United States Patent [19]

Carter

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[54] X-RAY TARGET CHANGER USING A TRANSLATING ANODE

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[52] **U.S. Cl.**.....**313/60,** 313/57
[51] **Int. Cl.**.....**H01j 35/24**
[58] **Field of Search**.....313/57, 60

[56] **References Cited**

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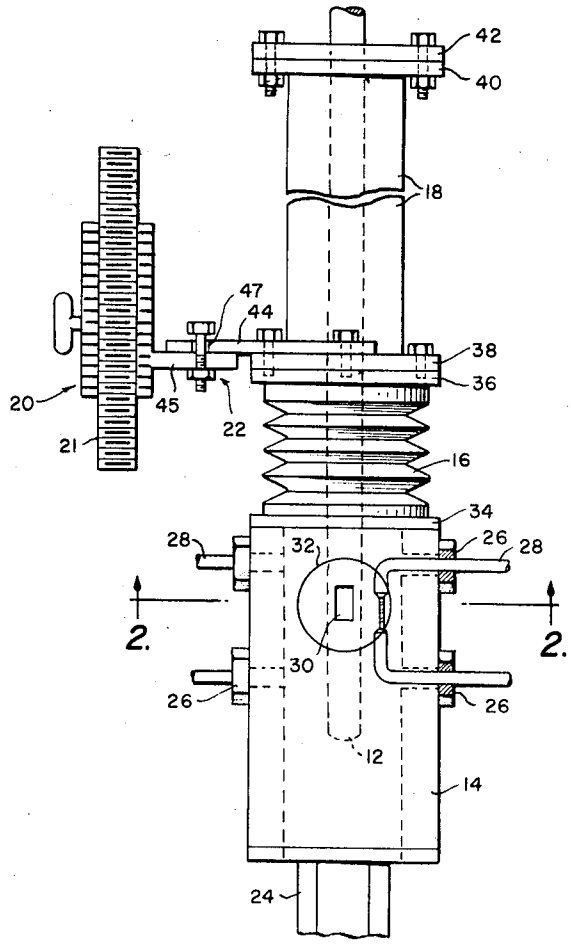
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[57] **ABSTRACT**

Means for moving in two orthogonal directions the target anode of an X-ray tube within the tube body comprising bellows inserted between the tube body section and a glass-insulator section, the anode being fixed to the sealing flange of the insulator section. Longitudinal translation means are attached to the flange by which the insulator section is mounted to the bellows. Operation of the translation means moves the anode and insulator section relative to the tube since the bellows can contract or expand.

5 Claims, 3 Drawing Figures



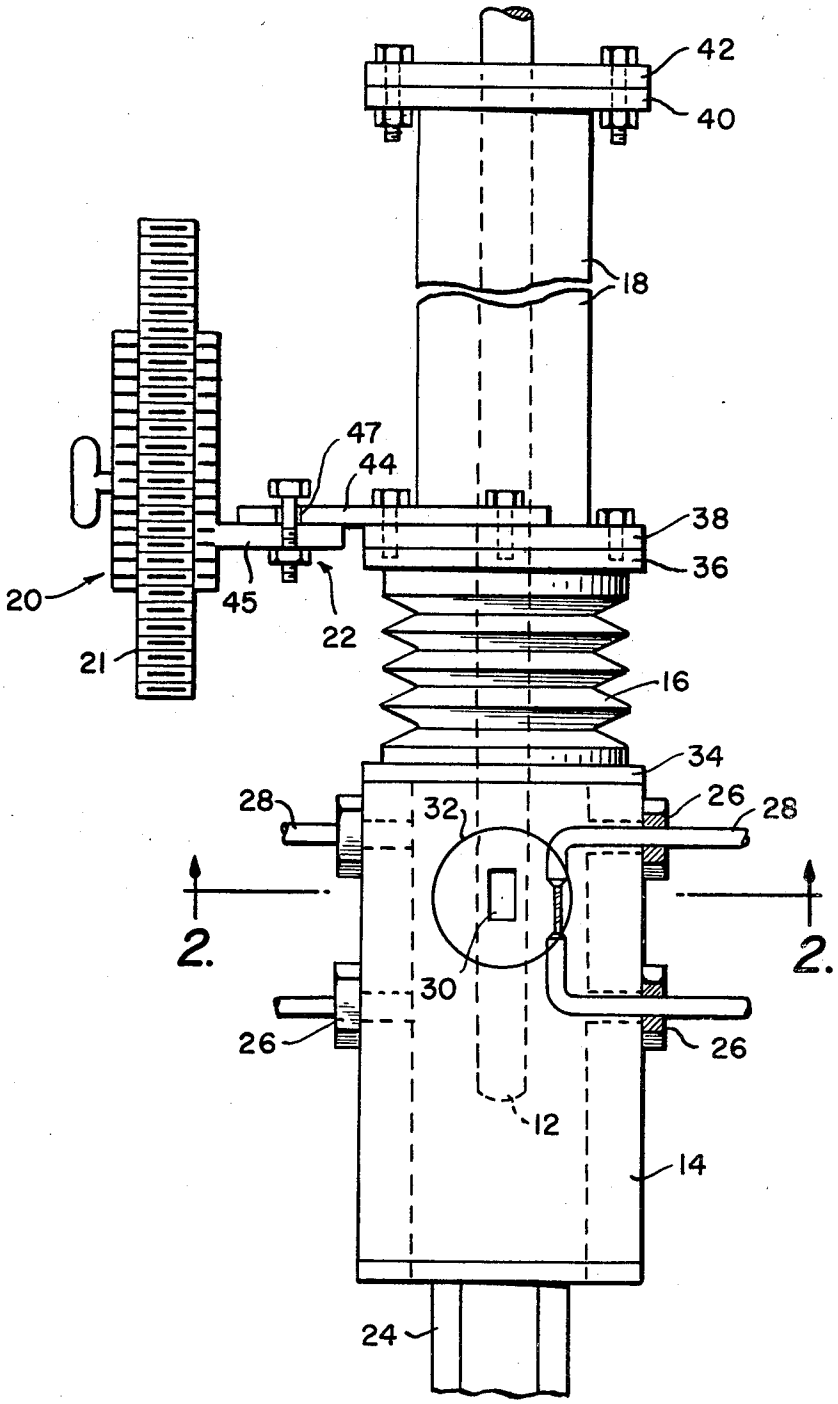


FIG. 1.

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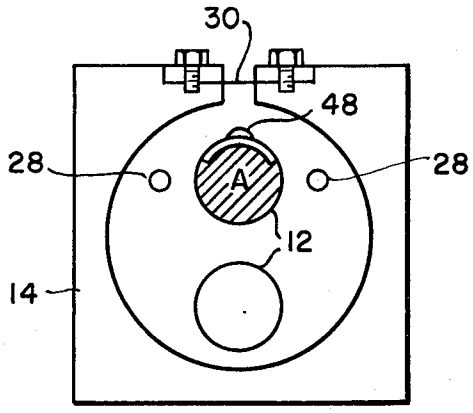


FIG. 2.

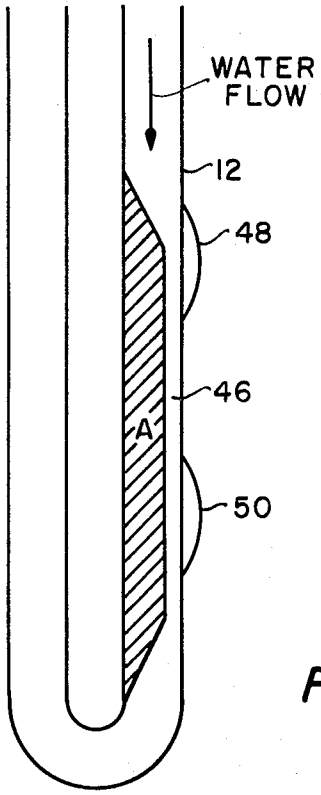


FIG. 3.

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X-RAY TARGET CHANGER USING A TRANSLATING ANODE

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

This invention relates to X-ray tubes and especially to anode translation means for such tubes.

The most common type of X-ray tube is the sealed typed. This type is limited to harder radiations, such as CuK and MoK, because the thickness of the vacuum-tight X-ray window (usually Be foil) causes it to absorb too much of radiations softer than CrK. For these sealed tubes, a change of targets requires: (1) shutting off the power and discharging the high-voltage circuitry; (2) turning off the water supply and draining the cooling coils and the X-ray tube on the tube stand; (3) disconnecting the high-voltage cable and demounting the X-ray tube; and (4) reversing this procedure in mounting an X-ray tube of a different target.

In the production of soft X-ray radiation, unsealed tubes are employed. These use such a thin window that the pressure differential across the window must be limited to a few torr or the window will be ruptured. Also, in this case, the X-ray tube body is usually left in place and only the anode containing the target material is replaced. To the procedure for changing an X-ray tube described above must be added a step involving the release of the vacuum on both sides of the window so that the window material will not be ruptured. Similarly, after the anode is replaced, a vacuum must be drawn in such a way that the window is not ruptured.

Soft X-rays are often used in the study of materials and their surfaces via the techniques of X-ray emission and absorption and photoelectron spectroscopy (ESCA, electron spectroscopy for chemical analysis). In certain studies employing these techniques, the surface cleanliness of the specimen is of prime importance; in these cases the delay caused by oxidation or other contamination of the target surface when the vacuum is broken far exceeds the time normally required to change the target since the target surface must be recleaned, a job which may require tens of hours under hard vacuum condiations.

SUMMARY OF THE INVENTION

These delays are obviated by the invention which provides means for translating the anode in two orthogonal directions within the X-ray tube body without requiring the breaking of the vacuum.

THE OBJECT

An object of the invention is to enable targets in an X-ray tube to be changed quickly and without breaking the vacuum on either side of the X-ray tube window.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

THE DRAWINGS

FIG. 1 is a schematic illustration of an embodiment of the invention;

FIG. 2 is a cross-sectional view taken through the X-ray tube body along the line 2—2 in FIG. 1; and

FIG. 3 is a schematic illustration of an anode as used with the invention.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 illustrates an embodiment of the invention with a movable anode **12.** The apparatus comprises an X-ray tube body **14,** a bellows section **16,** an insulating section **18,** and anode **12,** anode longitudinal translating means **20** and anode-transverse-position adjusting means **22.** Conventionally, X-ray tube apparatus would not include the bellows section or the anode position-adjusting means.

The X-ray tube body **14** includes means **24** for coupling the inside of the tube body **14** to an evacuating pump, filament feed-throughs **26** through which the filaments **28** enter the tube body **14,** an X-ray window **30,** e.g., Beryllium foil, and the window holder **32** which may be bolted to the tube body **14.**

A bellows **16,** comprising a means capable of contracting or expanding in the longitudinal translational direction of the anode **12,** is attached to the top edge of the X-ray tube body **14.** The bellows **16** may have flanges (**34** and **36**) at both ends.

A voltage-insulating section **18,** which may be of glass, is attached by a flange **38** to the bellows flange **36.** The insulating section **18** also has an upper flange **40** to which a anode-holding, or sealing, flange **42** is attached. The anode **12** is affixed to this flange **42** which also seals off the vacuum chamber extending through the tube body **14,** the bellows **16** and the insulating section **18.**

The anode translating means **20,** which may, for example, be a rack-and-pinion device (not shown in detail since these are well known in the mechanical arts) or a screw translation device is affixed to a rigid bar **44** which, in turn, is affixed to the insulating section flange **38.** A portion **21** of the rack-and-pinion means is fixed in position relative to the tube body section **14.** Thus, operation of the translating means **20** acts to move the insulating section **18** and the attached anode **12** up and down (or longitudinally, the direction of translation) and these translating movement is permitted to occur by the contractibility and expansibility of the bellows **16.**

Movement of the anode **12** in a direction transverse to the longitudinal direction is accomplished by the anode transverse-adjustment means **22** which, in this case, comprises a nut and bolt for clamping the rigid bar **44** to a bar extension **45** on the anode translation means **20** plus and enlarged hole **47** in the rigid bar **44** through which the bolt extends. Thus, the rigid bar **44** can be moved transversely before it is bolted down. The transverse flexibility of the bellows **16** permits the anode **12** and insulating section **18** to move transversely when the rigid rod **44** is moved. Actually, the means for adjusting the transverse portion (anode transversing means) could be said to comprise the flexibility of the bellows in the transverse directions, the rigid rod **44** and the enlarged bolt hole in the rod **44.** Translation of the anode **12** permits transverse centering of the anode with respect to the window **30** and

with respect to the electron-emitting filaments **28** for focusing purposes.

A cross-section of the X-ray tube body **14** taken along the line 2—2 in FIG. **1** is shown in FIG. **2.** The filaments **28** are positioned on both sides of one section of the anode **12** which in FIG. **3,** is seen to be a hollow tube, which may be of copper, having a constricted area **46.** Water flows through the anode **12** for cooling purposes. The X-ray targets are small areas of film (e.g., a magnesium film target **48** and a aluminium film target **50**) only three being indicated although there may be more (the copper anode also constitutes a target). In operation, the anode **12** may be translated to place either target **48** or **50** or the copper tubing under the window **30** where the electrons may bombard the target so that it emits X-rays through the window. The electrons follow a curved path from the filaments striking the target in front of the window — this is described in "Demountable High Power Source for Soft X-ray Region", by Deslattes and Simson, Review of Scientific Instruments, Vol. 37, No. 6, June 1966, page 753.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed and desired to be secured by Letters Patent of the United States is:

1. In X-ray tube apparatus having a voltage insulating section, an X-ray tube body section which includes an X-ray window, and anode means carrying at least two spaced target areas extending through said tube body past said window in the longitudinal direction relative to said tube body,

anode-positioning means for moving said anode means and its target areas longitudinally with respect to said window, said anode-positioning means comprising

bellows means positioned between and affixed to said insulating and tube body sections for providing a longitudinally expandable or contractable section, said anode means extending through said insulating section and said bellows section into said tube body section and being affixed either to said insulating or said bellows section, and

anode-translation means having an immovable section and a section which is movable relative to the immovable section, said immovable section being fixed in position relative to said tube body and said movable section being rigidly coupled with said bellows section whereby movement of said movable section expands or contracts said bellows section thereby correspondingly moving said insulating section and said anode means longitudinally past said window thus enabling different target areas to be exposed to the X-ray beam as desired.

2. Apparatus as in claim **1,** further including means rigidly coupled with said section to which said anode means is affixed for transversely positioning said anode means relative to said window.

3. Apparatus as in claim **1,** wherein

said insulating section includes an upper and a lower flange and

said bellows includes an upper flange, said upper bellows flange being affixed to said lower insulating-section flange,

said apparatus further including an anode flange and mounting means, said anode means being affixed to said anode flange which, in turn, is affixed to said upper insulating-section flange and to said anode translation means and including means for moving said mounting means relative to said tube body in the transverse direction.

4. Apparatus as in claim **1,** wherein

said anode translation means comprises rack-and-pinion means.

5. Apparatus as in claim **1,** wherein

said anode translation means comprises screw translation means.

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