in Fig. 6 the upper gear 20 is carried by a shaft 23 having right and left hand threads thereon and journalled in the casing 5 so that this shaft 23 is rotated in either direction by rotation of the control knob 8 and by means of the gears 18, 19 and 20. An identical shaft 24 is disposed on the opposite side of the casing 5 parallel with the shaft 23 and both of the shafts 23 and 24 are provided with a pinion gear 25 (Fig. 2) each of which mesh with a worm gear 26 carried at each end of a cross shaft 27 (Fig. 6) journalled in the casing 5 in a direction normal to the shafts 23 and 24. Hence, upon rotation of shaft 23 in the manner previously described, the gears 25 and 26 will rotate the cross shaft 27 with the result that the gears 25 and 26 at the opposite end will cause rotation of shaft 24 in the same momentary direction of rotation as the shaft 23.

Still referring to Fig. 6, it will be noted that a pair of X-ray impervious shutter plates 28 and 29 are suspended between the shafts 23 and 24 and connected thereto by hub portions 30 which are internally threaded with either right or left hand threads to match the threaded part of the shafts 23 and 24 to which they are connected, so that upon rotation of these shafts as above mentioned, the X-ray impervious shutter plates 28 and 29 will travel along the shafts 23 and 24 toward or away from each other depending upon the direction of rotation of the shafts 23 and 24 in response to rotation of the control knob 8, as previously mentioned. In the fully open position of the shutter plates 28 and 29, as viewed in Fig. 6, it will be noted that their combined width is only about one-half the spacing therebetween so in order to completely close the shutters when desired, the plates 28 and 29 are provided with upwardly extending pins 32 (Fig. 9) projecting into slots 33 of a pair of superimposed X-ray impervious shutter plates 34 and 35 which are pulled along a channel track 36 by this pin and slot connection when the shutter plates 28 and 29 have been moved toward each other a distance corresponding to the length of the slots 33, with the shutter plates 34 and 35 being returned to their normally open position by coil springs 37 when the shutter plates 28 and 29 are fully opened by the control knob 8. The combined widths of the mating shutter plates 28—34 and 29—35 are such that in their fully extended position toward each other the inner edges of plates 28 and 29 will touch each other and thus block off the cone of X-rays passing therethrough from the X-ray tube to the patient and film disposed beneath the cone assembly.

For the purpose of making any size rectangular opening from 8 in. x 8 in. square to 17 in. x 17 in. square as hereinbefore mentioned, the control knob 9 also operates a gear arrangement identical to that shown in Fig. 7 with its associated upper gear 20' (Fig. 5) being carried by a right and left threaded shaft 23'. A parallel-disposed shaft 24' is rotated by a cross shaft 27' through the worm gears 25' and 26' and these shafts 23' and 24' carry X-ray impervious shutter plates 28' and 29' movable along such shafts by the threaded hub connection 30'. Also in an identical manner the shutter plates 28' and 29' are provided with upstanding pins 32' projecting into slots 33' so that upon movement of the shutter plates 28' and 29' toward each other further shutter plates 34' and 35' are pulled along therewith in channel tracks 36' and these are returned to their normally open position by coil springs 37'. From the foregoing it can thus be seen that there are two sets of X-ray impervious shutters with one set 28—34 and 29—35 being movable toward and away from each other by rotation of the control knob 8 while the other set 28'—34' and 29'—35' are likewise movable toward and away from each other by operation of control knob 9 but the movement of the latter set of shutters 28'—34' and 29'—35' is in a parallel plane at right angles to the movement of the other set of shutters 28—34 and 29—35.

Accordingly, any desired size of rectangular opening from a complete cut-off of the X-ray beam up to a maximum size film area of 17 inches by 17 inches can be obtained by simply adjusting the control knobs. Since the X-ray impervious shutters are positioned at a varying distance from the patient and film, depending upon the total area of the body to be radiographed, but nevertheless serve to cut-off the beam at a determinable cross-section thereof, it is highly desirable that at a given setting of the shutter plates the diverging beam does not extend beyond a given area and hence that the shutters give a sharp cut-off so as to accurately restrict this area to that for which the shutters are preset. Consequently, to give such assurance at all shutter settings and for all shutter to film distances the X-ray cone of the present invention is provided with a further set of X-ray impervious shutter plates spaced in a horizontal plane below the above-noted sets.

By reference now more particularly to Fig. 4 it will be seen that the lower smaller gear 22 is connected to a shaft 43 having right and left hand threads thereon and that an identical type shaft 44 is positioned parallel to the shaft 43 having right and left hand threads thereon and that an identical type shaft 44 is positioned parallel to the shaft 43 on the other side of the casing 5. Again each of these shafts 43 and 44 are provided with a pinion gear 45 which meshes with a worm gear 46 carried at each end of a cross shaft 45. Consequently, upon rotation of control knob 8, which drives the intermediate gear 19, gear 22 will be rotated in the same direction as gear 20 and the shafts 43 and 44 will be rotated in the same direction by the cross-shaft 47. A pair of single plate shutters 48 and 49 are connected by properly threaded hubs 50 to these shafts 43 and 44 and hence such shutter plates 48 and 49 move toward and away from each other, depending upon the direction of rotation of the control knob 8, and simultaneously with movement in the same direction of shutter plates 28—34 and 29—35. However, because gear 22 is smaller (approx. 30 teeth) than gear 20 (approx. 36 teeth) such gear 22 rotates faster than gear 20 with the result that the shutter plates 48 and 49 move faster than do the shutter plates 28—34 and 29—35 which thus accurately compensates for the divergence in the X-ray beam due to the spacing between the upper shutter plates 28—34 and 29—35 and the shutter plates 48 and 49 at all shutter plate openings and tube to film spacings, with these latter shutter plates 48 and 49 also sharply cutting off the X-ray beam, which thus definitely confines the area of the beam at the patient and film level to the precise preselected area.

The lower set of shutter plates are completed by the arrangement shown more particularly in Fig. 3. Again the control knob 9 rotates a smaller gear 22' identical to that of the gear 22, which gear 22' is carried by a right and left hand threaded shaft 43' and an identical type shaft 44' is positioned parallel to the shaft 43' on the other side of the casing 5. Each of these shafts are provided with worm and pinion gears 45' and 46' carried at each end of a cross-shaft 47'. Thus the control knob 9 will rotate the shafts 43' and 44' in the same direction and cause a pair of single shutter plates 48' and 49' to move toward or away from each other due to their connection to the shafts 43' and 44' by internally threaded hubs 50' but, as shown, the movement of the shutter plates 48' and 49' are in a direction at right angles to the movement of shutter plates 48 and 49. Again, however, the shutter plates 48' and 49' move simultaneously with the shutter plates 28'—34' and 29'—35' and in the same direction under operation of the control knob 9 but because the gear 22' is smaller

than gear 20' movement of shutter plates 48' and 49' are faster and hence operate in the same manner as the shutter plates 48 and 49, in compensating for the divergence of the X-ray beam in the opposite direction to that of the shutter plates 48 and 49.

For the purpose of accurately indicating the size of the beam area at the patient-film level, the casing 5 is provided with the previously mentioned direct reading indicators 10 and 12, such as shown in Fig. 10, disposed adjacent the respective control knobs 8 and 9. Each of these indicators have identical scales 52 (Fig. 11) provided with indicia thereon which gives the size of the opening of the shutter plates at various X-ray tube-to-film distances as controlled by the respective control knobs 8 and 9. Thus upon turning of the knob to move the shutter plates controlled thereby, a threaded block 53 moves along the cross-shaft 47 and 47' in a direction dependant upon the direction of rotation of such shafts. As shown more clearly in Fig. 10, the block 53 carries a pointer movable over the scale 52 so that when the pointer registers with the desired indicia thereon this gives a clear and direct reading of the precise size of the shutter opening in inches for the tube-to-film distance which is observable through a transparent window 55. As a check when desired, the operator need merely turn the test lamp reflector 13 about its pivot until the light beam from the enclosed lamp is in alignment with the cone axis. Rotation of the reflector 13 to its central test position may operate a switch 56 (Fig. 2) to close a circuit to the lamp thus energizing the lamp with the light beam therefrom extending upwardly through the shutter opening and being reflected again downwardly by the mirror 15 on to the surface of the patient-support for actual measurement of the beam area, as controlled by the shutter plates. It will be noted that the block 53 preferably moves along the threaded cross-shafts 47 and 47' rather than any other shaft and thus such block moves the pointer 54 over the scale 52 in direct proportion to the movement of the shutters 48—49 and 48'—49' which latter control the final field area of the beam thus giving a very accurate direct reading on the scale 52.

It should thus become obvious to those skilled in the art that an X-ray cone assembly has been herein provided which utilizes a double diaphragm to accurately give a preselected definite field area of the X-ray beam and wherein the diaphragm is controllable to give a very sharp cut-off of such area over the entire field range. Moreover, one of the sets of shutter plates which comprise one half of the double diaphragm is movable toward and away from each other at a different rate of speed than the other set so as to accurately compensate for the diverging X-ray beam and yet effect accurate cut-off thereof at the desired boundary of the field area. Also, the present invention provides a direct reading indicator scale which gives at a glance the precise selected shutter opening size in inches at various tube-to-film distances.

Although one embodiment of the present invention has been shown and described it is to be understood that still further modifications thereof may be made without departing from the invention as set forth in the appended claims.

I claim:

1. An X-ray cone assembly comprising a housing, shutter control mechanism within said housing and operable to move two pairs of X-ray impervious shutter plates toward and away from each other to preselect the size and shape of an X-ray beam passing through the spacing between said shutter plates and impinging upon a patient or film positioned below said cone assembly, a second shutter control mechanism within said housing and operable to move a second set of two pairs of X-ray impervious shutter plates spaced below said first set toward and away from each shutter of its corresponding pair at a different speed of movement than

that of said first set of impervious shutter plates to accurately restrict the diverging cone of X-ray radiations passing between asid first set of shutter plates and impinging on the patient or film to a precisely definite field, and control members exteriorly of said housing for operating each shutter control mechanism accompanied by the desired movement of its respective pairs of X-ray impervious shutter plates.

2. An X-ray cone assembly comprising a housing, a set of two pairs of X-ray impervious shutter plates within said housing movable toward and away from each other with one pair of said set being movable at right angles to the other pair of such set to preselect the size and shape of the shutter opening for the passage therethrough of two pairs of X-ray beams, a second set of X-ray impervious shutter plates within said housing and spaced from said first set and movable toward and away from each shutter of its corresponding pair with one pair of said second set being movable at right angles to the other pair of said second set with the opening formed by said second set of shutter plates being always of larger area than that formed by the first set of shutter plates to accurately restrict the diverging cone of X-radiations passing through said first set of shutter plates and impinging on the patient or film to a precisely definite field area, control mechanism including a member disposed exteriorly of said housing and operable to cause the simultaneous operation of the pair of shutter plates of each set which move in the same direction, and said control mechanism being also operable to cause the pair of shutter plates of said second set to move at a higher speed than the corresponding pair of shutter plates of said first set simultaneously moving in the same direction.

3. An X-ray cone assembly comprising a housing, a set of two pairs of X-ray impervious shutter plates within said housing movable toward and away from each other with one pair of said set being movable at right angles to the other pair of such set to preselect the size and shape of the shutter opening for the passage therethrough of an X-ray beam, a second set of two pairs of X-ray impervious shutter plates within said housing and spaced from said first set and movable toward and away from each shutter of its corresponding pair with one pair of said second set being movable at right angles to the other pair of said second set to accurately restrict the diverging cone of X-radiations passing through said first set of shutter plates and impinging on the patient or film to a precisely definite field area, control mechanism including a member disposed exteriorly of said housing and operable to cause the simultaneous operation of the pair of shutter plates of each set which move in the same direction, and said control mechanism being also operable to cause the pair of shutter plates of said second set to move at a higher speed than the corresponding pair of shutter plates of said first set simultaneously moving in the same direction, and a direct reading indicator carried by said housing adjacent said exteriorly disposed control member and provided with a pointer movable by operation of said control mechanism for giving a precise direct reading of the opening of said shutter plates as an accurate indication of the X-ray beam field area at the patient-film level at various tube-to-film distances.

4. An X-ray cone assembly comprising a housing, a set of two pairs of X-ray impervious shutter plates within said housing movable toward and away from each other with one pair of said set being movable at right angles to the other pair of such set to preselect the size and shape of the shutter opening for the passage therethrough of an X-ray beam, a second set of two pairs of X-ray impervious shutter plates within said housing and spaced from said first set and movable toward and away from each shutter of its corresponding pair with one pair of said second set being movable at right angles

to the other pair of said second set to accurately restrict the diverging cone of X-radiations passing through said first set of shutter plates and impinging on the patient or film to a precisely definite field area, a light reflecting member in said housing in the path of the X-ray beam passing therethrough, a test light rotatable into a position on the vertical axis of said cone assembly to project a light beam upwardly into said housing on to said reflecting member and which light beam is then projected downwardly to give a visual indication of the precise radiation field area at the patient-film level, control mechanism including a member disposed exteriorly of said housing and operable to cause the simultaneous operation of the pair of shutter plates of each set which move in the same direction, and said control mechanism being operable to cause the pair of shutter plates of said second set to move at a higher speed than the corresponding pair of shutter plates of said first set simultaneously moving in the same direction, and a direct

reading indicator carried by said housing adjacent said exteriorly disposed control member and provided with a pointer movable by operation of said control mechanism for giving a precise direct reading of the opening of said shutter plates as an accurate indication of the X-ray beam field area at the patient-film level at various tube-to-film distances.

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