Aug. 26, 1941. J. ITEN 2,253,622

SECONDARY RAY SCREEN

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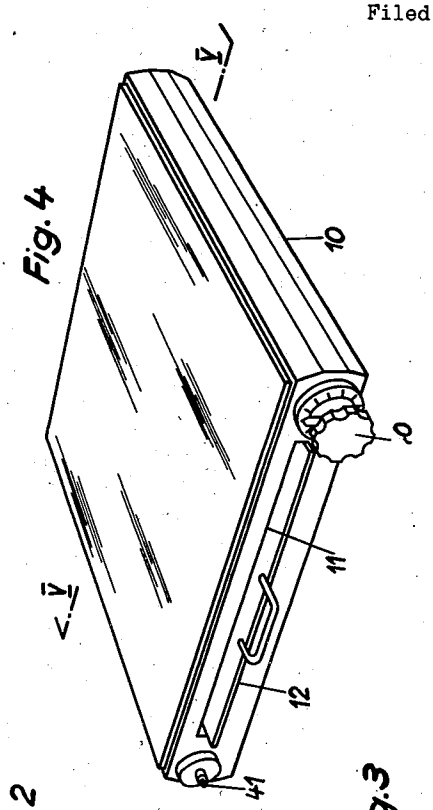


Fig. 4

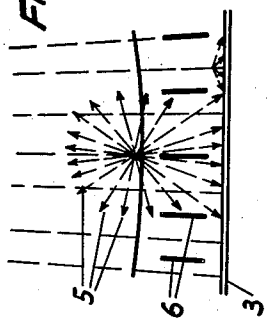


Fig. 2

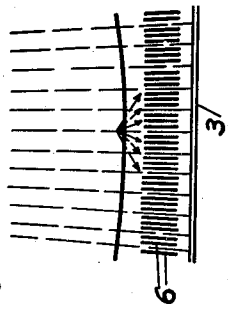


Fig. 3

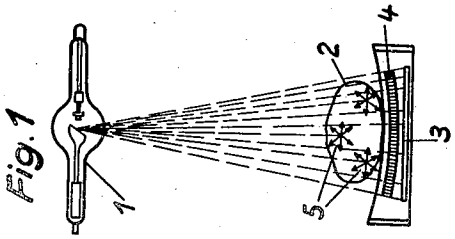


Fig. 1

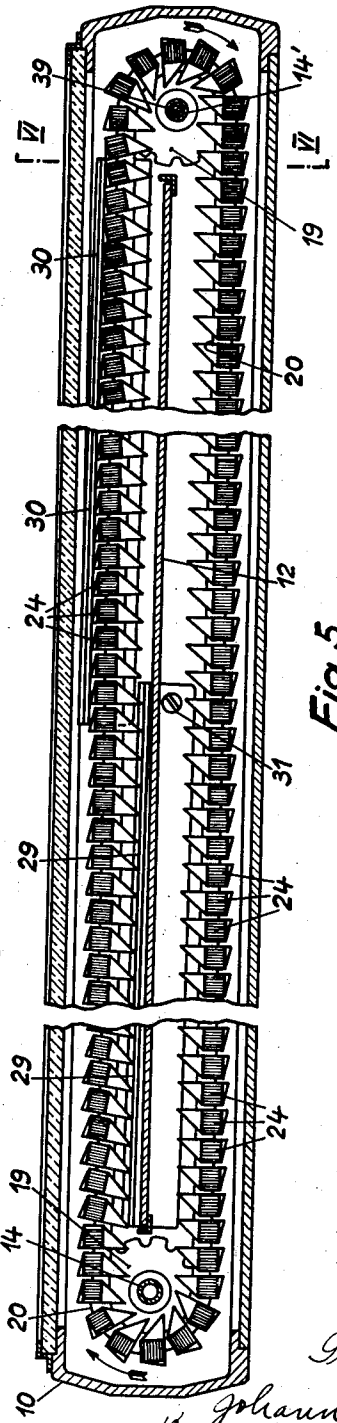


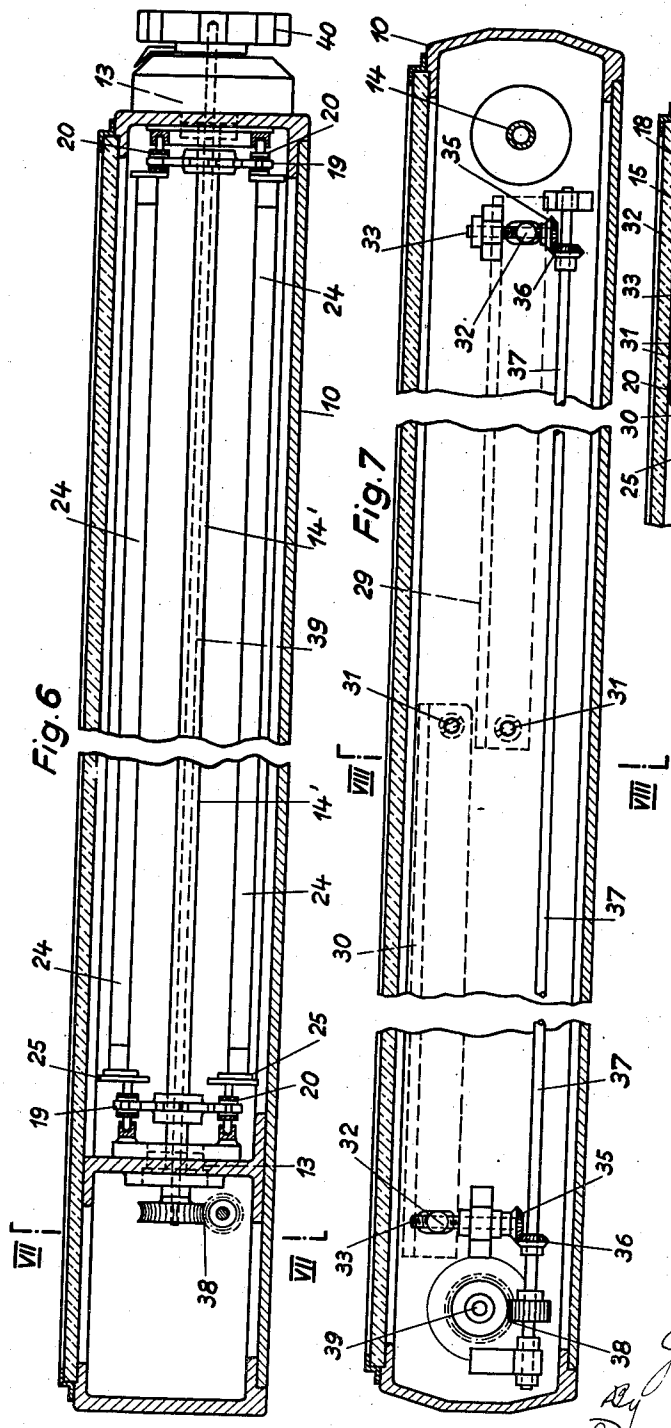
Fig. 5

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Fig. 9

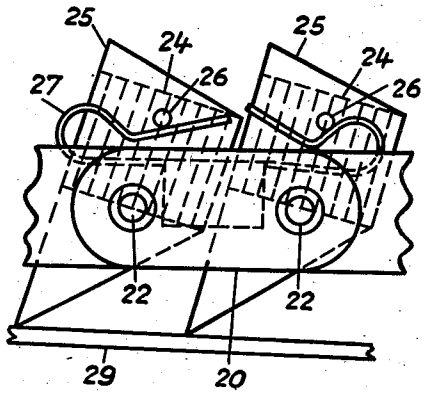


Fig. 10

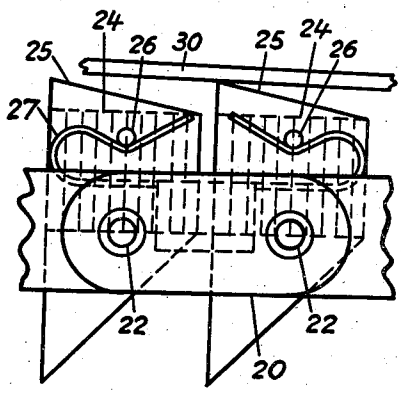


Fig. 13

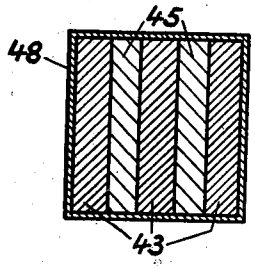


Fig. 14

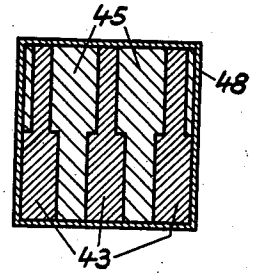


Fig. 15

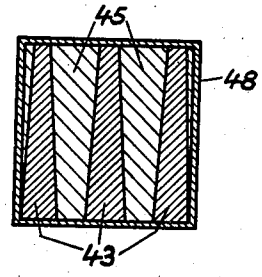


Fig. 16

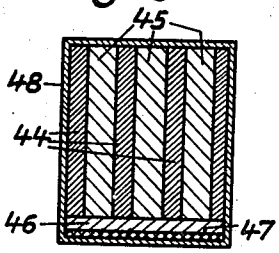


Fig. 17

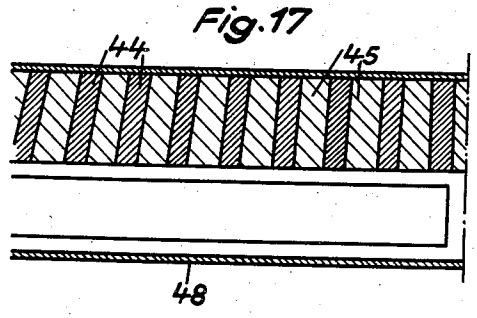
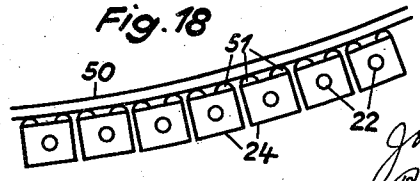


Fig. 18

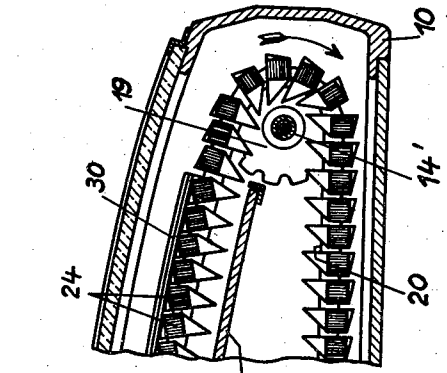


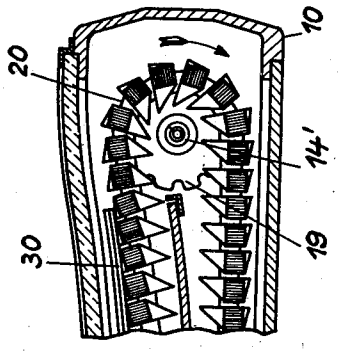
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SECONDARY RAY SCREEN

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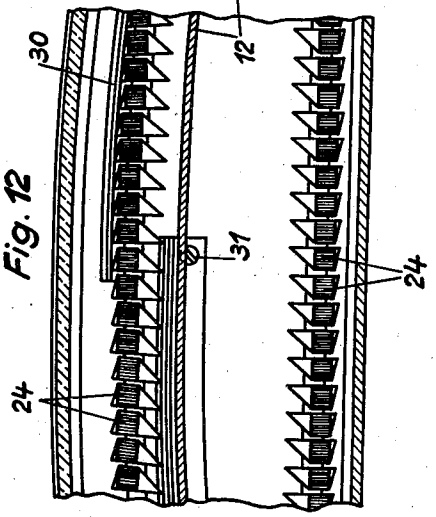


Fig. 12

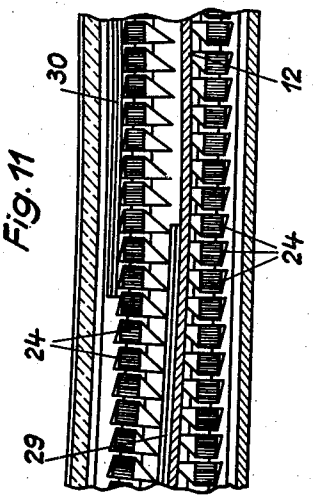
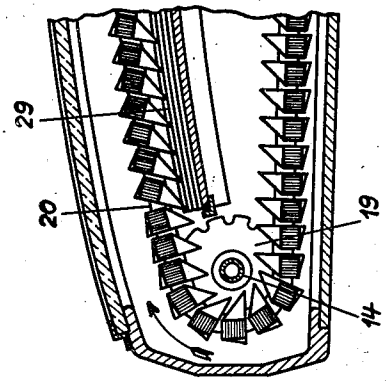
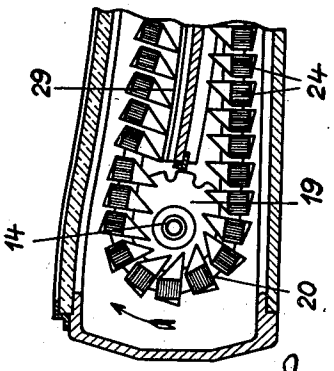


Fig. 11





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UNITED STATES PATENT OFFICE

2,253,622

SECONDARY RAY SCREEN

Johann Iten, Zurich, Switzerland

Application November 7, 1939, Serial No. 303,299
In Switzerland December 10, 1938

5 Claims. (Cl. 250—63)

It is well known that the secondary rays produced on the passage of Roentgen or gamma rays through a body effect a veiling of the image receiving layer and that when examining the rays secondary ray screens are placed between the body of the patient to be examined or the commercial article and the image receiving layer (illuminating screen or photographic layer).

These known secondary ray screens consist as a rule of comparatively thin laminae, arranged parallel to one another and transversely to the incoming radiation, whilst the laminae themselves are produced from a material which is easily permeable for the rays (wood, Celluloid, light metal) which in turn are covered with a material which renders the passage of rays difficult, such as ordinary lead or tin. The assembly of laminae, which are combined in a frame in the form of a plate under pressure with the use of adhesive, is moved uniformly, during the examination, over the image receiving layer so as to prevent a disturbing shadow formation by the heavy metal strips of the laminae.

As long as curved screens are used, of which the laminae are directed at every moment towards the focus of the source of rays the absorption of the primary rays remains at the same minimum for every position of the screen. When however there are utilised flat screens, which at the present time have been introduced for practical reasons, the efficiency is reduced the more the direction of the rays emanating from the ray source differs from that of the laminae and the higher the screen factor, that is to say the greater the height of the heavy metal strips in proportion to the relative spacing thereof.

Endeavours have been made to introduce screens with positively actuated laminae, the screen being moved uniformly to and fro or as an endless rotating band. All these proposals failed by reason of the impossibility of producing laminae which whilst being of sufficient mechanical strength produce a minimum weakening of the primary rays and in the impossibility of maintaining the small distance, necessary for an efficient image action, between the source of rays and the layer for receiving the objective image and the construction of suitably simple actuating devices for the laminae which require little space.

The problem of the moved directed screen and thus also the adjustability for the various spacings between the source of the rays and the image receiving layer remains unsolved. The rotary screens with a motor drive have the advantage that the speed of the screen movement can be made independent of the time adjustment, when the speed of rotation of the driving motor is so selected that even in the case of the shortest time of exposure the formation of streaks on the image receiving layer disappears. It would also have been possible to adapt the secondary ray diaphragms to the shape of certain articles of investigation in industry.

According to the present invention the movable screen of the secondary ray diaphragm is composed of narrow screens which at every moment are directed towards the centre of the source of rays. The narrow screens are mechanically more rigid than a single lamina and can be rendered operable more easily by means of relatively simple technical means than a single thin lamina.

In the accompanying drawings there is shown the development of the best form of screen known at the present time and from this the new screen has been developed.

There are illustrated by way of example forms of construction of the narrow screens for medicinal and technical purposes and also forms of construction of complete secondary ray diaphragms for medicinal and technical purposes.

Figs. 1 to 3 serve to explain the method of operation of a secondary ray diaphragm.

Fig. 4 shows a first form of construction in perspective.

Fig. 5 is a section on the line V—V of Fig. 4 to a larger scale.

Fig. 6 is a section on the line VI—VI of Fig. 5.

Fig. 7 is a section on the line VII—VII of Fig. 6.

Fig. 8 is a section on the line VIII—VIII of Fig. 7.

Figs. 9 and 10 each show the ends of two narrow screens to a large scale and in different positions.

Figs. 11 and 12 each show an enlarged detail view of different portions of Fig. 5.

Figs. 13 to 17 each show a modification of a narrow screen.

Fig. 18 shows a guide for the narrow screen.

In Fig. 1, 1 is the Roentgen tube, 2 a body which is to be photographed on a film 3 and 4 is the secondary ray diaphragm for screening the secondary rays 5.

Fig. 2 shows that a large spacing of the screen laminae 6 produces an insufficient removal of the secondary rays 5. Consequently it is necessary in practice to select a screen according to Fig. 3 with the laminae located closely together.

The form of construction of the secondary ray diaphragm shown in Figs. 4 to 8 is provided with a casing 10 provided at the front with a slot 11 through which the film is introduced into the interior of the casing by a movable plate 12. In the casing there are rotatably mounted on ball bearings 13 two hollow shafts 14, 14'. To the shaft 14 is keyed a bevel wheel 15 gearing with a second bevel wheel 18 keyed to the rotor

shaft of a motor 17. Near the ends of the shafts 14, 14' are provided sprocket wheels 19 around which pass link chains 20 (for example sprocket chains). On each pin 22 (Figs. 9 and 10) of the chain 20 there is rotatably mounted a narrow screen 24 in such a manner that the pin 22 is located at the lower edge of the screen. At one end the narrow screens 24 are each provided with a segment 25 in which there is provided a pin 26. Each two pins 26 co-operate with a spring 27 secured to the chain 20. The segments 25 are actuated by control rails 29, 30 pivotally mounted on pivots 31. The free ends of the rails 29, 30 (Figs. 7, 8) are each provided with a sliding member 32 through which there passes a screwed bolt 33. The latter are mounted so as not to be movable in an axial direction and each carries a bevel wheel 35 with which there engage two further bevel wheels 36 secured to a common shaft 37. The shaft 37 is connected by gearing 38 to a shaft 39 (Fig. 6) which passes through the hollow shaft 14' and at its free end, projecting from the casing 10, carries a rotary knob 40.

Each narrow screen 24 consists of laminae of a thickness of a maximum of 1 mm. and has a height of about 8 mm. and a width of approximately 10 mm. (for the secondary ray diaphragm for medicinal purposes). Poplar, birch or similar wood is used to which the heavy metal foils are secured by means of glue. The laminae obtained in this manner are glued under pressure in connection with which it has been found that by gluing the wood on both sides of the lead foils, there is obtained the necessary mechanical strength and resistance for the narrow screens. For commercial purposes the thickness of the laminae varies between 1 and more millimetres and the height from about 10 to 20 mm.

The method of operation of the above described ray diaphragm is as follows.

By means of a switch 41 (Fig. 4) the motor 17 is set in operation, the latter through the wheels 18, 15, the shaft 14 and the wheels 19 setting the link chain 20 in movement and thus the screens 24 in the direction of the arrow (Fig. 5). During this movement the segments 25 run with their lower ends on the guide rail 29 (Figs. 5, 9). The guide rail 29 is inclined towards the centre of the diaphragm towards the plane of the image receiving layer (film) and thus produces an inclination of the narrow screens coming from the left. The inclination of the narrow screens 24 decreases towards the middle of the diaphragm and at the middle itself assumes a vertical position relatively to the image receiving layer. To the right of the middle the guide rail 30 produces by its inclination to the image receiving layer and the engagement of the upper ends of the segments 25 (Figs. 5, 10) an increasing inclination of the narrow screens 24 towards the left to the centre of the source of rays.

In Figs. 6 to 8 there is shown the device for the adjustment of the guide rails at various distances between the ray source and the image receiving layer. It has already been explained how the guide rail 29 imparts to the narrow screens, coming from the left, the inclination towards the focus in one direction, whilst the guide rail 30 produces the opposite inclination. A given inclination of the guide rails to the plane of the image receiving layer (film) corresponds with a predetermined distance of the focus from the image receiving layer. In order to obtain the correct inclination of the narrow screens for varying distances it is only necessary to vary the inclination of the guide rails to the plane of the image receiving layer. For this purpose the guide rails 29 and 30 are rotatably mounted on the pivots 31 which may be provided with an eccentric disc for the accurate adjustment. The free ends of the rails are connected to sliding members 32, movable upwardly and downwardly, which are guided in the screw threads of screwed bolts 33. A compensating device provides for the disengagement of the action of the distance variation between the pivot and bearing when turning the rails. The bolts 33 can be turned by the knob 40 through the medium of the parts 39, 38, 37, 36 and 35 and thus the ends of the rails 29 and 30 can be adjusted in height whereby the inclination of the rails is obviously varied.

It is possible to so construct the secondary ray diaphragm that its screens by spring force in combination with an oil brake can be moved from their position of rest only in one direction or can be moved to and fro by an electric motor. The screen in the secondary ray diaphragm is preferably constructed as an endless moving band. The drive may also be effected by hand or by a spring.

Instead of the link chain it is also possible to use a fabric or rubber band which is guided positively over suitably constructed rollers. In this construction the narrow screens are secured to the band. The band may also be used in combination with a link chain, an apertured metal band or a metal cable.

Figs. 11 and 12 show further forms of construction of secondary ray diaphragms, especially for adjusting welded seams on high pressure and steam boilers. The diaphragm in Fig. 11 with the screen of concave curvature corresponds as regards the form of the screen for a dispersion ray diaphragm as used originally exclusively for medicinal purposes. Fig. 12 shows a convex shape, unknown hitherto, which can only be obtained by controlled narrow screens.

The narrow screens may have the forms shown in Figs. 13 and 17 wherein tin strips 43 or lead strips 44 alternate with strips 45 of readily transparent material. Tin has the advantage that no disturbing natural radiation occurs, but has the disadvantage of a low absorption property, so that relatively wide strips must be used which considerably weaken the primary rays.

In some cases it is therefore necessary to provide a stepped arrangement of the tin strips as is shown in Figs. 14 and 15. Lead can be used in strips of small thickness but in the case of high voltages there occurs a natural radiation which produces a veiling effect. For eliminating this natural radiation there is used a combination of tin 46, copper 47 and aluminium. This combination can be included in the narrow screens as shown in Fig. 16, the aluminium filter being omitted when aluminium cases are used for the film. The combination may also be used directly as cover and bottom for the case or be applied above and below the usual case, underneath the case for protection against the natural radiation emanating from the lead support used by reason of reflection.

In order to screen the secondary rays up to the maximum obtainable amount there is used the narrow screen according to Fig. 17 wherein two layers of laminae extending transversely to one another and located one above the other are combined. In this case the adjustability of the

various distances between the focus and the image receiving layer is omitted.

For increasing the strength of the narrow screens these may be placed in a square tube **48** of hard paper or light metal or have this or a similar material secured thereto by adhesive. This covering is also used when it is desired to protect the narrow screens from dust and moisture (drops) or other external influences.

The inclination of the narrow screens by guiding results in an increase in the distance between the object and the film, which however is slight and in general does not influence the image formation in practice. In order to keep the distance at a minimum the edges of the narrow screens are rounded.

Fig. 18 shows a simplified guide which simultaneously centres the moving screen in the concave curved construction according to Fig. 11. In this figure, **50** indicates the guide rail, **51** the spherical bearing points against the guide rail and **22** the pivots on which the narrow screens are mounted on the moving band, preferably a link chain. The shape of the segments may be unsymmetrical as shown in Figs. 9 and 10, in which case the bearing pivots **22** are located in the lower edge of the narrow screens **24**. This construction is necessary when the screens are short for the purpose of increasing the slight height of the rails **29**, **30** so as to obtain the maximum inclination of the narrow screens. In the case of commercial screens, for example in Fig. 13, the segments are symmetrical and the bearing pivots are located on the longitudinal axis of the narrow screens which enables the weight of the relatively heavy metal insertions to be distributed symmetrically.

I claim:

1. In an X-ray apparatus, an X-ray tube, an endless continuously driven screen for suppressing the shadowing effect of secondary rays, said screen including a pair of driving chains therefor, a plurality of screen elements, each of which is pivotally attached with its ends to said chains, each screen element being composed of a number of alternate permeable and impermeable laminations united to form a single bar-like element, and means for guiding the screen elements during their travel so that the main extension of the section of their laminations are directed toward the focus of said X-ray tube, said means comprising a cam on one end of each said screen elements, stationary guide rails engaging said cams, and spring means associated with said cams for urging the latter in engagement with said guide rails.

2. In an X-ray apparatus, an X-ray tube, an endless continuously driven screen for suppressing the shadowing effect of secondary rays, said screen including a pair of driving chains therefor, a plurality of screen elements, each of which is pivotally attached with its ends to said chains, each screen element being composed of a number of alternate permeable and impermeable laminations united to form a single bar-like element, and means for guiding the screen elements during their travel so that the main extension of the section of their laminations are directed toward the focus of said X-ray tube, said means comprising a cam on one end of each said screen elements, stationary guide rails engaging said cams, and spring means associated with said cams for urging the latter in engagement with said guide rails, and means for adjusting the position of said stationary guide rails in accordance with the distance of the focus of the X-ray tube from said screen.

3. An X-ray screening diaphragm, including within a casing, two parallel shafts substantially arranged in a horizontal plane, a pair of sprockets on each shaft, a pair of endless chains trained over said sprockets, means for driving said shafts to advance said chains continuously in one direction, a plurality of screen elements, each of which is pivotally attached with its ends to said chains, each screen element being composed of a number of laminations alternately permeable and impermeable respectively to X-rays, the laminations in each screen element being rigidly attached to each other so as to form a composite bar-like screen element, and means for adjusting the group of screen elements forming in any one instance the effective portion of the screening diaphragm about their respective pivot axes so that the main extensions of the section of the laminations are directed substantially toward a point common to all screen elements in said group, said means comprising a cam on one end of each said screen elements, stationary guide rails engaging said cams, and spring means associated with said cams for urging the latter in engagement with said guide rails.

4. An X-ray screening diaphragm, including within a casing, two parallel shafts substantially arranged in a horizontal plane, a pair of sprockets on each shaft, a pair of endless chains trained over said sprockets, means for driving said shafts to advance said chains continuously in one direction, a plurality of screen elements, each of which is pivotally attached with its ends to said chains, each screen element being composed of a number of laminations alternately permeable and impermeable respectively to X-rays, the laminations in each screen element being rigidly attached to each other so as to form a composite bar-like screen element, and means for adjusting the group of screen elements forming in any one instance this effective portion of the screening diaphragm about their respective pivot axes so that the main extensions of the section of the laminations are directed substantially toward a point common to all screen elements in said group, said means comprising a cam on each of said screen elements, adjustable guide rails engaging said cams, and a manually operable member on the outside of said casing for adjusting said guide rails in accordance with the distance of said common point from the effective portion of said screen.

5. In an X-ray apparatus, an X-ray tube, a movable screen for suppressing the shadowing effect of secondary rays, said screen including a carrier comprising a pair of spaced parallel members and a plurality of screen elements between said members, said screen elements being pivotally attached with their ends to said carrier, each screen element being composed of a number of alternate permeable and impermeable laminations united to form a single bar-like element, and means for tilting the screen elements during the movement of said carrier so that the main extension of the section of their laminations is directed toward the focus of said X-ray tube.

JOHANN ITEN.