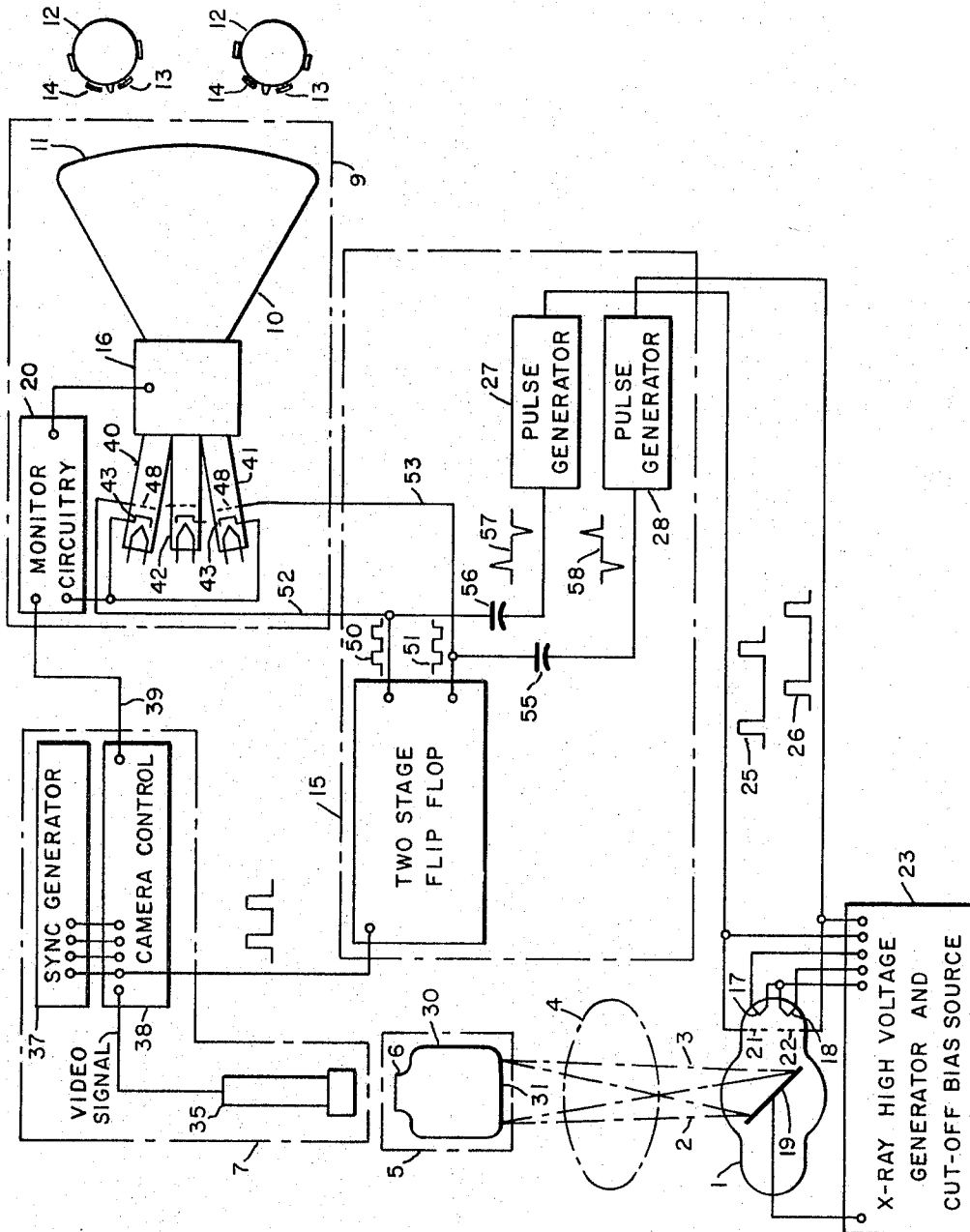


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X-RAY STEREOSCOPIC APPARATUS FOR PRODUCING ALTERNATE
IMAGES OF DIFFERENT COLORS ON A CATHODE RAY TUBE
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WITNESSES

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X-RAY STEREOSCOPIC APPARATUS FOR PRODUCING ALTERNATE IMAGES OF DIFFERENT COLORS ON A CATHODE RAY TUBE

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The present invention relates to X-ray apparatus, and more particularly to a stereoscopic X-ray apparatus.

Stereoscopic X-ray apparatus as heretofore proposed have been characterized by a certain degree of complexity including, for example, excessive duality of component devices, cumbersome image display systems which accommodate a viewer only from a particular observation position or which limit observation to a single viewer at any one time, or which inherently suffer from lack of brightness and/or definition, etc.

Accordingly, it is one object of the present invention to provide improved stereoscopic X-ray apparatus.

It is another object of the present invention to provide a stereoscopic X-ray apparatus which is so displayed on a single screen as to present stereoscopic image viewable simultaneously by a number of viewers and of a brightness and clarity not afforded heretofore.

Other objects and advantages of the invention will become apparent from the following description when taken in connection with the accompanying drawing having a single figure showing schematically the pertinent features of an illustrative embodiment of the invention.

Referring to the drawing, the general features of the exemplified embodiment include a dual X-ray beam source 1 for directing X-ray beams 2 and 3 through the object or patient 4 from two different angular attitudes; image-producing-and-amplifying means 5 for producing on an output screen 6 X-ray images resultant from penetration of the patient or object 4 by the two X-ray beams 2 and 3; a single video camera means 7 in observance of the output screen 6 of means 5 to produce closed-circuit video-signal information to a television monitor 9 having a picture tube 10 for display of stereo X-ray images in lateral displacement on its screen 11 in a manner which can be viewed directly by viewers 12 wearing appropriate glasses with filters 13 and 14 to separate the images respectively to the eyes of each; and a control means 15 for effecting alternate periodic generation of the two X-ray beams 2 and 3 and corresponding alternate mutually-time-exclusive picturization of the corresponding laterally-displaced stereo images on the screen of the picture tube 10.

The dual-X-ray beam source 1, as illustrated, is in the form of a single X-ray tube having dual cathodes 17 and 18 and a common anode 19 to produce the two separated, relatively-angulated beams 2 and 3 during conduction between such anode and cathodes, together with two control grids 21 and 22 for controlling conduction respectively to the two cathodes. Per the usual technique, as is well known in the art, a high voltage and cut-off bias source generator 23 is employed in connection between cathodes and anodes for conduction therebetween upon adjustment of the cut-off bias supply to the grids 21 and 22. By applying out-of-phase square wave pulses 25 and 26 from pulse generators 27 and 28 to the grids 21 and 22 the cathodes 17 and 18 are made to conduct alternately to produce the X-ray beams 2 and 3 alternately at regular intervals. By employment of the image-producing and amplifier means 5, each X-ray beam 2 and 3 need not persist for longer than about two milliseconds, and for reasons which hereinafter will become apparent, the repetition rate of each of the pulses

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25 and 26, and hence of each of the X-ray beams 2 and 3, is fifteen per second in the illustrative embodiment described herein.

The image-producing and-amplifying means 5 per se is well known in the art and includes circuit means, not shown, for energizing the well-known image amplifier tube 30 having an enlarged fluorescent input screen 31 receiving the X-rays from the two beams 2 and 3 after passing through the object or patient 1, as well as the brightened image-display or output screen 6, which is of reduced size relative to input screen 31. Such an image amplifier tube has a brightness amplification in excess of 3000 over a conventional fluorescent screen. Each X-ray pulse image will persist on the screen 6 of the tube 30 for a period of no more than one-thirtieth of a second.

The camera means 7 includes a camera tube 35 preferably of the type, such as the image orthicon, which is relatively sensitive and capable of responding to what may be moving light images on the screen 6 to fill a frame on the television monitor 9 at the standard rate of thirty frames per second, or, in other words, at the scanning time of one-thirtieth of a second per frame, with clearly defined images. Camera means 7 is of the conventional construction such as is used for black-and-white single-kinescope-tube monitors and includes the usual sync generator 37 and camera control circuitry 38 as well as camera output line 39 for supply video and sixty-cycle blanking signals for the monitor 9.

The tube 10 of monitor 9 is a commercially available color picture tube having the usual two guns 40 and 41, respectively to such as the red and green dots on a tri-color shadow mask screen, and a third gun 42, respectively to the third color, which third gun is ignored for purposes of the present invention. The cathodes 43 of the two guns 40 and 41 are connected to branches of the camera output line 39 to simultaneously receive the same signal information from the camera means 7, which includes the periodic video-information signals corresponding to both X-ray beam pulses. The guns 40 and 41, however, are caused to conduct alternatively in synchronism with the pulsation of the two X-ray beams 2 and 3 produce alternate images on the screen 11, first of one color and then the other, which represent the X-ray images produced by the two relatively-angulated X-ray beams, and are separated laterally on the color tube screen. When viewed by one or more observers 12 wearing filters 13 and 14 of respective colors, red and green, for example, the alternate laterally-displaced color images become separated respectively to the eyes of each observer and a stereo effect results.

The monitor 9 as exemplified herein is a color monitor which includes the well-known deflection coil means 16 and conventional circuitry 20 including such as high voltage supply, video amplifier, horizontal and vertical sweep generators, filament current supply, etc., which normally cause simultaneous scanning of the beams from the three guns 40, 41, 42 to scan the screen 11 twice in one-thirtieth of a second to fill a frame with two interlaced scans. As will be appreciated from preceding remarks, however, one gun 42 for example, is deactivated and the usual simultaneous scanning from the remaining guns 40 and 41 are instead scanned alternately at consecutive one-thirtieth second periods by virtue of the cut-off bias control pulses supplied to their grids 48 in accord with the modification of such color monitor as advanced by the illustrative embodiment of the present invention described herein.

In behalf of simplification, the alternate cut-off of the respective color beams of the color picture tube 10 and of the X-ray beams 2 and 3 of tube 1 are synchronized by the sixty-cycle sync signal produced by the sync

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generator affiliated with the video camera means 7 for controlling vertical beam drive in the monitor. To produce bias pulses suitable for such control, the sixty-cycle sync signals from sync generator 37 are fed to a two stage divider or flip-flop which produces square wave pulses 50, 51 each of one-thirtieth second duration at a fifteen cycle repetition rate in two output 52 and 53, respectively; the pulses 50 being 180° out of phase with the pulses 51. Outputs 52 and 53 are connected to the grids 48 of guns 40 and 41, respectively, and the pulses 50 and 51 cause these guns to conduct alternately at periods of one-thirtieth second each, to give thirty frames per second on the color picture tube screen.

At the same time, the square wave pulses 50 and 51 in outputs 52 and 53 are tapped by respective branches differentiated by respective capacitors 55 and 56 to produce differentiated pulses 57 and 58 fed to the aforementioned pulse generators 27 and 28 to produce the dual-beam X-ray tube-conduction-control pulses 25 and 26 aforedescribed.

Although the preceeding is a description of an illustrative embodiment of the invention, it will be understood that the spirit and scope of such invention embraces modifications which will occur readily to those versed in the art, and that therefore such invention should be interpreted to cover such modifications as lie within the spirit and scope of the appended claims.

What is claimed is:

1. Stereoscopic X-ray apparatus comprising X-ray source means operable to radiate X-rays to an object from two different angles alternately, means producing electrical signals corresponding to alternate X-ray images of such object respective to said two different angles, means, including a cathode ray tube productive of two images of different colors, respectively, on its screen respective to two signal inputs, and means for effecting such alternating operation of said X-ray source means and for rendering said two signal inputs alternately responsive to said electrical signals correspondingly with alternation of X-ray radiation angles, whereby two horizontally spaced apart images are alternately presented on the cathode ray tube screen in respective colors which may be separated respective to the eyes of a viewer by color filter eye glasses.

2. Stereoscopic X-ray apparatus comprising X-ray source means operable to radiate X-rays to an object at two different angles alternately; means for producing light images of X-ray images of such object; a black-and-white video camera means productive of video sig-

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nals corresponding to such light images and including a sync generator productive of sixty-cycle blanking signals for a video monitor; a video monitor, including a multi-gun color picture tube productive of different colors on the screen of such tube by respective electron beams, operable to scan such beams in synchronism with the aforesaid sixty-cycle blanking signals to fill a frame on the screen each one-thirtieth of a second, and operable to respond to video signals from said camera means to modulate such electron beams to produce color images; and control means regulated by said sixty-cycle blanking signals to effect the alternate different-angled radiation of X-rays at a rate of thirty pulses per second and to effect alternate response of two of the electron beams to video signals from said camera means respectively to the angles of X-ray radiation, whereby images of the observed object are alternately presented on the screen of said color picture tube at horizontally offset positions in accord with the different angles of X-ray radiation and in respective colors which may be separated by the viewer for stereo effect with use of two-color eye glasses.

3. The X-ray apparatus of claim 2, wherein said means for producing light images includes an image amplifier tube, and the X-ray source means is controlled to generate X-rays only for intervals substantially less than the time required to fill a frame on the screen of the color picture tube.

4. Stereoscopic X-ray apparatus as set forth in claim 2, wherein said control means comprises a two-stage flip-flop circuit which converts sixty-cycle blanking pulses to two out-of-phase fifteen cycle square waves for biasing cut-off control of the electron beams in the color picture tube, capacitors for converting samples of said square waves to respective differentiated pulses, and pulse generators for converting said differentiated pulses to respective out-of-phase bias pulses for controlling alternation, rate and conduction time of the X-ray source means.

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