Dec. 23, 1941. A. SIMON 2,267,141

X-RAY CIRCUIT FOR ELIMINATING GRID SHADOWS

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Fig. 1.

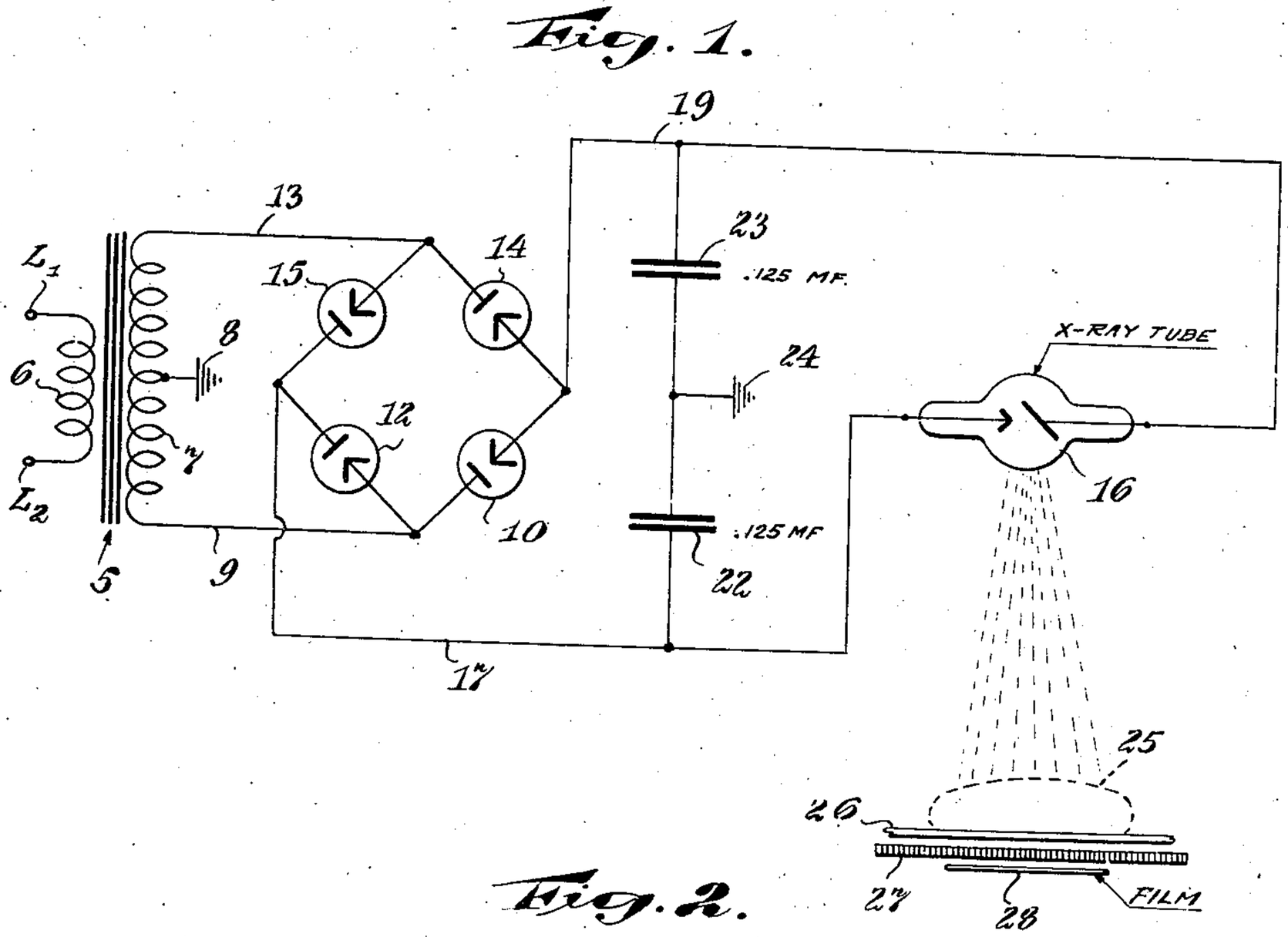


Fig. 2.

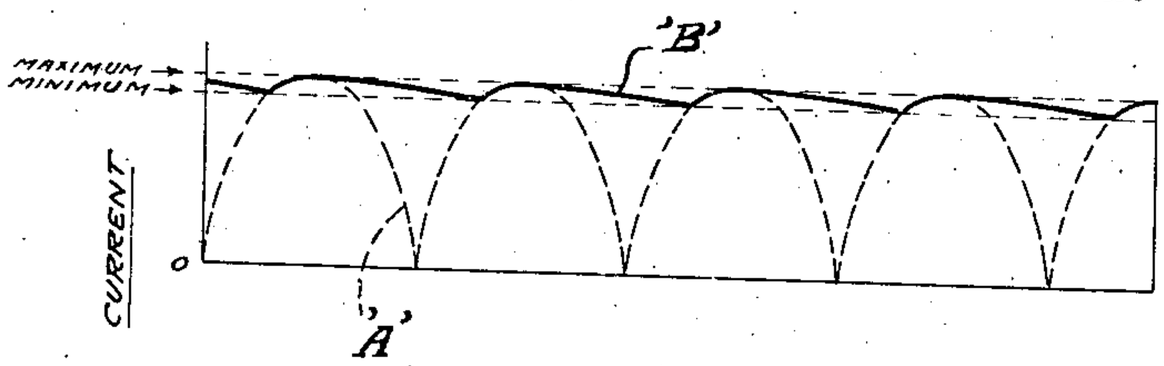
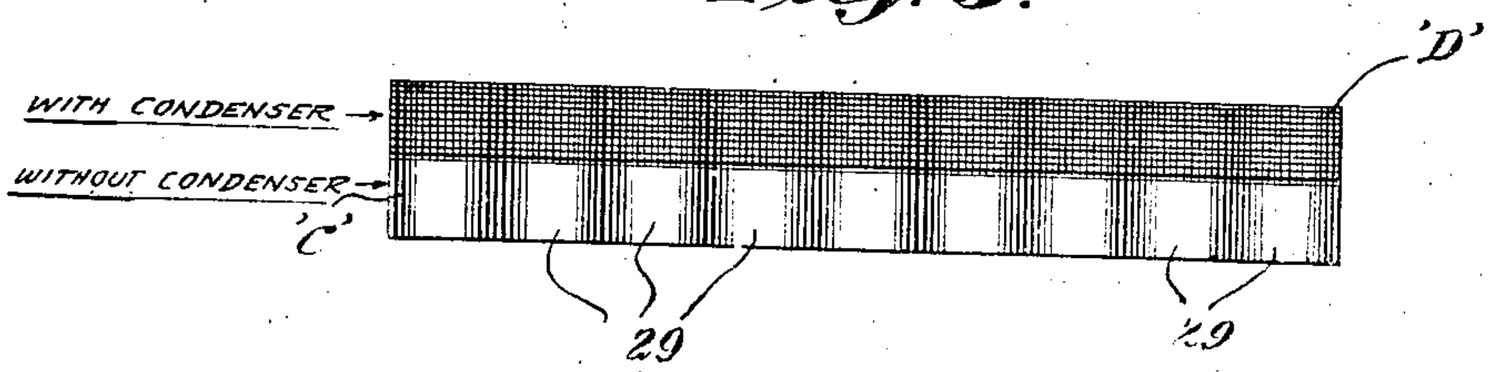


Fig. 3.



INVENTOR
ALFRED SIMON
BY J. W. Green. Howe
ATTORNEY

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X-RAY CIRCUIT FOR ELIMINATING GRID SHADOWS

Alfred Simon, Jackson Heights, Long Island, N. Y., assignor, by mesne assignments, to Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

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4 Claims. (Cl. 250—62)

The present invention relates to X-ray systems and particularly to such systems wherein high voltage is employed for the making of radiographic exposures utilizing a Bucky grid and in which grid lines heretofore appearing on the film are eliminated.

It has long been recognized in the art that in radiographing solid substances such as the human body, secondary radiations are generated by the primary radiations striking denser portions such as the bones. To prevent these secondary radiations from fogging a film, it has been customary to employ what is known in the art as a Bucky grid which is composed of alternate strips of X-ray pervious and impervious material. During exposure, this grid is moved between the object and film so that the grid pattern on the film becomes obliterated.

While the grid eliminates fogging of the film from secondary radiations, it nevertheless, unless moved during exposure, leaves grid lines on the film where the primary rays do not penetrate the X-ray impervious sections, which all to frequently renders the film exceptionally difficult to diagnose. It naturally follows that if the X-ray tube is energized by direct current, no grid lines will appear upon the developed film when the grid is uniformly moved during exposure. Since it is exceptionally difficult and frequently impossible due to commercial conditions to obtain high voltage direct current, it is customary to employ alternating current as the energizing source which is stepped up by a high voltage transformer.

Inasmuch as the current and voltage reverse many times a second, depending upon the frequency, and thus pass through zero points of the alternating current wave as well as high points, there are naturally very brief intervals when no X-rays are generated followed by longer periods when the intensity of the X-rays rises from zero to maximum and again falls to zero. This rise and fall of the intensity of the X-rays is what causes the registration of the grid lines on the film with the width thereof being dependent upon the difference in time between the frequency of the alternating current and the speed of movement of the grid.

Various attempts have been made by workers in the art to eliminate the grid lines by increasing the speed of movement of the grid. Such attempts have proven unsuccessful because no practical way has at yet been found to make the speed of the grid such that those speeds that are in simple or multiple synchronism with the X-ray frequency are avoided when employing alternating current of commercial frequencies ranging from 25 cycles per second to 60 cycles per second, which thus results in the appearance of grid lines. While prior art workers have been concerned with the mechanical requirements of adjusting the speed of movement of the grid, I have discovered that by the proper electrical design of the energizing circuit, radiographs can be taken using a Bucky grid and wherein grid lines on the film are eliminated.

It is accordingly the primary object of the present invention to provide an X-ray system for the taking of radiographic exposures wherein a Bucky grid is employed to intercept secondary radiations and wherein grid lines on the film are eliminated.

Another object of the present invention is the provision of an X-ray system of relatively high power for the taking of radiographic exposures with the utilization of a Bucky grid to eliminate secondary radiations and wherein the sinusoidal wave form of the alternating current source is suppressed so that grid lines are prevented from registering upon the exposed film.

Still further objects of the present invention will become obvious to those skilled in the art by reference to the accompanying drawing wherein the single figure is a diagrammatic illustration showing the system for the taking of radiographic exposures utilizing a Bucky grid in accordance with the present invention.

Referring now to the drawing in detail, the system as shown in Fig. 1 comprises a high tension transformer **5** having its primary winding **6** connected to a suitable source of electrical energy of the customary potential of 110 or 220 volts as shown by the terminals L1, L2. The high potential secondary winding **7** is grounded in the center at **8** and has one end thereof connected by a conductor **9** to the respective anode and cathode of a pair of rectifying valve tubes **10** and **12**.

Similarly the remaining end of the secondary winding **7** is connected by a conductor **13** to the respective anode and cathode of another pair of rectifying valve tubes **14** and **15**. In order to supply full wave rectified unidirectional current to the X-ray tube **16**, a conductor **17** connects the thermionic cathode of the X-ray tube **16** to the anode of the two rectifying valves **12** and **15**, while the anode of the X-ray tube is connected by a conductor **19** to the thermionic cathodes of the other rectifying valve tubes **10** and **14**.

The thermionic cathodes of the rectifying valves 10, 12, 14 and 15 as well as the thermionic cathode of the X-ray tube 16 receive heating current from any suitable source such as batteries, individual low voltage heating transformers or a single transformer as desired, although such low voltage source has not been shown in the drawing for the sake of simplicity.

For the purpose of suppressing the usual sinusoidal ripple, such as shown by the curve A in Fig. 2 which is characteristic of full wave rectified unidirectional current, a pair of series connected condensers 22 and 23 are connected in electrical parallel with the X-ray tube and grounded at 24. Accordingly, upon connection of the primary winding 6 of the high voltage transformer 5 to the customary domestic source of potential, a high voltage alternating current is induced in the secondary winding 7. The current then flows through one or the other of the pairs of rectifying valves during each half wave of the alternating current cycle, thus converting the alternating current into unidirectional current which is supplied to the X-ray tube.

The condensers 22 and 23 having a capacity of approximately .125 microfarad each, which may be a single condenser or a bank of condensers of the desired capacity, being in electrical parallel with the X-ray tube are accordingly charged and during the periods when the flow of current is approaching zero the condensers discharge through the X-ray tube. The resulting effect is a substantially constant potential wherein the current falls only about 10% below what it would if true direct current were employed, such as shown by the curve B of Fig. 2.

The circuit thus described, wherein a constant potential is employed to energize an X-ray tube, has been heretofore used in the art in connection with the administration of therapeutic treatments. So far as I am aware, the use of high power full wave rectified single phase current of the order of 100 to 300 milliamperes has never been employed for the taking of radiographic exposures particularly in combination with a Bucky grid for the elimination of grid lines on the film.

By subjecting a patient 25 to the X-ray tube 16 while positioned on a table 26, and disposing a Bucky grid 27 between the patient and a film 28, and moving the grid while the exposure is made, no grid lines appear on the exposed film. For example, I have found from my experiments that with a given speed adjustment of the Bucky grid and utilizing a full wave rectified current varying from 100 to 300 milliamperes without constant potential, the resulting film had the appearance of the grid having been stationary, such as shown at C in Fig. 3 wherein the grid lines 29 are immediately discernible. Moreover, the speed of movement of the grid was varied and even at the optimum speed, such grid lines were still quite pronounced. However, by utilizing a high powered constant potential in combination with the Bucky grid, the lines were completely eliminated even at the worst speeds of the grid, resulting in a film such as that shown at D in Fig. 3.

It will thus become obvious to those skilled in the art that an electrical system is herein provided wherein high powered constant potential electrical current is utilized to energize an X-ray tube so that a Bucky grid may be employed during the exposure to eliminate secondary radiations and wherein grid lines on the developed film are eliminated.

Although one specific embodiment of the present invention has been shown and described, it is to be understood that further modifications thereof may be made without departing from the spirit and scope of the appended claims.

I claim:

1. In an X-ray system for the taking of radiographic exposures free of grid lines, the combination of a Bucky grid for intercepting secondary radiations and uniformly movable between the object to be radiographed and a sensitized film during exposure of the latter, a source of high power electrical energy and of high constant potential, and an X-ray tube connected to said source and operable to generate X-rays of substantially constant intensity for the purpose of eliminating grid lines on said film when exposed to X-rays from said tube and after passing through said grid.

2. In an X-ray system for the taking of radiographic exposures free of grid lines, the combination of a Bucky grid for intercepting secondary radiations and uniformly movable between the object to be radiographed and a sensitized film during exposure of the latter, a source of high power alternating current electrical energy, rectifying means connected to said source for converting the alternating current into full wave unidirectional current, means connected to said rectifying means and operable to suppress the sinusoidal wave form attendant full wave rectified unidirectional current to produce a constant potential, and an X-ray tube connected to both said means for energization by the constant potential produced by said last mentioned means to cause the generation of X-rays of substantially constant intensity for the purpose of eliminating grid lines on said film when exposed to X-rays from said tube and after passing through said grid.

3. In an X-ray system for the taking of radiographic exposures free of grid lines, the combination of a Bucky grid for intercepting secondary radiations and uniformly movable between the object to be radiographed and a sensitized film during exposure of the latter, a source of high power alternating current electrical energy comprising a high voltage transformer provided with a secondary winding, a plurality of rectifying valve tubes connected to said secondary winding for converting the alternating current into full wave unidirectional current, capacitor means connected to said rectifying valve tubes and operable to suppress the sinusoidal wave form attendant full wave rectified unidirectional current to produce a constant potential, and an X-ray tube connected to said capacitor means for energization by the constant potential produced thereby to cause the generation of X-rays of substantially constant intensity for the purpose of eliminating grid lines on said fim when exposed to X-rays from said tube and after passing through said grid.

4. In an X-ray system for the taking of radiographic exposures free of grid lines, the combination of a Bucky grid for intercepting secondary radiations and uniformly movable between the object to be radiographed and a sensitized film during exposure of the latter, a source of high power alternating current electrical energy comprising a high voltage transformer provided with a secondary winding, a plurality of rectifying valve tubes connected to said secondary winding

for converting the alternating current into full wave unidirectional current, a bank of condensers of a predetermined capacity connected to said rectifying valve tubes and operable to suppress the sinusoidal wave form attendant full wave rectified unidirectional current to produce a constant potential, and an X-ray tube connected to said rectifying valve tubes and in electrical parallel with said condensers for energization by the constant potential produced thereby to cause the generation of X-rays of substantially constant intensity for the purpose of eliminating grid lines on said film when exposed to X-rays from said tube and after passing through said grid.

ALFRED SIMON.