March 22, 1927. 1,621,814

H. S. SAWFORD

X-RAY SCREEN

Filed July 24, 1925 3 Sheets-Sheet 1

Fig. 1.

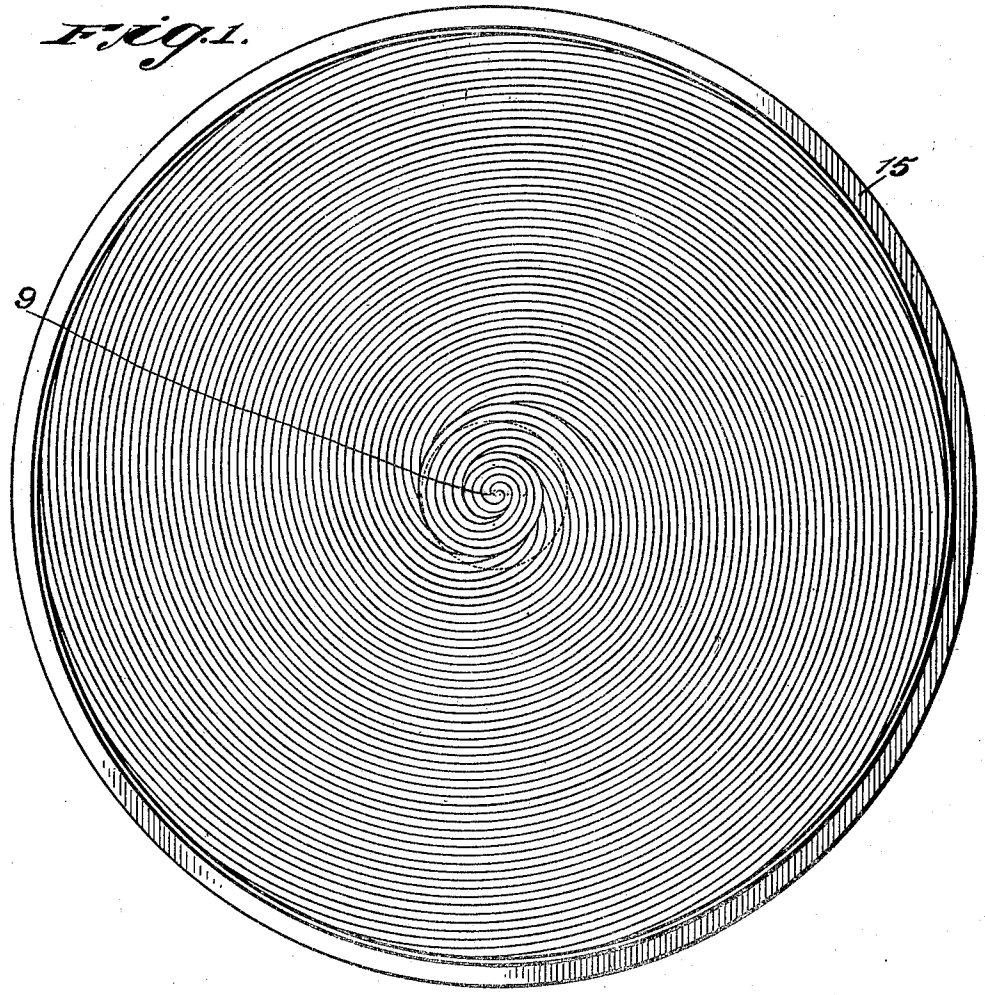


Fig. 2.

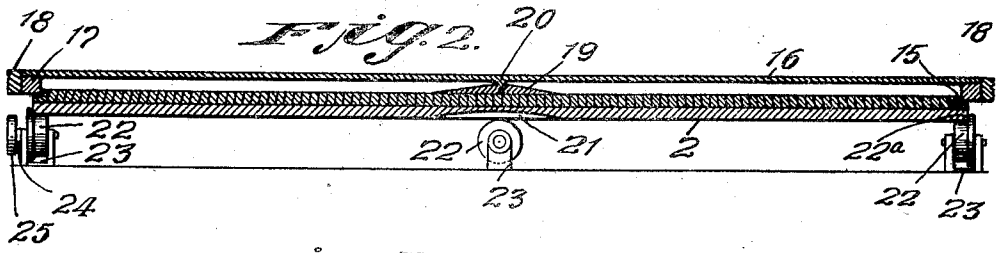
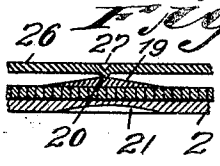


Fig. 3.



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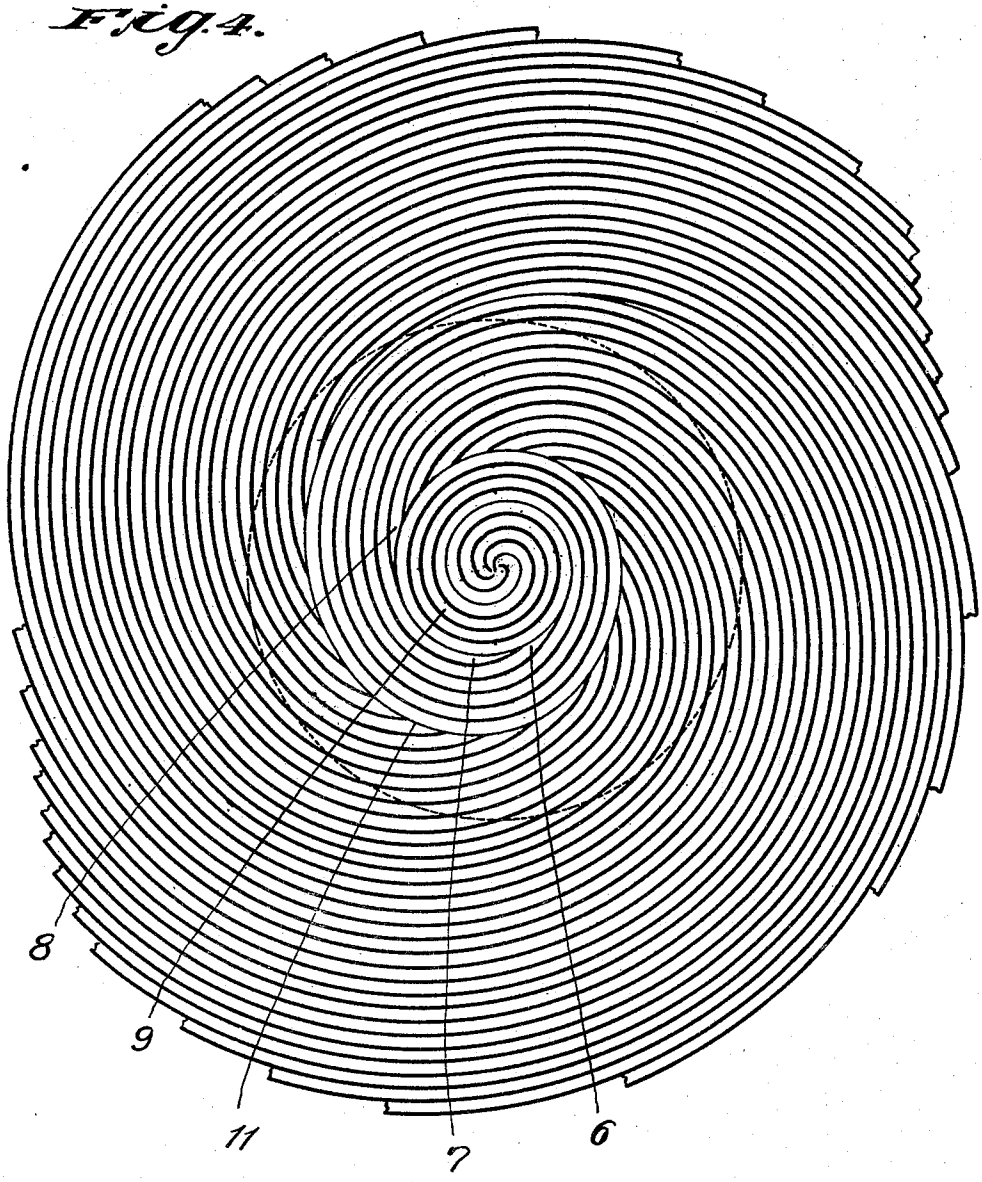
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X-RAY SCREEN

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Fig. 4.



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X-RAY SCREEN

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Fig. 6.



Fig. 5.

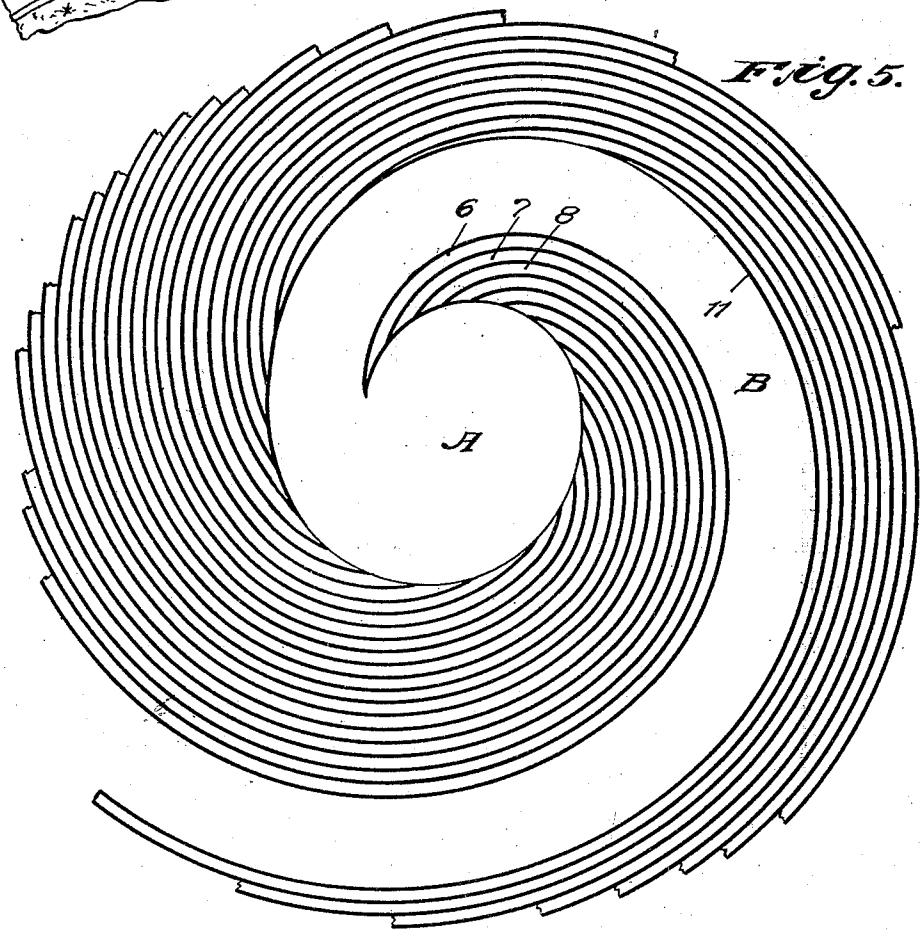




Fig. 7.

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Patented Mar. 22, 1927. 1,621,814

UNITED STATES PATENT OFFICE.

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X-RAY SCREEN.

Application filed July 24, 1925. Serial No. 45,734.

This invention relates to rotary screens used for suppressing secondary rays in Roentgenography. It is an important object of the invention to provide a screen of this kind which will be efficient in use and which is capable of being manufactured economically.

It is a further object of the invention to devise a method for manufacturing screens of this kind in an economical and commercially practical manner.

The screen is desirably composed of a multiplicity of composite strips, each comprising a layer of material impervious to X-rays and a layer of material transparent to X-rays, the strips being spirally wound together and inclined toward the point of origin of the X-rays, so that substantially all rays originating at other sources will be intercepted by the impervious portions of the screen.

According to the preferred method of making the screen the centre or core of the screen is left open until the last, a suitable space for the core forming strips being maintained at the centre of the screen and throughout a spiral band that winds to the periphery of the screen. All of the composite strips except the few which are to form the core are set with their inner ends abutting upon or projecting slightly within the core space. Strips thus put in place are wound together around the core space and the spiral band, being temporarily held in place by suitable retaining pins, and permanently united by a suitable binding substance such as shellac. The inner ends of these strips are then trimmed so that the core space is bounded by a spiral or other volute curve of accurately predetermined contour. Additional composite strips are then wound in spirally to fill the core space, the outer ends of these strips being continued spirally to the periphery of the screen to fill the spiral band preserved for them.

It is an important feature of the invention to so combine the strips that uniform shading may be obtained without the necessity for pre-forming most of the strips with tapered inner ends. For this purpose the composite strip which abuts the trimmed inner end of the strips first set in place, is made with less than the usual proportion of impervious material to offset the excess of impervious material which would otherwise be present in this field due to the numerous meeting points of the strips.

Another object of the invention is to provide means for maintaining the centre of the rotating screen in a uniform location and for driving the screen steadily so that blurring is avoided even when heavy objects placed over the screen cause it to sag and to be contracted at its periphery. To this end, transparent centre bearings are provided and the screen is preferably arranged to be driven by means engaging its lower margin.

Other objects and advantages will hereinafter appear.

In the drawings:

Figure 1 is a plan view of a complete screen constructed in accordance with the present invention, although in actual practice the number of ribbons may desirably be two or three times as great as in the illustrative example;

Figure 2 is a vertical section through the centre of the screen, showing the centre bearings and the marginal supporting and driving means of the screen;

Figure 3 is a fragmentary vertical section of the centre of the screen showing a modified construction of the centre bearing member;

Figure 4 is a plan view on a larger scale than Figure 1 showing the central portion of a screen, the arrangement of the strips at the core of this screen being somewhat different from the arrangement shown in Figure 1;

Figure 5 is a fragmentary view of a screen in the course of construction, showing how a large number of the strips are caused to terminate at their inner ends upon a volute curve bounding the core space;

Figure 6 is a fragmentary detail view showing one way of avoiding an excess of shading in the field of the curve upon which said strips terminate; and

Figure 7 is a detail view illustrating another way of accomplishing the same result.

The screen 1 is designed for use in apparatus for use in Roentgenography. In such apparatus the X-rays all originate at

a common source, and the useful rays travel through the object to be X-rayed and fall upon the sensitized X-ray film. If the rays falling upon the X-ray film are confined to those coming directly from the X-ray origin, a distinct and satisfactory shadow picture will be produced from which useful and reliable information can be gained. It is well known, however, that some objects in the paths of X-rays absorb the X-rays and themselves become sources of radiation, sending forth rays in all directions. The rays from these sources, which are known as secondary rays, have practically the same penetrating power as the primary rays, and are therefore apt to cause " fogging " of the sensitized film or plate, and so to lead to imperfect and very unsatisfactory results. The screen 1 is provided for suppressing these secondary rays.

The screen is composed of alternate plies or strips of impervious and transparent material, all of which are so cut that they are caused to incline toward the point of origin of the X-rays when wound together to form a screen. This provides transparent spaces through which rays travelling from the X-ray target may pass, but through which rays that travel in substantially different directions, as nearly all of the secondary rays do, cannot pass.

The screen is thus effective to filter out nearly all of the secondary rays. The screen, itself, would cast shadow stripes upon the photograph if permitted to remain stationary, however. Provision is accordingly made to rotate the screen about its centre during the exposure. In order to cause the shading effect of the screen to be rendered uniform throughout the X-ray film by such rotation so that no shadow rings or zones will appear, the strips are arranged in spiral form. The flare of the spirals is made quite substantial to cause the periods of shading of any given spot to be very brief. It is evident that to gain this result the strips must be very numerous, except at the core of the screen.

It is an important object of the present invention to construct a screen of this type which can be accurately made in an economical and commercially practical manner. The screen 1 comprises a strong supporting plate 2 of material transparent to X-rays, such as aluminum, and a ray filtering portion made up of a multiplicity of composite strips, each strip consisting of a ply 3 of material impervious to X-rays, such as lead, and a spacing and supporting ply 4 of flexible material highly transparent to X-rays, such as cork.

The manner in which these composite strips are combined with one another may be understood best by reference to Figure 5. This figure shows a partially completed screen in which all but a small number of composite strips have been set and secured in final position, ready for the addition of the few remaining strips necessary to fill the core space A and the spiral band B extending therefrom. It will be seen upon inspection of this figure that a large number of composite strips are placed about the core space A at the middle of the screen and wound outward to the periphery of the screen, care being taken to preserve the spiral band B for receiving the outer portions of the subsequently added core filling strips. This arrangement can be conveniently obtained by marking out a pattern of the core space A and the spiral band B upon a pattern sheet, and placing the inner ends of the strips upon the periphery of this pattern one by one, the strips being retained in place temporarily by pins inserted in the pattern or its support.

The strip 6 may be first put in place and held in the shape shown by suitable pins placed at the inside and at the outside of said strip. The strip 7 may next be put in place, and pins placed inside it to hold it against the strip 6. The strips 6 and 7 are both held in place by these latter pins, which replace the pins first set inside the strip 6. The strip 8 is next put in place and secured in like manner, and the other strips shown in Figure 5, except the strip marked 11, are thereafter put in place successively, until all have been correctly located. These strips are coated with shellac or other suitable binding substance for permanently holding them together.

When the strips have been permanently combined in this manner their inner ends are smoothly cut by a suitable cutting tooth along the widely flaring spiral which coincides with the lead strip marked 11 in Figure 5. At this time the lead strip marked 11 has not been put in place, however. The cutting bevels the inner ends of the strips, so that additional strips 9 can be smoothly fitted and wound within them to fill the core space. Obviously, a form or templet could be employed in the core space and the spiral band, and would form a convenient means for positioning and forming the strips 6, 7, 8, etc.

Any one of several suitable arrangements may be adopted in arranging the strips 9 within the core space.

In Figure 4 all of the strips 9 are shown spirally wound together all the way to the centre of the screen.

In Figure 1, on the other hand, only two of the strips run to the centre of the screen, the others terminating short of the centre and having their inner ends tapered to avoid an excess of metal.

The way in which the strips 9 are combined within the core space is not important

so long as an arrangement is used which provides for a substantial flare of the strips and a uniform ratio of impervious to transparent material. In both illustrative forms the outer ends of the strips 9 are continued outward beyond the core and fill the spiral band which was preserved for their reception.

An important feature of this invention has to do with the avoidance of an excess of shading along the line of the inner ends of the strips 6, 7, 8, etc., where these strips butt upon the core, without pre-forming the inner ends of these strips with a taper. This is attained, first, by terminating the inner ends of the strips on a widely flaring spiral curve, and, second, by providing a strip having less than the usual proportion of impervious material to lie along the curve bounding the inner ends of the strips 6, 7, 8, etc.

As shown in Figure 6 a strip is provided which is composed of a ply 10 of cork of the usual thickness and a ply 11 of lead substantially less than the usual thickness. It has been found that by making this lead ply 11 of approximately one-half the usual thickness of the lead plies, the termination of the numerous strips 6, 7, 8, etc., in contact with this ply is compensated for so that no variation of shading is shown in this field of the X-ray pictures.

In Figure 7 an arrangement for providing even proportioning of cork to metal in the field of the inner ends of the strips 6, 7, 8, etc., is shown. In this form a spiral strip is provided to abut the inner ends of the strips 6, 7, 8, etc., which has a ply 12 of lead of the same thickness as the other lead plies but includes two plies 13 and 14 of cork at opposite sides of the lead ply 12. It has been found that by interposing the extra ply 14 of cork between the inner ends of the strips 6, 7, 8, etc., and the lead ply 12, and by making the cork ply 14 of approximately one-half the thickness of the other cork plies of the screen, the termination of the numerous strips 6, 7, 8, etc., in contact with it is compensated for so that no variation of shading is shown in this field of the X-ray pictures. The strips 9 may be secured to one another and to the other strips of the screen by shellac or other binding material.

The filter part of the screen, built up in the manner described, is secured upon an aluminum support within a circular angle bar 15 that forms a rim or frame for the screen. The screen is illustrated as supported in horizontal position immediately beneath a sheet 16 of material which is strong yet highly transparent to X-rays, such as bakelite. This sheet 16 is mounted upon a ring 17 fixed in suitable frame members 18, and may form a horizontal support upon which the object to be X-rayed is supported. A patient, for example, may place his arm or leg upon the support 16 or may lie or sit upon this support.

In the latter case the support and the underlying screen are apt to be deflected under the weight of the body and to cause the screen to be contracted at its periphery. Such contraction interferes seriously with the centering and driving of a peripherally guided and driven screen. The screen is constructed to give even shading when rotated about its centre. Rotation of it about any other point is apt to be very objectionable, being likely to result in blurring and uneven shading.

Provision is made in the present construction of means for positively maintaining the centre of rotation of the screen uniform, and for driving the screen steadily and evenly at all times. For this purpose a central bearing 19 of bakelite or other suitable material transparent to X-rays is provided at the centre of the screen and a cooperating transparent cone bearing 20, preferably of bakelite, is projected downward from the bakelite support 16 for engagement in a recess of the bearing 19. With this arrangement the centre of the screen cannot be shifted, the screen being contracted symmetrically with reference to a fixed centre at the point of the cone bearing 20, when placed under load. The bearings 19 and 20, although made of material highly transparent to X-rays, will nevertheless tend to cast a slight shadow at the centre of the picture. This tendency is offset, however, by recessing the lower face of the aluminum screen base 2, as seen at 21. In this way the absorption of some of the X-rays by the bakelite bearing members is compensated for by reducing the absorption of the rays by the base 2 in the same field. As bakelite is more transparent to X-rays than aluminum, a very shallow recess in the aluminum may be effective to compensate for the shading of the bearings.

The screen is supported and driven through its lower margin when positioned horizontally, instead of through its periphery, as heretofore. Rolls 22, supported in bearing brackets 23, engage the lower margin of the aluminum screen base 2 beyond the photographic field. One of these rolls 22 is mounted on a shaft 24 which is driven by any suitable means such as a pulley 25 and frictionally drives the screen. The engagement of the rollers 22 with the screen margin is not affected by the contraction of the screen under load, the rollers being effective to support and drive the screen uniformly under all operating conditions.

The supporting and driving rolls 22 are also formed with flanges 22^a which normally engage the periphery of the screen. These

flanges are effective to support and drive the screen when the apparatus is mounted to position the screen vertically, instead of horizontally.

In Figure 3 a slightly modified form of object support 26 is shown. In this form a bakelite bearing 19 on the screen 1 is engaged by a cone shaped bearing 20 on the object support 26. The aluminum base 2 is recessed at 21 as in Figure 2, but in addition the object support 26 is recessed at 27 to offset the shadow cast by the cone bearing 20.

It is also within the scope of the invention to reverse the bearing arrangement shown in Figure 2 by providing the cone bearing upon the bakelite bearing 19 and forming a cooperating recess in the bakelite sheet 16.

Variations may be resorted to within the scope of the invention and parts of the improvements may be used without others.

Certain features disclosed but not claimed herein are disclosed and claimed in my pending application Serial No. 688,761 for screens for reducing secondary radiation from X-rays, filed January 26, 1924. Such features comprise the forming of the screen of a multiplicity of composite strips, each comprising a layer of material impervious to X-rays, and a layer of material transparent to X-rays by winding the strips spirally together so that they incline toward the point of origin of the X-rays.

What I claim is:

1. The method of making an X-ray screen which comprises providing a winding core or templet locating a multiplicity of composite transparent and impervious strips around the templet with their inner ends abutting the same, removing the templet, trimming the inner ends of said strips to bevel them along a smooth volute curve, and winding in additional composite strips to fill the space vacated by the templet.

2. The method of making a rotary X-ray screen which comprises setting a multiplicity of composite strips with their inner ends terminating roughly upon a widely flaring volute curve, trimming said inner ends smoothly upon the volute curve, and winding additional composite strips within the space bounded by said curve.

3. The method of making a rotary X-ray screen which comprises setting a multiplicity of like, composite transparent and impervious, strips about a space substantially bounded by a volute curve, trimming the inner ends of all said strips upon said curve, arranging a composite strip having less than the usual ratio of impervious to transparent material along the curve upon which the first mentioned strips terminate, and winding in additional strips to fill the space bounded by said curve.

4. The method of making a rotary X-ray screen which comprises arranging a multiplicity of like, composite transparent and impervious, strips about a space bounded by a volute curve with their inner ends terminating on said curve, and spirally winding additional composite strips into the space bounded by said curve to fill said space.

5. The method of making a rotary X-ray screen which comprises forming a multiplicity of like, composite transparent and impervious, strips about a space bounded by a volute curve with their inner ends terminating on said curve, positioning a complete strip having the same width of impervious material but a greater width of transparent material than the other strips along said curve and winding in additional composite strips.

6. The method of making an X-ray screen which comprises positioning and spirally wrapping together a multiplicity of composite transparent and impervious strips of uniform cross sections with their inner ends terminating roughly upon a volute curve, trimming the inner ends of said strips smoothly along said curve, and adding additional composite strips to fill the space within said curve.

7. A rotary X-ray screen for suppressing secondary rays comprising a multiplicity of like composite transparent and impervious strips spirally wound together and having their inner ends terminating upon a volute curve, a composite strip having the usual thickness of transparent material but less than the usual thickness of impervious material positioned along said curve, and additional composite strips wound in with the first mentioned strips and filling the space within said curve.

8. A rotary X-ray screen for suppressing secondary rays comprising a multiplicity of composite transparent and impervious strips spirally wound together and having their inner ends trimmed on a bevel to lie upon a smooth volute curve, a composite strip having the usual thickness of transparent material but less than the usual thickness of impervious material positioned along said curve, and additional composite strips wound in with the first mentioned strips and filling the space within said curve.

9. A rotary X-ray screen for suppressing secondary rays comprising a multiplicity of like composite transparent and impervious strips spirally wound together and having their inner ends terminating upon a volute curve, a composite strip having the usual thickness of impervious material but more than the usual thickness of transparent material extending along said curve, and additional composite strips wound in spirally with the first mentioned strips and filling the space within said curve.

10. A rotary X-ray screen for suppressing secondary rays comprising a multiplicity of

like, composite, transparent and impervious strips, spirally wound together and having their inner ends terminating upon a volute curve, a composite strip positioned along said curve and having the usual thickness of impervious material and the usual thickness of transparent material at the inner side thereof, but also having an additional thickness of transparent material at the outer side thereof to space its impervious portion from the inner ends of the first mentioned strips.

11. A rotary X-ray screen for suppressing secondary rays, comprising a multiplicity of like, composite, transparent and impervious strips, spirally wound together and having their inner ends terminating upon a volute curve, a composite strip positioned along said curve having the usual thickness of impervious material and the usual thickness of transparent material at the inner side thereof, but also having an additional ply of transparent material of less thickness than the other transparent plies of the screen, said transparent ply spacing the impervious ply from the inner ends of the first mentioned strips.

12. A rotary X-ray screen for suppressing secondary rays comprising a multiplicity of like composite transparent and impervious strips spirally wound together and having their inner ends terminating upon a volute curve, a composite strip having less than the usual ratio of impervious to transparent material extending along said curve, and additional composite strips wound in spirally with the first mentioned strips and filling the space within said curve.

13. A rotary X-ray screen for suppressing secondary rays comprising a multiplicity of like, composite transparent and impervious strips of uniform cross section having their inner ends bevelled along a volute curve, a composite strip extending along said curve adjacent said inner bevelled ends, and additional composite strips wound in with the first mentioned strips to fill the space within said curve.

14. In an apparatus for making Roentgenographs, a screen for suppressing secondary rays, means for rotating said screen, a transparent support for objects to be Roentgenographed extending across said screen, and means for fixing the centre of the rotating screen, comprising cooperating transparent bearing members on the screen and on the transparent support, at the centre of the screen.

15. In an apparatus for making Roentgenographs, a screen for suppressing secondary rays comprising an X-ray filter part and a transparent support for said filter part, a transparent support for objects to be photographed, located above the screen, and cooperating, transparent, projecting bearing members on the object support and on the screen at the centre of the screen, the supporting part of the screen being recessed to offset the shadow cast by said bearing members.

16. In an apparatus for making Roentgenographs, a rotary screen for suppressing secondary rays, a transparent bearing at the centre of the screen, fixed transparent means overlying the screen and providing a centering bearing for cooperation with said screen bearing, and means engaging the lower margin of said screen for supporting and driving the screen.

17. In an apparatus for making Roentgenographs, a rotary screen for suppressing secondary rays, a transparent bearing at the centre of the screen, fixed transparent means overlying the screen and providing a centering bearing for cooperation with said screen bearing, rotary members supporting the screen at its margins beyond the Roentgenographic field, and means for driving one of said rotary members to rotate the screen.

18. In an apparatus for making Roentgenographs, a rotary screen thin enough to flex under pressure, centrally located transparent means for fixing the centre of the screen, and means for engaging the margin of the screen to drive the latter, the arrangement being such that the screen is driven substantially uniformly and about a fixed centre regardless of the flexture of the screen.

19. In an apparatus for making Roentgenographs, a rotary screen comprising an X-ray filtering part and a supporting part, a shadow casting central bearing member for fixing the centre of the screen, the said supporting part of the screen being recessed to offset the shadow cast by said bearing member.

20. In an apparatus for making Roentgenographs, a transparent support for objects to be Roentgenographed, a rotary screen adjacent said support comprising an X-ray filter portion and a supporting portion, a bearing of transparent material projecting from the lower surface of the object support and a cooperating bearing of transparent material formed on the upper surface of the screen, the object support and the supporting portion of the screen being recessed to offset the shadows cast by said bearing.

21. In an apparatus for making Roentgenographs, a rotary screen thin enough to flex under pressure, means for guiding the screen, and frictional driving means arranged to drive the screen by engagement with the lower margin thereof.

22. The method of making a rotary X-ray screen, which comprises arranging a multiplicity of like, composite transparent and impervious, strips about a core space bounded by a volute curve with their inner ends

terminating on said curve and completing the screen by locating additional spirally wound strips in the core space.

23. In an apparatus for making Roentgenographs, a screen for suppressing secondary rays, means for rotating said screen, a transparent support for objects to be Roentgenographed extending across said screen, and means for definitely controlling movement of the screen with reference to a fixed central point comprising a transparent bearing in the Roentgenographic field, engaging a recess in said support.

In testimony whereof I have affixed my signature to this specification.

HAROLD S. SAWFORD.