

[54] FERRO DEVICE FOR THE AUTOMATIC CONTROL OF X-Y DISPLACEMENTS IN X-RAY EXAMINATION

2,885,618	5/1959	Belstering	318/579 X
3,039,035	6/1962	Rudolf, Jr. et al.....	318/579
3,136,936	6/1964	Eisengrein	318/579
3,174,089	3/1965	Hawkins et al.....	318/579
3,573,586	4/1971	Littwin.....	318/579
3,700,994	10/1972	Gopfert.....	318/579

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[21] Appl. No.: 281,343

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Related U.S. Application Data

[63] Continuation of Ser. No. 17,392, March 9, 1970, abandoned.

Foreign Application Priority Data

Mar. 10, 1969 France 69.06691

[52] U.S. Cl. 318/579, 250/449

[51] Int. Cl. G05b 19/24

[58] Field of Search 318/579

References Cited

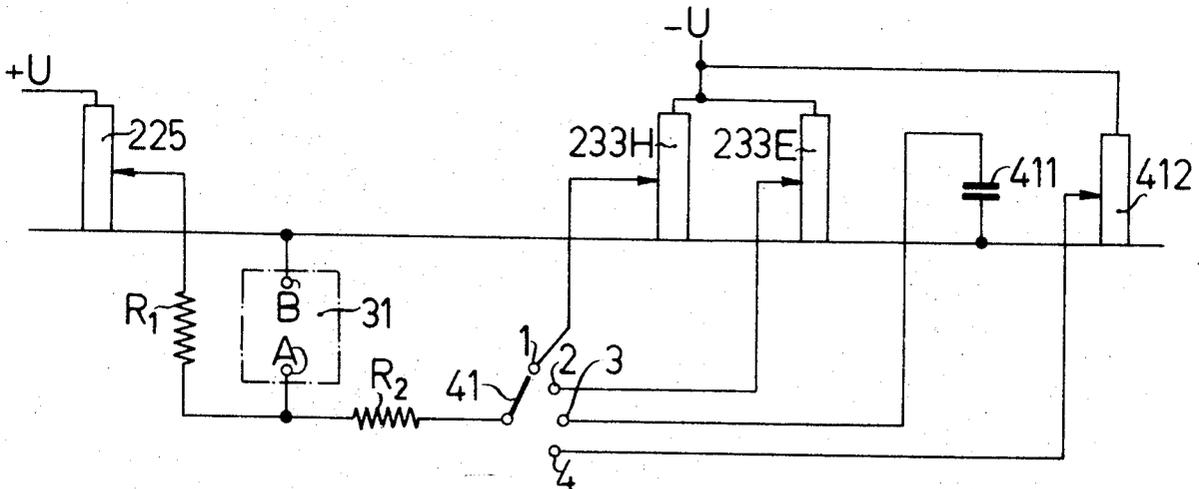
UNITED STATES PATENTS

2,359,160 9/1944 Santer 318/579 UX

[57] **ABSTRACT**

An X-ray radiating apparatus which includes an automatic device for controlling the simultaneous displacements of the radiating and recording parts of the apparatus, the device comprising a platform adapted to revolve with constant angular speed, along a diameter of which is displaced a finger driving parallelograms holding the apparatus and various coding members corresponding to the curves to be traced. The actuation of a coder determines the displacements of the finger.

8 Claims, 10 Drawing Figures



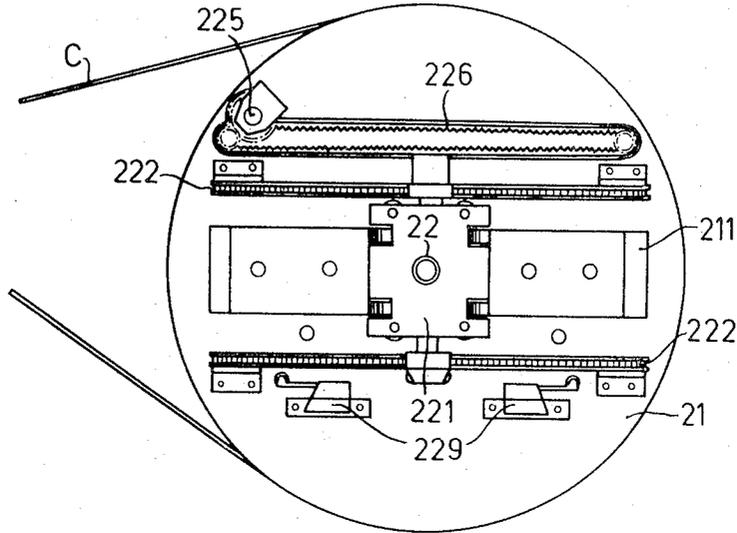


Fig.1

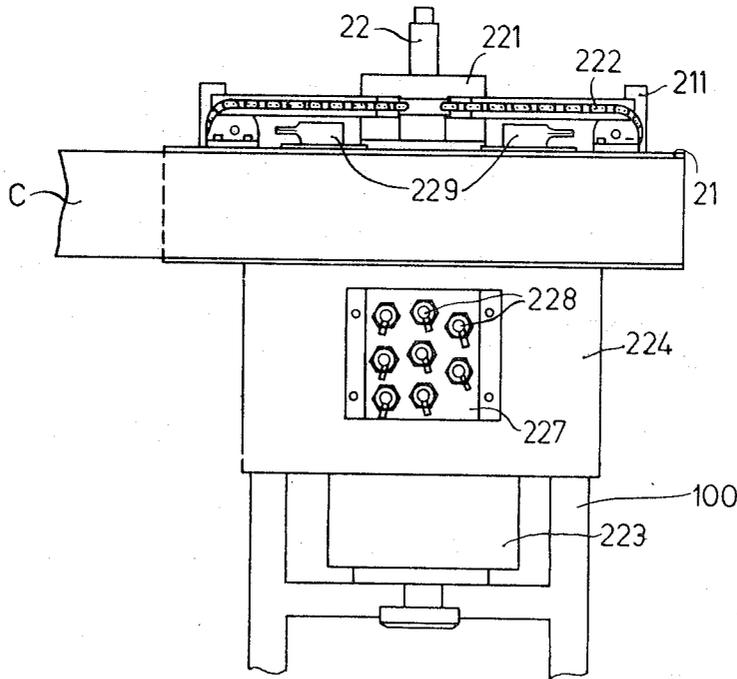


Fig.3

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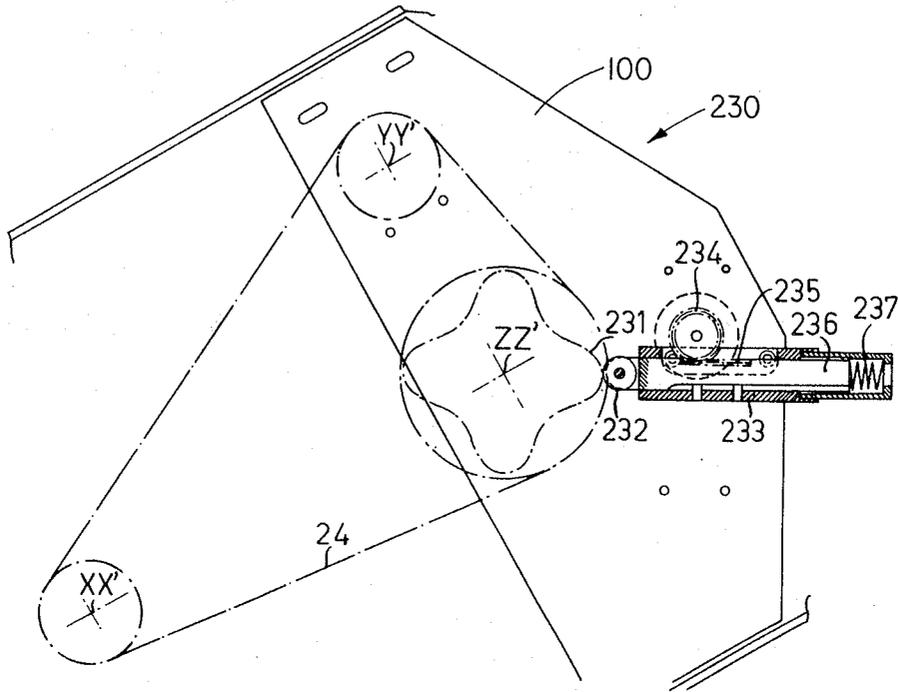


Fig. 2

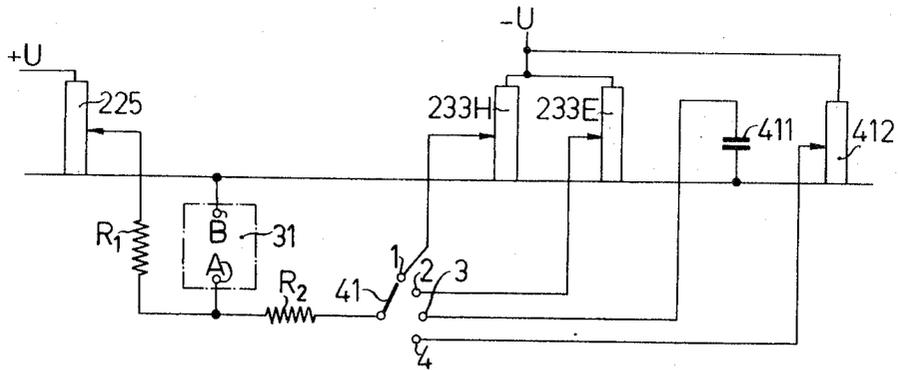


Fig. 4

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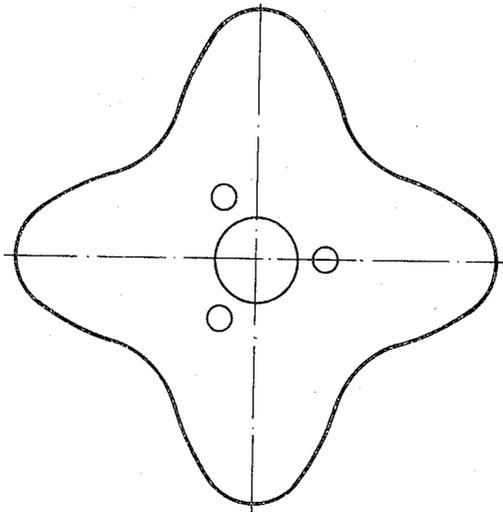


Fig. 5a

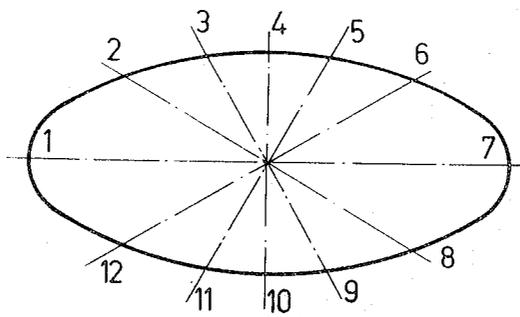


Fig. 5b

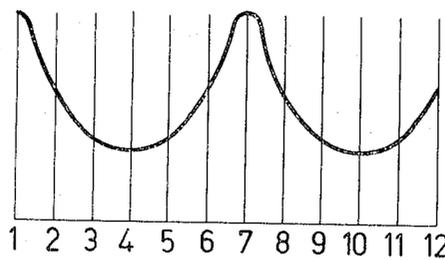


Fig. 5c

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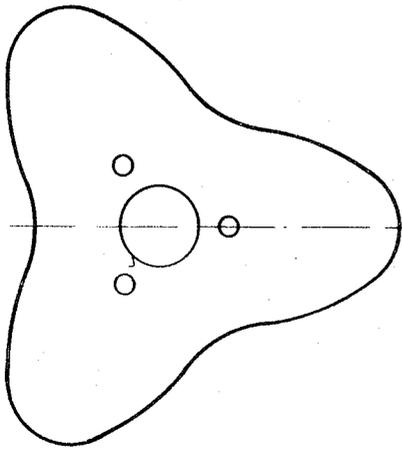


Fig. 6a

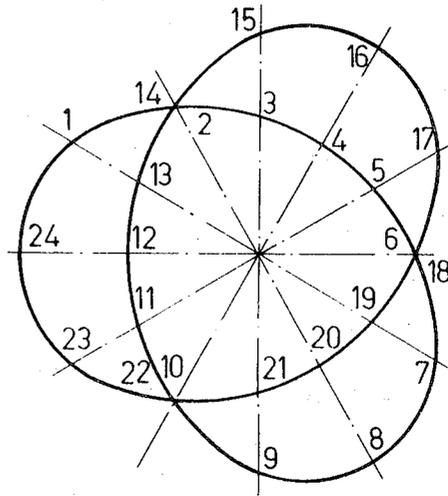


Fig. 6b

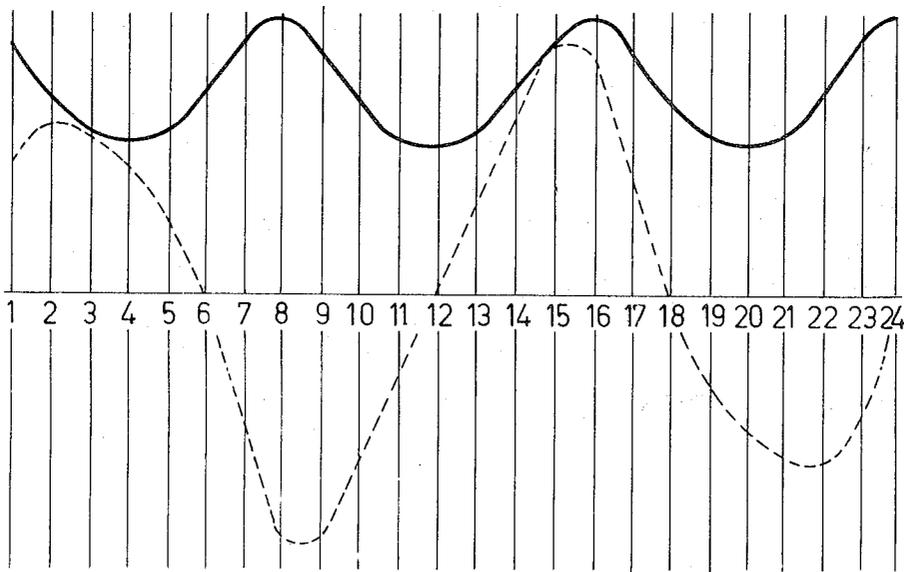


Fig. 6c

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FERRO DEVICE FOR THE AUTOMATIC CONTROL OF X-Y DISPLACEMENTS IN X-RAY EXAMINATION

This is a continuation, of application Ser. No. 17,392, filed Mar. 9, 1970 now abandoned.

This invention in the domain of X-ray technology applied to medical diagnostics, and relates to a device for the automatic control of simultaneous displacements of the X-ray analysing and recording apparatus, particularly for X-ray examination in sections termed radiographs.

When the pivotal axis of these apparatus is located in the plane of the section, the analysing apparatus (X-ray tube) and the recording apparatus (film cassette), held by identical parallelograms can describe various curves such as straight lines, circles, ellipses, hypocycloids.

The control-boxes usually employed with these apparatus do not permit of controlling automatically the changes of the curves. These boxes have various openings corresponding to the various curves and any change of the curve is obtained by the manual displacement of a stub screwed in the corresponding box opening, i.e., straight lines and ellipses (by means of stubs of different lengths in the same opening), hypocycloids, small circles.

Moreover, various proposals based on a decomposition of the various curves into given Cartesian coordinates lead to complicated embodiments, especially in the case of a hypocycloid.

The invention provides a novel control-device operating completely automatically and permitting of carrying out changes of curves from a distance and of restoring automatically in a simple manner the rest position.

According to the invention the control-device comprises a control-box for the various displacements operating by means of an electronic assembly, which is controlled by taking into circuit two variable elements, one for said displacements and the other selected from an assembly of elements coding the various curves, said electronic assembly operating so that at any instant the voltages across the two variable elements are equal to each other.

Other features of the invention and the preferred embodiment thereof will be apparent from the following description given by way of example with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of the upper part of a control-box according to the invention,

FIG. 2 is a schematic bottom view of the control-box,

FIG. 3 a side elevation of the same box,

FIG. 4 the circuit diagram of the electronic assembly controlling the movements of the box,

FIGS. 5a, 5b, 5c a cam profile and the decompositions of the elliptic curve into polar data;

FIGS. 6a, 6b, 6c a further cam profile and the decompositions of the hypocycloid curve into polar data.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The device according to the invention is based on the principle of decomposing the curves into polar data. For the sake of clarity the device will first be described and afterwards the operation will be specified in accor-

dance with the various curves (in this example: straightline, circle, ellipse, hypocycloid).

The device comprises a box controlling the various movements by means of an electronic assembly, which is controlled from a panel by taking into circuit variable elements forming part of the box and/or being independent. The control-box, which forms a characteristic part of the device, will be described hereinafter with reference to FIGS. 1, 2 and 3, and the basic circuitry of the electronic assembly for the specification of the various curves will be explained with reference to FIG. 4 in order to facilitate a good understanding of the operation of said box.

As shown in FIGS. 1 and 3, box comprises a platform carried by a supporting frame 100 21, adapted to be driven electrically with a constant angular speed by a belt C transmitting the movement by an external motor (not shown). The device is arranged so that a choice can be made from a range of speeds.

Over a diameter of the platform 21 formed by a support 211, a finger 22 is displaceable to perform the necessary displacement of the X-ray tube and the film cassette. The finger 22 is held by a carriage 221, accurately guided and pushed over a set of rails 222, which transmit to the carriage 221 the movement of a motor 223 (axis X X') via a reducing mechanism 224. In this way it is possible to move the finger 22 at any instant into any position previously defined on the diameter concerned. Two safety stop members are indicated at 229 on the platform.

The successive positions of the finger determine the curves simultaneously described by the X-ray tube and the cassette holder.

On the rotating platform any position of the finger 22 is converted into an electric magnitude A by a potentiometer 225, driven by a toothed belt 226 during the movement of the finger 22. These successive positions are automatically controlled by means of a coding member 230, of the coders of which is actuated, when a curve differing from a straight line or a circle has to be obtained, which curve requires suitable combinations of the movements. In the example described the coding member is designed for two curves i.e., hypocycloid curve and elliptic curve. The coders may be formed by rotatable potentiometers, the tappings of which occupy respectively a position depending upon the positions of cams turned around the axis ZZ' by means of a transmission belt 24 which may be driven by a motor not shown, or by motor 233.

FIG. 2, which illustrates schematically a bottom view of the box, shows one of the coders. The cam 231, whose profile matches, for example, the ellipse, is adapted to rotate about the vertical axis ZZ'. A sensor 232 which follows up the cam profile, is associated with the rotatable potentiometer 233, driven by a gear wheel 234 which cooperates with a toothed rack 235 on a rod 236, associated with a spring 237.

Hereinafter 233E and 233H will designate the ellipse and the hypocycloid respectively. The variation of the radius of the cam is thus converted into a variation of the position of the tapping (not shown) of the potentiometer; to this position of the tapping corresponds an electric magnitude B.

The control-device according to the invention performs the movement so that at any instant the difference between the two electric magnitudes A and B approaches zero as closely as possible, said two electric

magnitudes (e.g., voltages) being applied to the terminals of the electronic assembly 31 (FIG. 4), which control the rotation of the motor 223 the difference between said two magnitudes constituting a control signal.

For this purpose the electronic assembly 31 is connected on the one hand to the potentiometer 225 and on the other hand in accordance with one of the four positions of the switch 41 (on the control-panel) to one of the four following elements:

potentiometer 233H for the hypocycloid curve,
potentiometer 233E for the elliptic curve,
capacitor 411,
potentiometer 412. The latter two elements are external of the control-box.

Therefore the control-box (FIG. 3) is provided with a multiple input 227 for the electric connections such as 228 comprising, for example, two wires for the winding of the motor 223, three wires for the control-potentiometer, three safety wires.

By the combination of the two movements of rotation with constant speed and of linear displacement of the finger as controlled by the electronic assembly, the control-device describe above permits of describing in a simple manner the following curves:

1. a circle: by the rotation of the platform 21 with constant speed; a circle of variable radius in accordance with the position of the finger 22 on a diameter of the platform can be obtained by manual actuation of the potentiometer 412 on the control-panel;

2. a straight line: by the linear displacement of the finger 22 under the control of the capacitor 411, the slope of the straight line is a function of the voltage of the capacitor; moreover, by revolving the platform 21 by the manual displacement of the potentiometer 412 the straight line can be orientated;

3. ellipse: referring to FIGS. 5a, 5b, 5c by the combination of the two movements, while the electronic assembly 31 is connected to the potentiometer 233E.

The movement of the finger 22 is then transmitted to the elliptic position coder, the cam profile of which is shown in FIG. 5a; the decomposition into polar coordinates of the elliptic curve is illustrated in FIGS. 5b and 5c.

4. Hypocycloid: referring to FIGS. 6a, 6b and 6c, by the combination of the two movements, while the electronic assembly 31 is connected to the potentiometer 233H. The movement of the finger 22 is then transmitted to the hypocycloid position coder.

5. It is also possible to obtain a spiral passing through the centre and returning through its extremity by the consecutive use of the two movements: the rotation of the platform during the preparation of the X-ray photograph to which is added a linear displacement of the finger solely during the X-ray exposure (connection to the capacitor 411).

Moreover, in static operation the movement of the finger is controlled by the positioning potentiometer 412, which allows centering or inclination of the radiation. By a slow revolution of the platform the plane of radiation may be changed relatively to the longitudinal axis of the analysing table (not shown).

The invention is not limited to the example described above and within the scope of the invention modifications may be carried out, for example, in the number and the shape of the cams and in the finger driving

mechanism. Moreover, the changes of orientation may be obtained by an angular displacement of the cams.

The invention is particularly suitable in tomography, since it allow a rapid and simple control of the orientation of the various exposures.

What is claimed is:

1. In an apparatus for controlling the movement of an x-ray radiating assembly which includes an x-ray source and a film cassette which are arranged to be displaceable in relatively opposite directions and are adapted to swing about a pivotal axis for making radiographs of plane body sections, wherein an x-ray passing through any point to be radiographed will always strike the same point at the film, the apparatus further including a control assembly comprising, a rotatable platform, first means for rotating said platform, a guide member carried and rotated by the platform and movable longitudinally on said platform, the guide member adapted to displace said x-ray tube and film cassette according to a predetermined cycle including rotational and longitudinal movement, second means for driving said guide member in longitudinal movement on said platform, a first potentiometer on said platform engaged and driven by said guide member for converting each position of said guide member into a first electrical signal corresponding to its movement, a rotatable cam-coding member carried by the assembly, this cam having a cam-shape to provide said predetermined cycle of movement, means for rotating the cam, a cam follower driveable in longitudinal movement by said cam, a second potentiometer driven by said follower for converting displacement of the follower into a second electric signal having magnitude corresponding to the cam-shape and to the distance the guide member is to move, third means for comparing the first signal with the second signal and producing the profile signal corresponding to the difference between said signals, said control signal being communicated to said second means to move said guide member longitudinally until the first and second signals are equal and there is no difference between these signals.

2. Apparatus according to claim 1 wherein said platform rotates at a constant angular speed, and said movable member is arranged at said platform for movement along a diameter thereof.

3. Apparatus according to claim 2 further comprising a cam rotating with constant speed corresponding to the rotation of the platform for operating said coding member, the profile of the cam being a function of the curve to be traced.

4. In an apparatus for controlling the movement of an x-ray radiating assembly which includes an x-ray source and a film cassette which are arranged to be displaceable in relatively opposite directions and are adapted to swing about a pivotal axis for making radiographs of plane body sections, whereby an x-ray passing through any point to be radiographed will always strike the same point at the film, the apparatus further including a control assembly comprising, a rotatable platform, first means for rotating said platform, a guide member carried and rotated by the platform and movable longitudinally on said platform, the guide member adapted to displace said x-ray tube and film cassette in both rotational and longitudinal movement, second means for driving said guide member in longitudinal movement on said platform, sensing means for sensing the longitudinal position of said guide member and for providing

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a first electric signal corresponding to said position, a function generator for providing a second electric signal corresponding to a desired predetermined longitudinal motion of said guide member, means for comparing the first signal with the second signal and producing a control signal corresponding to the difference between said first and second signals, said control signal being communicated to said second means to move said guide member longitudinally until the first and second signals are equal and there is no difference between these signals.

5. Apparatus according to claim 4 wherein said function generator comprises a potentiometer for providing a constant voltage signal of manually selectable magnitude.

6. Apparatus according to claim 5 wherein said function generator further comprises a rotatable cam-coding member carried by the assembly, the cam having a cam-shape to provide said predetermined motion, means for rotating the cam, a cam follower drivable in longitudinal movement by the cam, a second potentiometer driven by said follower for converting displacement of the follower into the second electric signal having magnitude corresponding to the cam shape and to the distance the guide member is to move.

7. Apparatus according to claim 4 wherein said function generator comprises a capacitor, means for supplying constant voltage to the capacitor, and means for discharging said capacitor.

8. In an apparatus for controlling the movement of an x-ray radiating assembly which includes an x-ray source

and a film cassette which are arranged to be displaceable in relatively opposite directions and are adapted to swing about a pivotal axis for making radiographs of plane body sections, whereby an x-ray passing through any point to be radiographed will always strike the same point at the film, the apparatus further including a control assembly comprising, a rotatable platform, first means for rotating said platform, a guide member carried and rotated by the platform and movable longitudinally on said platform, the guide member adapted to displace said x-ray tube and film cassette in both rotational and longitudinal movement, second means for driving said guide member in longitudinal movement on said platform, sensing means for sensing the longitudinal position of said guide member and for providing a first electric signal corresponding to said position, a function generator for providing a second electric signal corresponding to a desired predetermined longitudinal motion of said guide member said function generator comprising means for providing a plurality of different electric signals as said second signal, switch means for selecting one of said plurality of signals, means for comparing the first signal with the second signal and producing a control signal corresponding to the difference between said first and second signals, said control signal being communicated to said second means to move said guide member longitudinally until the first and second signals are equal and there is no difference between these signals.

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UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,792,334
DATED : Feb. 12, 1974
INVENTOR(S) : SERGE ROUGE

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the title, "FERRO" should be --SERVO--

Column 2, line 14, after "3," insert --the--;
after "platform" insert --21--

line 15, delete "21"

Signed and Sealed this

Fourth Day of January 1977

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

UNITED STATES PATENT AND TRADEMARK OFFICE
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