# United States Patent [19]

**Kunert**

[11] **3,875,411**

[45] **Apr. 1, 1975**


[54] **X-RAY APPARATUS**


[75] Inventor: **Heinz-Peter Kunert**, Amselweg, Germany

[73] Assignee: **U. S. Philips Corporation**, New York, N.Y.



[22] Filed: **Aug. 29, 1973**

[21] Appl. No.: **392,754**

[30] **Foreign Application Priority Data**

Sept. 30, 1972 Germany ..... 2248101

[52] **U.S. Cl.** ..... **250/402**, 250/416, 250/511

[51] **Int. Cl.** ..... **G03b 41/16**

[58] **Field of Search** ..... 250/402, 416, 511, 512, 250/513, 514



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 3,206,604 | 9/1965 | Burchell | 250/512 |
| 3,502,878 | 3/1970 | Stewart | 250/512 |
| 3,581,094 | 5/1971 | Peyser | 250/511 |
| 3,643,095 | 2/1972 | Shuster | 250/514 |



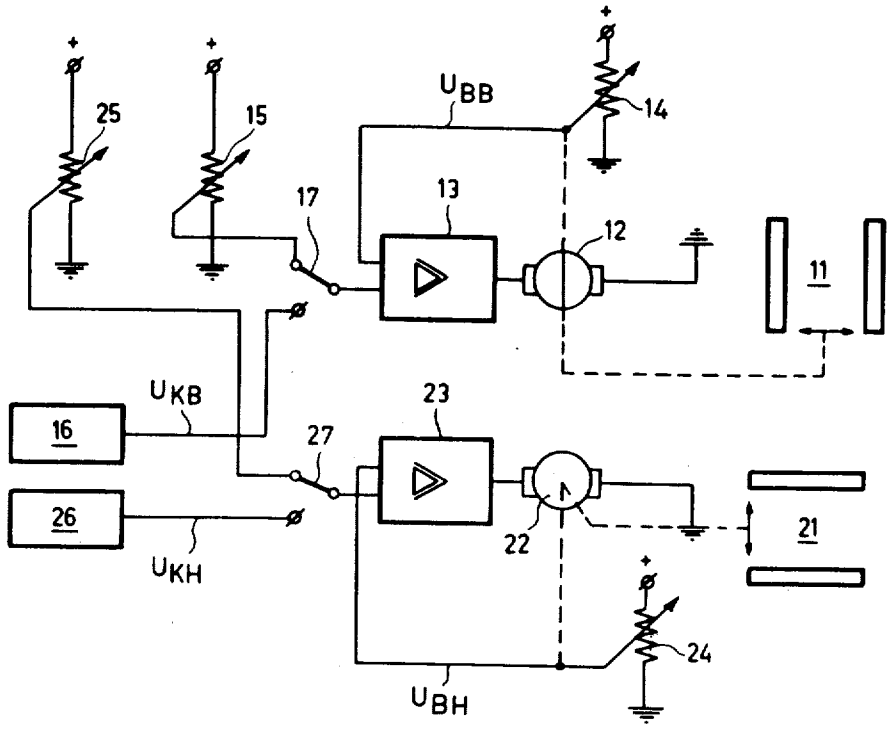
*Primary Examiner*—James W. Lawrence
*Assistant Examiner*—C. E. Church
*Attorney, Agent, or Firm*—Frank R. Trifari



[57] **ABSTRACT**

X-ray apparatus provided with an excessive-size indication which gives a signal to the radiologist when the cross-sectional area of the beam used for fluoroscopic examination exceeds the size of the radiograph to be made.


**3 Claims, 2 Drawing Figures**



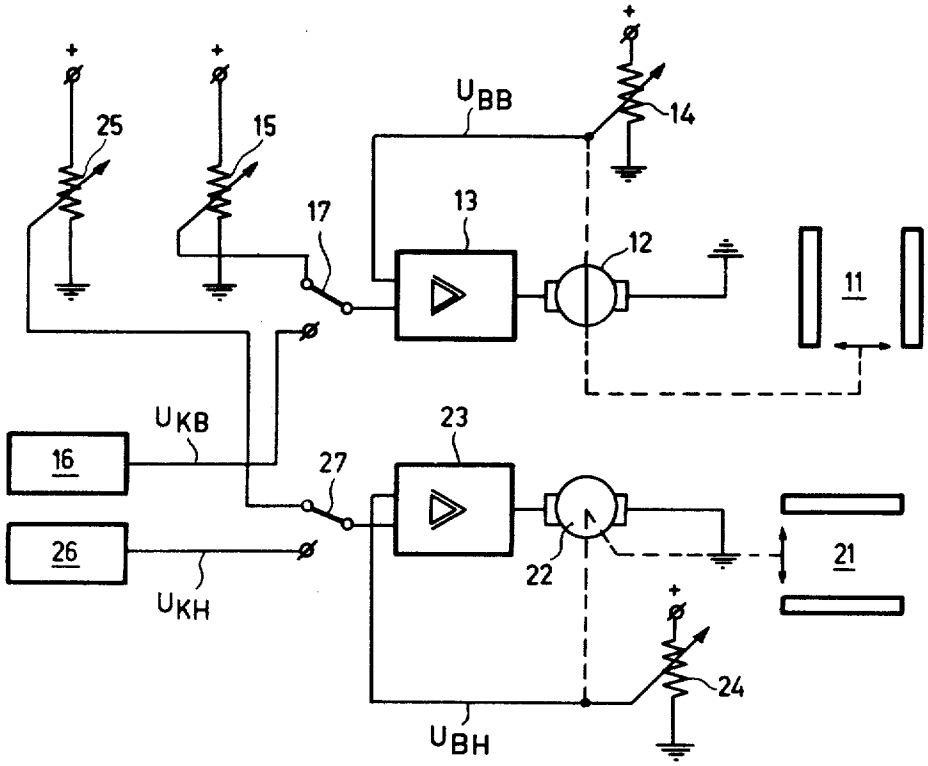

25
15
17
$U_{BB}$
14
13
12
11
$U_{KB}$
16
27
23
26
$U_{KH}$
22
21
24
$U_{BH}$

Fig.1

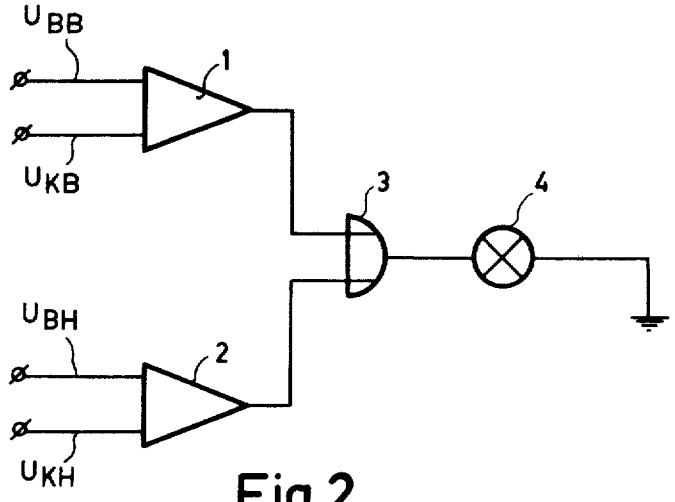

$U_{BB}$
1
$U_{KB}$
3
4
$U_{BH}$
2
$U_{KH}$

Fig.2

# X-RAY APPARATUS

The invention relates to an X-ray apparatus having a first pair of diaphragm blades which are adapted to be displaced by a motor and serve to limit an X-ray beam in the horizontal direction and a second pair of diaphragm blades which are adapted to be displaced by a motor and serve to limit the X-ray beam in the vertical direction, a servo-control system being provided for displacing the diaphragm blades so as to limit the beam to a size required for making a radiograph, in which a motor displaces the diaphragm blades until a direct voltage which depends upon the positions of the associated diaphragm blades corresponds to a control voltage which depends upon the size of the radiograph to be made, said X-ray apparatus being further provided with a control device for displacing the diaphragm blades independently of the size of the radiograph to be made.

Such an apparatus is described in principle in U.S. Pat. No. 3,502,878. Usually radiography is preceded by fluoroscopy, and the setting of the diaphragm may be different in the two processes. In this case, before the commencement of radiography the diaphragm is set to the required size by means of the servo-control system. A disadvantage of this automatic change-over to the setting required for radiography is that when the fluoroscopic image previously set by the radiologist is greater than the size of the radiograph, under certain circumstances details essential for diagnosis then are not recorded. However, this will be perceived only after development of the radiograph. It is an object of the present invention to provide a design for an apparatus of the aforementioned kind such that during fluoroscopy the radiologist is given an indication when the size of the radiograph is smaller than the size of the image on the fluoroscope as set by the radiologist during fluoroscopy.

According to the invention this problem is solved in that a comparison device is provided which is arranged to compare the direct voltages which on operation of the control devices, result from the positions of the diaphragm blades with the control voltages and to control an indicating device, the arrangement being such that an indication is given when the height or the width of the size of the radiograph to be made is smaller than the corresponding dimension of the X-ray beam as limited by the diaphragm.

The invention will now be described, by way of example, with reference to an embodiment shown in the accompanying diagrammatic drawings, in which

FIG. 1 is a simplified block-schematic diagram of a known X-ray apparatus, and

FIG. 2 is an embodiment of a circuit arrangement according to the invention to be added to the apparatus shown in FIG. 1.

Referring now to FIG. 1, an X-ray apparatus comprises two pairs of diaphragm blades 11 and 21, which are inserted in the ray path and determine the width and the height respectively of the X-ray beam. The diaphragm blades are displaceable by means of motors 12 and 22. These motors are controlled by control amplifiers 13 and 23 respectively. In addition, the motors 12 and 22 each displace a tapping on a potentiometer 14 and 24 respectively connected to the input of the associated control amplifier 13 and 23 respectively. The control amplifiers 13 and 23 each compare the voltage set up at the tapping on the potentiometer 14 and 24 respectively (actual value) with another voltage (desired value), the motors 12 and 22 each running in a direction such that the said other voltage becomes equal to the voltage set up at the potentiometer 14 and 24 respectively. The resulting positions of the diaphragm blade pairs 11 and 21 consequently each depend upon the value of the voltage which via a switch 17 and 27 respectively is applied to the control amplifier 13 and 23 respectively, the said switches each connecting the input of the associated control amplifier either to the tapping on a potentiometer 15 and 25 respectively or to a signalling source 16 and 26 respectively.



The signalling sources 16 and 26 each supply a direct voltage which is dependent upon the width and the height respectively of the size of the radiograph (which width and height are determined by the width and the height respectively of the cassette and by the preselected division). Thus the cross-sectional area of the X-ray beam as limited by the diaphragm 11, 21 corresponds to the size of the radiograph when the switches 17 and 27 establish connections to the signalling sources 16 and 26 respectively. If on the other hand the inputs of the control amplifiers 13 and 23 are connected via the switches 17 and 27 respectively to the tappings on the potentiometers 15 and 25 respectively, the radiologist can himself determine the cross-sectional area of the X-ray beam by displacing the tappings on the potentiometers.

Usually radiography is preceded by fluoroscopy, permitting the radiologist to obtain optimum setting of the diaphragm by displacing the tappings on the potentiometers 15 and 25 whilst looking at the image on the fluoroscope. On termination of the fluoroscopic examination the switches 17 and 27 are automatically changed over to the signal sources 16 and 26, so that before radiography is started the diaphragm is automatically set to the size required for making a radiograph.

FIG. 2 shows a comparison circuit (comparator) 1 to which are applied a voltage $U_{BB}$ which is derived from the tapping on the potentiometer 14 and is proportional to the width of the fluoroscopic image and a control voltage $U_{KB}$ which is supplied by the signalling source 16 and is proportional to the width of the size of the radiograph. Similarly a voltage $U_{BH}$ which is derived from the tapping on the potentiometer 24 and is proportional to the height of the fluoroscopic image and a control voltage $U_{KH}$ supplied by the signalling source 26 are applied to a comparison device 2. The comparison devices 1 and 2 each provide a binary output signal, i.e. a logic signal "1" if the voltage $U_{BB}$ and $U_{BH}$ respectively exceeds the control voltage $U_{KB}$ and $U_{KH}$ respectively and a logic signal "0" if the voltage $U_{BB}$ and $U_{BH}$ respectively is smaller than, or equal to, the control voltage $U_{KB}$ and $U_{KH}$ respectively. The outputs of the comparison devices 1 and 2 are connected to an OR-gate 3 the output circuit of which includes an indicating lamp 4. The lamp will be illuminated if to at least one of the inputs a "1" is applied, i.e. when the width and/or the height of the fluoroscopic image exceeds the corresponding dimension of the size of the radiograph to be made.

When the potentiometer tappings 14 and 24 are coupled to the motors 12 and 22 so that the voltages derived from them are a maximum in the closed positions of the diaphragm blades 11 and 21, the voltages $U_{BB}$ and $U_{BH}$ are smaller than the control voltages $U_{KB}$ and $U_{KH}$ respectively when the width or the height respec-

tively of the fluoroscopic image is greater than that of the size of the radiograph to be made. In this case the comparison devices must supply the logic signal **1** when the voltage $U_{BB}$ or $U_{BH}$ is smaller than the control voltage $U_{KB}$ or $U_{KH}$ respectively.

The invention may be used in X-ray apparatus in which the cross-sectional area of the X-ray beam is limited by a diaphragm provided on the cassette-holder of the apparatus (secondary diaphragm) and in X-ray apparatus in which the cross-sectional area of the X-ray beam is limited by a diaphragm mounted on the X-ray tube and hence remote from the film (primary diaphragm); in the latter case the setting of the diaphragm **11, 21** required for a predetermined size of a radiograph and hence the values of the control voltages $U_{KH}$ and $U_{KB}$ depend upon the spacing between the diaphragm and the cassette holder of the X-ray apparatus, so that these voltages are to be varied with variation of this spacing in a known manner (see for example U.S. Pat. Nos. 3,511,995 and 3,502,878).

Although the invention has been described with reference to an X-ray apparatus in which the displacement of the diaphragm blades (by means of the potentiometers **15** and **25**) is effected via a servo-control system during fluoroscopic examination, the invention may also be used in X-ray apparatus in which this displacement is performed by means of a motor not provided with servo-control and in which consequently the control circuit of the servo-control system is interrupted during fluoroscopic examination (thus the servo-control system operates only after the change-over to radiographic operation). The tappings on the potentiometers **14** and **24** should of course in the case to be displaced by the motors **12** and **22** respectively.

What is claimed is:

**1.** In X-ray apparatus having both fluoroscopy and radiography capability and having an adjustable diaphragm controlling the X-ray beam size, apparatus for controlling said adjustable diaphragm and for alerting an operator when the display during fluoroscopy is larger than what would be recorded during radiography, comprising:

a servo system controlling said adjustable diaphragm in accordance with an input signal supplied thereto;

means for producing a first signal which when supplied as said input signal to said servo system causes said servo system to adjust said diaphragm so as to conform the size of the X-ray beam to the size of the radiographic film in said X-ray apparatus;

means for producing a manually variable second signal which when supplied as said input signal to said servo system causes said servo system to adjust said diaphragm to a variable size in accordance with said manually variable second signal;

switching means for supplying as said input signal to said servo system during fluoroscopy said second signal and during radiography said first signal;

comparing means responsive to said first and second signals during fluoroscopy for producing a suitable output signal when the beam size which corresponds to said second signal exceeds the beam size which corresponds to said first signal; and

visual indicating means responsive to said output signal for alerting an operator that the display during fluoroscopy is larger than what would be recorded during radiography.

**2.** In X-ray apparatus having both fluoroscopy and radiography capability and having a diaphragm adjustable separately in two dimensions controlling the X-ray beam size separately in two dimensions, apparatus for separately controlling said diaphragm in each of said two dimensions and for alerting an operator when the display during fluoroscopy is larger in either of said dimensions than what would be recorded during radiography, comprising for each of said two dimensions the elements of claim **1**.

**3.** Apparatus as defined in claim **2** wherein said visual indicating means for each of said two dimensions is the same visual indicating means, said same visual indicating means being responsive to said output signal corresponding to either of said two dimensions.

* * * * *