United States Patent

Cook

[15] 3,684,885

[45] Aug. 15, 1972

[54] ROTATABLE X-RAY GRID WITH NON-STATIONARY CENTER AND METHOD

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[22] Filed: **July 27, 1970**

[21] Appl. No.: **58,352**

[52] **U.S. Cl.** **250/62,** 250/63, 250/105

[51] **Int. Cl.**.....**G01n 23/20**

[58] **Field of Search**.....250/62, 63, 105

[56] **References Cited**

UNITED STATES PATENTS

3,489,897 1/1970 Wainer.....250/62

FOREIGN PATENTS OR APPLICATIONS

759,534 2/1934 France.....250/63

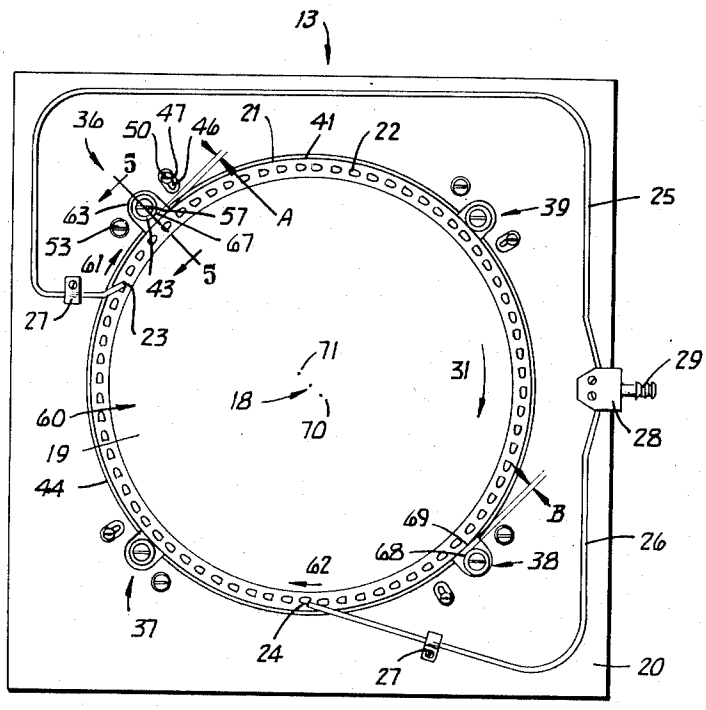
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[57] **ABSTRACT**

A rotatable grid having a non-stationary center for allowing primary directed x-rays to pass through while preventing scattered secondary radiation from passing through the grid. A disc composed of aluminum or fiber strips interspaced with lead strips has an outer rim rotatably housed in a frame spaced over x-ray film. Compressed air is directed to strike recesses on the rim imparting rotation to the rim with respect to the frame. Four bearing assemblies, each having a roller adjustable from the rim edge and a roller supporting the bottom horizontal rim surface, are attached to the frame. A fastening device on each bearing assembly may be adjusted thereby changing the distance between the rim edge and the rim roller allowing the rotating disc center to move in a direction parallel with respect to the film surface.

6 Claims, 6 Drawing Figures



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SHEET 1 OF 3

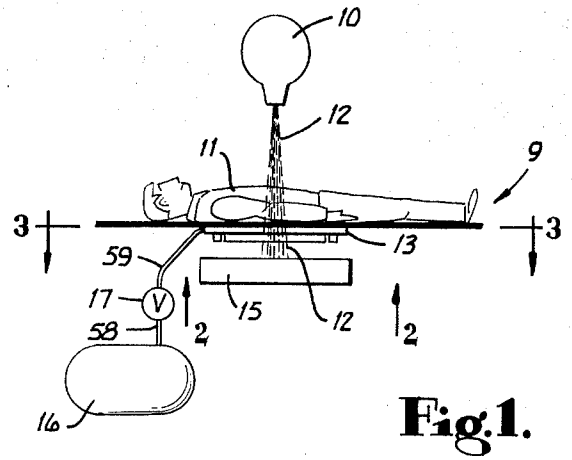


Fig.1.

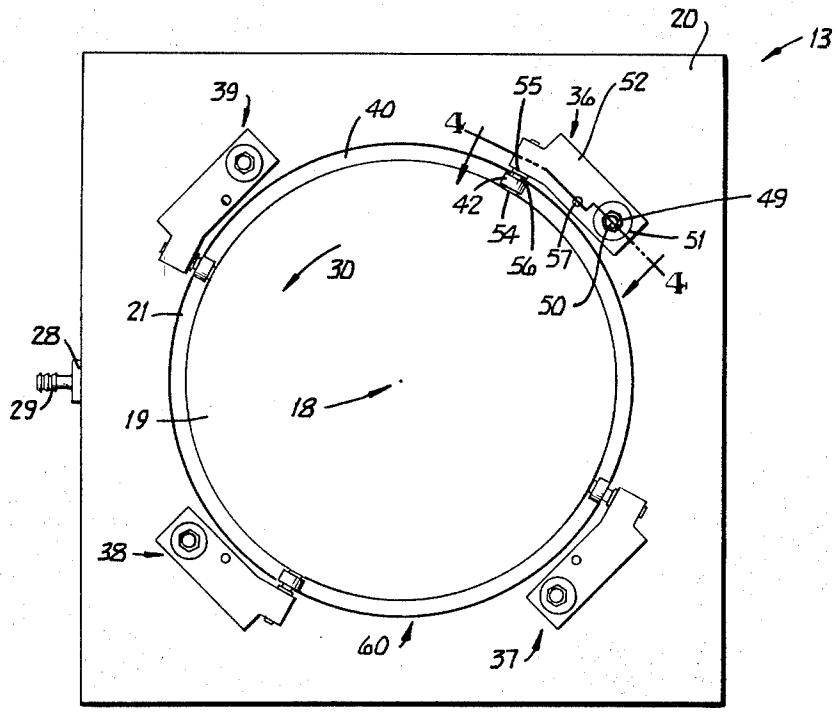


Fig.2

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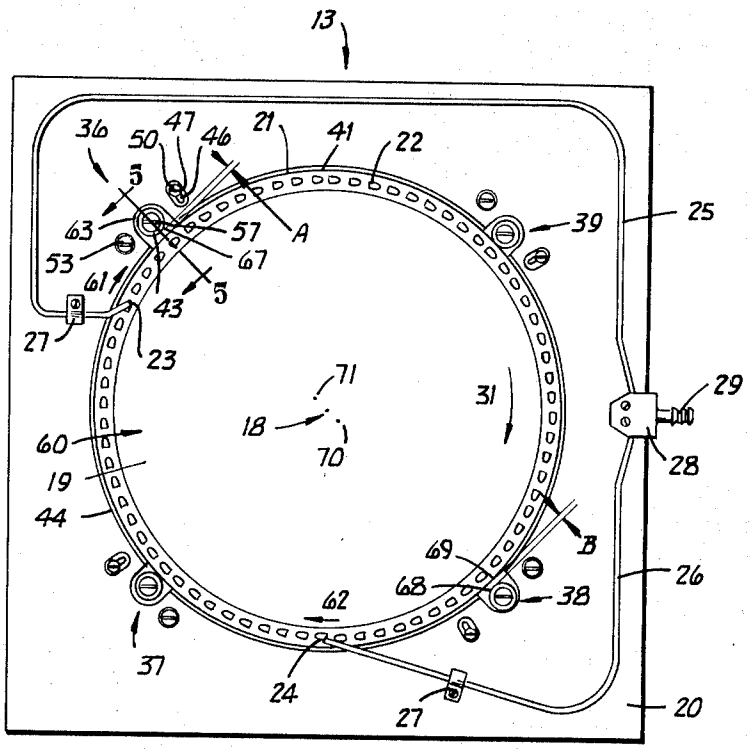


Fig.3.

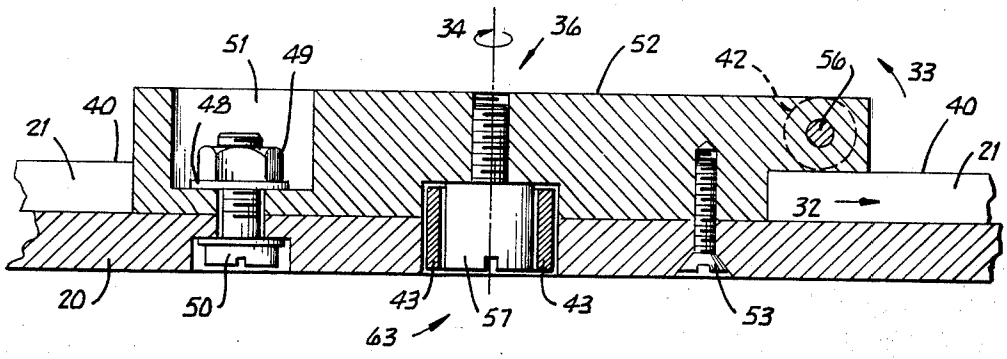


Fig.4.

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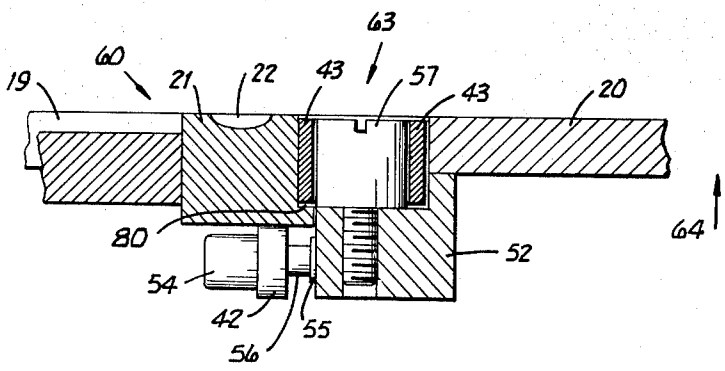


Fig.5.

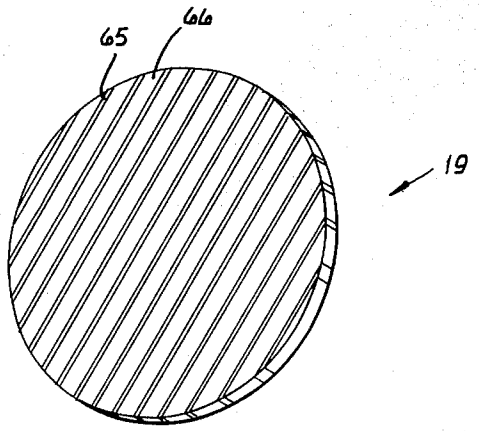


Fig.6.

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ROTATABLE X-RAY GRID WITH NON-STATIONARY CENTER AND METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an apparatus for reducing secondary radiation from x-rays.

2. Description of the Prior Art

When passing x-rays through a subject and exposing a film, the image thereon will be blurred or hazy since secondary or scattered radiation is produced by the subject. To eliminate this problem the "Bucky Diaphragm" was invented. Kurt Amplatz, M. D., Simple Bucky Diaphragm for High Speed Angiography, in American Journal Radiology 2: page 387, Nov/Dec 1967. Also see, Michel M. Ker-Pogossian, The Physical Aspects of Diagnostic Radiology, N.Y., Harper and Row, 1967, page 263, Library of Congress 66–19240.

Such a diaphragm is generally composed of strips of material opaque to scattered radiation interspaced between strips of material transparent to the primary radiation. The diaphragm is rotated, as in the following U.S. Pat. Nos.: 1,609,475 to Janus, 1,465,340 to Buck and 1,621,814 to Sawford, or may be reciprocated as in the following U.S. Pat. No.: 2,145,868 to Fisher and 3,163,989 to Maxwell.

It can be appreciated that in rotating a disc the center of the disc is stationary. Thus, in rotating a "-Bucky Diaphragm" the film immediately beneath the center of the diaphragm is subjected to secondary radiation and is therefore hazy and blurred. In addition, this area may be completely exposed or completely unexposed. Thus, there is a need for a structure for rotating an x-ray grid in such a manner so that the center of the grid is not stationary with respect to the film. The structure should allow the x-rays to pass through the grid center and should therefore avoid the center driving means utilized in the aforementioned reciprocating devices.

SUMMARY OF THE INVENTION

The present invention is a rotatable x-ray grid having a non-stationary disc center. The grid has alternate strips of lead and aluminum or fiber for reducing scattered radiation through the grid to an x-ray film. The disc is enclosed in an outer rim housed in a frame with air tubes mounted thereon. Compressed air exits the air tubes striking recesses in the rim surface thereby causing the rim and disc to rotate with respect to the frame. Four bearing assemblies are attached to the frame adjacent the rim. Each bearing assembly has a roller abutting the bottom horizontal rim surface and a second roller adjustable to and from the rim edge. A fastening device secures the frame and bearing housing together and may be adjusted to change the distance between the rim edge and the rim roller thereby allowing the center of the disc to move in a direction parallel with the film surface.

It is an object of the present invention to provide a rotatable x-ray grid having a non-stationary disc center and a method for obtaining a clear x-ray image on x-ray film beneath the grid and especially in the center.

Related objects and advantages of the present invention will be apparent from the following description.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is an illustration of x-rays originating from a source, passing through a subject and onto a film. An x-ray grid incorporating the present invention is located between the subject and the film.

FIG. **2** is an enlarged view of the x-ray grid shown in FIG. **1** and viewed in the direction of arrows **2—2**.

FIG. **3** is an enlarged view of the x-ray grid shown in FIG. **1** viewed along the line **3—3** and in the direction of the arrows.

FIG. **4** is a fragmentary enlarged section of one of the bearing assemblies shown in FIG. **2** and is taken along the lines **4—4** and viewed in the direction of the arrows.

FIG. **5** is a fragmentary enlarged view of a portion of the grid, rim and bearing assembly shown in FIG. **3** and is taken along the lines **5-5** and viewed in the direction of the arrows.

FIG. **6** is a perspective view of the grid of FIG. **1** without the rim or frame and particularly illustrates the layers of material in the grid.

DESCRIPTION OF THE PREFERRED EMBODIMENT

For the purposes of promoting and understanding the principles of the invention, reference will now be made to the embodiment illustrated in the drawing and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

Referring now more particularly to FIG. **1**, there is illustrated a source **10** emitting x-rays **12** towards and through a subject **11** resting on table **9** and finally exposing the film in film container **15**. The top of table **9** is made from a material, such as glass, which is transparent to x-rays. Subject **11** of course would be some portion of the patient such as, a hand or chest. Located between table **9** and film container **15** is a rotatable x-ray grid **13** having a non-stationary center. Rotating grid **13** is relatively transparent to x-rays **12** originating from source **10** and is relatively opaque to secondary radiation which impinges on the grid at angles different from that of transmitted x-rays **12**. Thus, the radiation has a reduced level of scattered components once it passes through grid **13**. Connected to grid **13** by tubes **58** and **59** is an air pressure source **16**. Valve **17** allows the user to control the flow of air to grid **13**.

FIG. **2** is an enlarged view of grid **13** taken in the direction of arrows **2—2** of FIG. **1**. Grid **13** has a frame **20** supporting disc assembly **60** and four bearing assemblies **36**, **37**, **38** and **39**. Disc assembly **60** has a disc **19** with a rim **21** around the disc perimeter. As may be seen from FIG. **3**, the disc assembly is located in grid receiving hole **44** and extends through both sides of frame **20**.

In the embodiment shown in FIG. **3**, rotation is imparted to disc assembly **60** by air impinging on cusp-like recesses **22** on the outer surface of rim **21**. One or more air tubes may be utilized to distribute the air to

the rim. As shown in FIG. 3, two air tubes **25** and **26** are provided with air, exiting outlet **23** in the direction of arrow **61** and outlet **24** in the direction of arrow **62** thereby causing disc assembly **60** to rotate in the direction of arrow **31**. The outlet ends of the tubes should be positioned over rim **21** so as to not touch the rim while directing air at an angle downward towards recesses **22**. Clamps **27** are fastened to frame **20** holding the air tubes in place. An air distribution box **28** is fastened to frame **20** and connects tubes **25** and **26** to the main air pressure source via nozzle **29**. The nozzle is connected to tube **59** (FIG. 1) which is connected to valve **17** for controlling the flow of air to the rim.

The four bearing assemblies **36** through **39** shown in FIG. 2 allow disc assembly **60** to rotate with respect to frame **20**. Bearing assembly **36** will now be described, it being understood that the bearing assemblies are identical and a similar description applies to bearing assemblies **37, 38, 39**. It will be helpful to refer to FIGS. 2 through 4 in describing the bearing assembly. FIG. 4 is a section taken along the line 4—4 in the direction of the arrows of bearing assembly **36** illustrated in FIG. 2. Bearing assembly **36** has a body **52** secured to frame **20** by a screw **53** and bolt **50** or other such fastening devices. Screw **53** extends through frame **20** and into a blind threaded hole in body **52**. Bolt **50** extends through a countersunk hole in frame **20** and body **52** and into complementary nut **49**. A counterbore **51** in body **52** accomodates nut **49** and washer **48**. As will be evident later, it is desirable to adjust the distance between the edge of disc assembly **60** and the bearing assembly. Thus, an elongated recess **47** (FIG. 3) and a slot **46** is provided in frame **20** allowing bolt **50**, and the body of the bearing assembly to be moved to and from disc assembly **60**.

Each bearing assembly has two rollers abutting the edge and horizontal surface of rim **21**. For example, roller **42** (FIGS. 2 and 4) of bearing assembly **36** extends out and abuts against the horizontal surface **40** of rim **21** being freely rotatable on shaft **56**. Roller **42** is kept in place by a head **54** attached to shaft **56** which is fixedly fastened through boss **55** to body **52**. The second roller **43** of bearing assembly **36** is shown in FIGS. 3 and 4 abutting against the outside edge **41** of rim **21**. Edge roller **43** is freely rotatable on a large diameter shoulder bolt **57** which passes through a U-shaped recess **63** in frame **20** and body **52** being threaded in a smaller diametered threaded hole in body **52**. FIG. 5 is a sectional view showing the relationship of the rim with respect to the two rollers and is taken along the line 5—5 of FIG. 3 and viewed in the direction of the arrows. Rim **21** has a shoulder **80** under a portion of roller **43** thereby preventing the disc assembly **60** from falling from frame **20** in the direction of arrow **64**. Of course, roller **42** prevents disc assembly **60** from falling from frame **20** in a direction opposite of arrow **64**.

A perspective view of disc **19** is shown in FIG. **6** without its associated rim in order to illustrate the arrangement of the material in the disc. The disc has strips **66** of material opaque to x-rays interspaced between strips **65** of material transparent to x-rays. It has been found that the best results are obtained by making strips **66** from lead with a width of approximately 0.3mm and strips **65** from aluminum with a width of 0.05mm. The approximate thickness of the disc is 3.6mm. The disc may be attached to a rim by any number of means such as adhesives. The rim and frame may be made from metal such as aluminum.

With the disc assembly **60** rotating in the direction of arrow **30** (FIG. 2), arrow **31** (FIG. 3), and arrow **32** (FIG. 4), the edge roller will rotate in the direction of arrow **34** and roller **42** will rotate in the direction of arrow **33**. It can be appreciated that when rotating a disc, the center of the disc remains in a stationary position. This causes a problem in the instant application in that the center of disc **19** will appear as a non-rotating point to the x-rays thus causing a dot or hazy area on the film. The above described structure precludes this from occurring by causing disc assembly **60** to rotate in such a manner so as to have a non-stationary center. Referring to FIG. 3, the dimension "A" is the distance between the rim edge **41** and the edge **67** of roller **43**. Likewise, the dimension "B" is the distance between the rim edge **41** and the edge **68** of roller **69**. By adjusting the distance between surface **67** of roller bearing assembly **36** and assembly **60** and the distance between surface **68** of roller bearing assembly **38** and disc assembly **60** until dimensions "A" and "B" each equal approximately 0.007 inches, a motion will exist relative to the center of the disc. This procedure can be accomplished by placing a feeler guage or shim having a thickness of 0.007 inches between edge **41** and edge **67** prior to tightening bolt **50** on bearing assembly **36**. The bolt should then be tightened and the shim withdrawn. Likewise, the spacing for dimension "B" can be accomplished in a manner similar to that for the dimension "A." As a result, center **18** of disc **19** will move between point **70** and point **71** as the disc assembly rotates and moves from edge **68** of roller **69** to edge **67** of roller **43**. The rollers of bearings **37** and **39** abut the rim edge in a running fit so as to not bind the disc in one position. Of course, the distance from point **70** to point **71** would equal 0.014 inches. Dimensions "A" and "B" may actually be each varied from 0.003 to 0.007 inches thereby allowing a total movement of center **18** from 0.006 to 0.014 inches. Good results have been obtained throughout the entire range of 0.006 to 0.014 inches. FIG. 3 has been exaggerated to show the spacing of dimensions "A" and "B." Bearing assemblies **37** and **39** could be adjusted in a similar manner while having rollers **43** and **69** abutting the rim edge in a running fit. It would also be possible to have the edge rollers of all four bearing assemblies **36** through **39** adjusted slightly away from the rim edge. Hole **44** must be sufficiently larger than disc assembly **60** to allow for the motion. Of course, the force of the compressed air on rim **21** causes the disc to rotate and the center **18** to move.

The present invention contemplates and includes many variations of the above described structure. For example, a permanent magnet motor arrangement having two or three electro-magnets spaced at equal intervals around the periphery of the grid could be used to drive the disc assembly in lieu of the compressed air as described above. In addition, the number and type of bearings used around the periphery of the disc assembly may be changed from that which has been described. While the distance between the grid and the film may be varied, best results have been obtained when the grid is approximately 1 inch from the film.

It will be evident from the above description that the present invention provides a rotatable x-ray grid having a non-stationary center and a method for obtaining a clear x-ray image on x-ray film beneath the grid and especially in the center.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirit of the invention are desired to be protected.

The invention claimed is:

1. An x-ray grid allowing primary x-ray radiation to pass through to an x-ray film while excluding secondary scattered radiation comprising:
- a rotatable disc allowing said primary x-ray radiation to pass therethrough;
- a frame housing said disc;
- power means to rotate said disc within said frame;
- bearing assemblies mounted to said frame around said disc with at least one of said assemblies having a bearing spaced away from said disc to allow the center of said disc to move in a direction parallel to said film simultaneously as said disc rotates, each bearing assembly has a first and second bearing, said first bearing abuts the bottom surface of said disc, said second bearing is adjustable to and from the edge of said disc providing a bearing surface for said edge to contact; and wherein:
- said disc has recesses around its edge;
- said power means has an air tube directing compressed air to said recesses to force said disc to rotate.

2. The grid of claim 1 wherein:
- said disc has strips of material opaque to said primary x-ray radiation interspaced with strips of material transparent to said primary x-ray radiation.

3. The grid of claim 2 wherein:
- each of said bearing assemblies have a main body fastened to said frame, each of said first bearings are roller bearings rotatably mounted to said main body and extending under said disc, each of said second bearings are roller bearings rotatably mounted to said main body, said second bearings have longitudinal axes parallel with said edge of said disc.

4. The grid of claim 3 wherein:
- said bearing assemblies are mounted to said frame 90° relative to each other about said center of said disc, said second bearings of at least two of said bearing assemblies have outside surfaces spaced at least 0.003 inches from said edge of said disc.

5. A method of moving an x-ray grid with respect to x-ray film so as to obtain a clear x-ray image on said film immediately beneath the center of said grid comprising:
- rotating said grid on bearings within a frame;
- holding said frame still relative to said film;
- spacing at least one of said bearings from the edge of said grid so said center moves relative to said film by at least 0.006 inches; and wherein:
- compressed air is directed to said grid to rotate said grid relative to said film.

6. An x-ray grid allowing primary x-ray radiation to pass through to an x-ray film while excluding secondary scattered radiation comprising:
- a rotatable disc allowing said primary x-ray radiation to pass therethrough;
- a frame housing said disc;
- power means to rotate said disc within said frame;
- bearing assemblies mounted to said frame around said disc with at least one of said assemblies having a bearing spaced away from said disc to allow the center of said disc to move in a direction parallel to said film simultaneously as said disc rotates; and wherein:
- said disc has a rim with a first and second side and a circumferential edge with a continuous ledge projecting therefrom, said first side has recesses formed therein;
- said power means is a source of pressurized gas directed into said recesses; and,
- each of said bearing assemblies has a first and second bearing with said second bearing positioned adjacent said edge and ledge, said first bearings are mounted to said frame contacting said second side cooperatively with said second bearings mounting said disc in said frame.

* * * * *

UNITED STATES PATENT OFFICE

Certificate

Patent No. 3,684,885 Patented August 15, 1972

William A. Cook

Application having been made by William A. Cook, the inventor named in the patent above identified, for the issuance of a certificate under the provisions of Title 35, Section 256, of the United States Code, adding the names of Quentin J. Westrick and Joseph J. Bookstein as joint inventors, and a showing and proof of facts satisfying the requirements of the said section having been submitted, it is this 27th day of November 1973, certified that the names of the said Quentin J. Westrick and Joseph J. Bookstein are hereby added to the said patent as joint inventors with the said William A. Cook.

FRED W. SHERLING,
Associate Solicitor.