

# United States Patent

Atlee et al.

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## [54] DOUBLE FOCUS X-RAY TUBE

[72] Inventors: Zed J. Atlee, Elmhurst; Viktor W. Pleil, Downers Grove, both of Ill.

[73] Assignee: Picker Corporation, Cleveland, Ohio

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[51] Int. Cl. .... H01j 35/00

[58] Field of Search .... 313/57

[56]

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Primary Examiner—Nathan Kaufman

Attorney—Buckhorn, Blore, Klarquist and Sparkman

[57]

### ABSTRACT

Double-focus X-ray tube has cathode focused to provide two contiguous line-focus focal spots each of 1 millimeter width. One of filaments connected to permit energization of only half-length to get fine focal spot.

5 Claims, 4 Drawing Figures

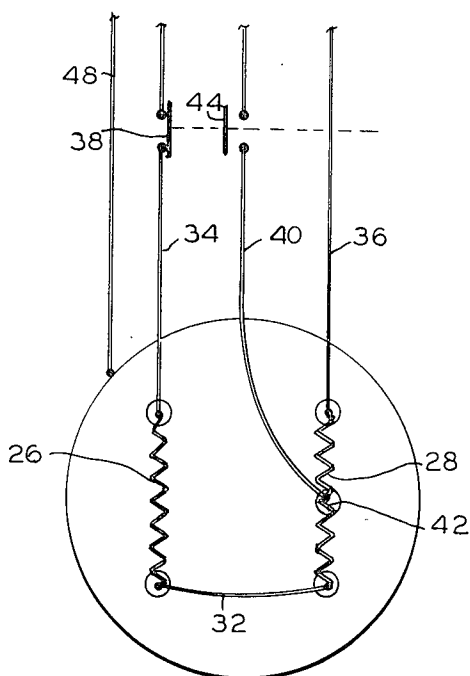
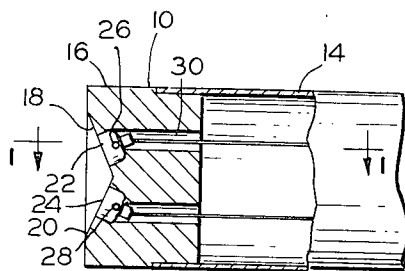


FIG. 1

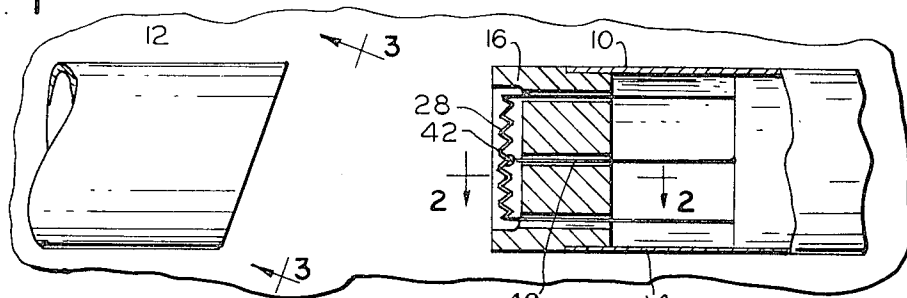


FIG. 3

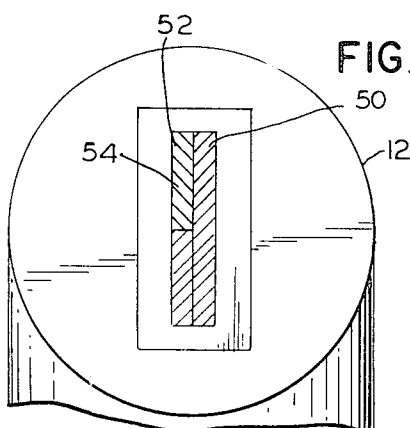


FIG. 2

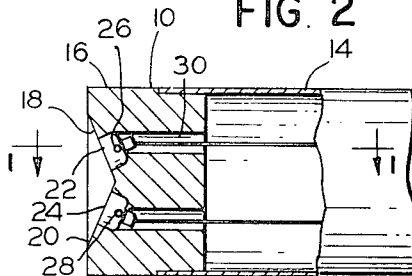
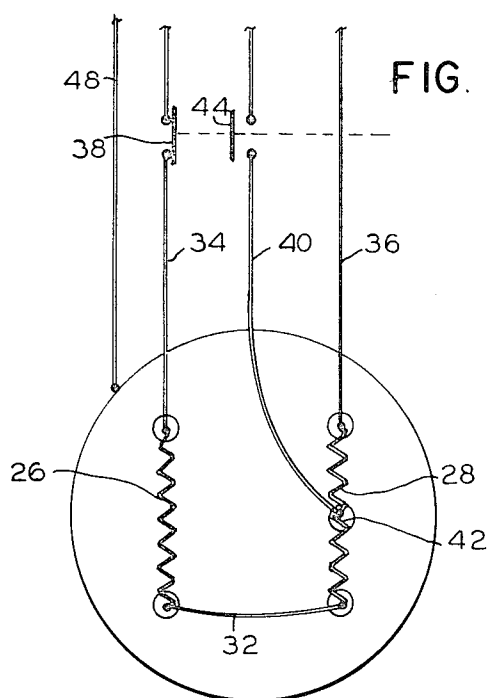


FIG. 4



ZED J. ATLEE  
VIKTOR W. PLEIL  
INVENTORS.

BY  
BUCKHORN, BLORE, KLARQUIST & SPARKMAN  
ATTORNEYS

## DOUBLE FOCUS X-RAY TUBE

## BACKGROUND OF INVENTION

For radiographic work double-focus tubes utilizing the line-focus principle and enabling the utilization of both a large and a small focal spot have long been available. Such prior tubes have, however, utilized separate filamentary arrangements for producing the large and the small focal spots and the geometry of the cathode structure has been such as to render difficult the cutoff of electron flow by biasing of the cathode body relative to the filamentary structure. Grid structures have been used requiring the positioning of wires between the filament and the anode and which wires can be biased to a cutoff voltage. However, such grid wires are undesirable from several standpoints.

## SUMMARY OF INVENTION

It is, therefore, an object of the present invention to provide a double-focus cathode structure which may be easily biased to cutoff by application of a negative voltage to the cathode body relative to the filamentary structure.

Still another object of the invention is to provide an improved arrangement for alternatively securing a large and a small focal spot upon an anode from a double-focus cathode arrangement.

In accordance with the present invention a cathode is provided having a pair of substantially parallel electron focusing recesses in each of which is mounted a filament. The recesses are focused such that when the entire length of each filament is energized focal spots of equal length are imposed upon an anode in side-by-side relation so as to create a unitary rectangular focal spot having an overall width of about 2 millimeters. One of the filaments is electrically connected so as to permit energization of only one-half its length independently of the energization of the other filament whereby a single focal spot 1 millimeter in width may be imposed upon the anode. The inclination of the anode is such that as viewed from the exposure area both the small and the large focal spots appear substantially as square, being 1 and 2 millimeters square respectively.

The utilization of focal spots of such thin width permits the use of a cutoff voltage of sufficiently low value as to minimize the electrical problems which have heretofore plagued attempts to provide cutoff bias by imposing a voltage difference between a cathode cup and the filamentary structure.

## DRAWINGS

FIG. 1 is a view showing the relation of anode and cathode in accordance with the invention;

FIG. 2 is a sectional view taken substantially along line 2—2 of FIG. 1;

FIG. 3 is an enlarged end view of an anode taken along line 3—3 of FIG. 1; and,

FIG. 4 is a schematic view showing the electrical connection for the filaments and cathode.

## EMBODIMENT OF INVENTION

The illustrated embodiment of the invention comprises a cathode 10 and an anode 12, the latter being illustrated as of the fixed type but which may be a rotating anode.

The cathode 10 comprises a supporting sleeve structure 14 suitably supported from an envelope (not shown), the sleeve supporting a body 16 formed of suitable metal. The cathode is formed with an reentrant face defined by intersecting plane surfaces 18, 20. The surface 18 has a focusing cup 22 formed therein and face 20 has a focusing cup 24 formed therein. Cups 22, 24 are substantially parallel to each other and identical in construction. Mounted in the cups 22, 24 are helically wound filaments 26, 28, respectively, to the opposite ends of which are connected leads which extend rearwardly through the body through openings 30 provided therefor, the filaments being electrically insulated with respect to the body 16.

Referring to FIG. 4, the filaments 26, 28 are series connected by a lead 32, power being supplied to the opposite ends of the filaments by leads 34, 36. Lead 34 is connected through switch contacts 38 which upon closure permit energizing action of filaments 26, 28 over their entire length.

Means are provided to permit energization of filament 28 over only one-half its length comprising a lead 40 connected to the midpoint 42 of filament 28 through switch contacts 44. Preferably, the contacts 38, 44 are interconnected as indicated whereupon opening of one set of contacts effects closure of the other set. A separate lead 48 is provided to the cathode body 16 so that a bias may be applied to such body independently of the filaments 26, 28.

The focusing cups 22, 24 and their respective filaments 26, 28 are so dimensioned as to cause when filaments 26, 28 are energized, the formation of a pair of contiguous, rectangular focal spots 50, 52 of substantially equal width and preferably not exceeding 1 millimeter in width upon the face of the anode 12. The focal spot 50 arises from the electrons generated at the filament 26, and the focal spot 52 from electrons generated at the filament 28. Focal spots 50, 52 are of equal length, their length being such that when viewed from the exposure area of the tube the combined focal spots will appear as a square. Where the focal spots are each one millimeter in width the spot would appear as 2 millimeters square.

When contacts 38 are open and contacts 44 closed, only half of the filament 28 is energized and which will cause the formation of a focal spot 54 of one half the width of the combined spots but only half the length of the focal spot 52. As viewed from the exposure area, the focal spot 54 will, of course, be a square.

An advantage of the construction shown is that the geometry of the filaments within the focusing cups 22, 24 is such as to cut off flow of electrons from the cathode to the anode upon application of a negative bias to the body 16 of the order 3,000 to 3,500 volts. In prior configurations the cathode cups were of larger dimension thus necessitating greater cutoff voltages and which, in turn, resulted in frequent arc-over between the filament and cup with a consequent surge of electrons upon the target. The higher the grid bias, the more likely it is, of course, that this problem will result. Utilizing only half the length of one of the filaments to generate electrons for the small focal spot simplifies, of course, the geometry of the X-ray tube.

Having illustrated and described a preferred embodiment of the invention it will be apparent that the invention permits of modification in arrangement and detail.

We claim:

1. A double-focus X-ray tube comprising:

an anode unit including a planar faced target,

a cathode unit comprising a head having a pair of substantially parallel electron focusing recesses therein and a pair of elongate filaments mounted one in each of said recesses,

said cup and filaments being arranged to direct the electrons emitted by said filaments when energized over their entire lengths upon said target in a pair of contiguous rectangular focal spots of equal length so as effectively to create a unitary rectangular focal spot on said target face, means for simultaneously connecting the opposite ends of said filaments to a source of electrical energy whereby each filament emits electrons over its entire length, and means for alternatively connecting only a portion of one of said filaments to a source of electrical energy whereby electrons are emitted from only said filament portion.

2. An X-ray tube as set forth in claim 1 wherein said pair of focal spots are of the same width.

3. An X-ray tube as set forth in claim 2 wherein said pair of focal spots are each of 1 millimeter in width.

4. An X-ray tube as set forth in claim 2 wherein said one filament portion is one half of said one filament.

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5. An X-ray tube as set forth in claim 3 wherein said filaments are electrically insulated from said head, and means are provided for applying an electrical potential to said head different from the potential applied to said filaments.

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