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(54) **MULTIPLE TARGET ANODE ASSEMBLY AND SYSTEM OF OPERATION**

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H01J 35/08 (2006.01)
H01G 1/60 (2006.01)

(52) **U.S. Cl.** **378/134**; 378/124; 378/9; 378/4

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See application file for complete search history.

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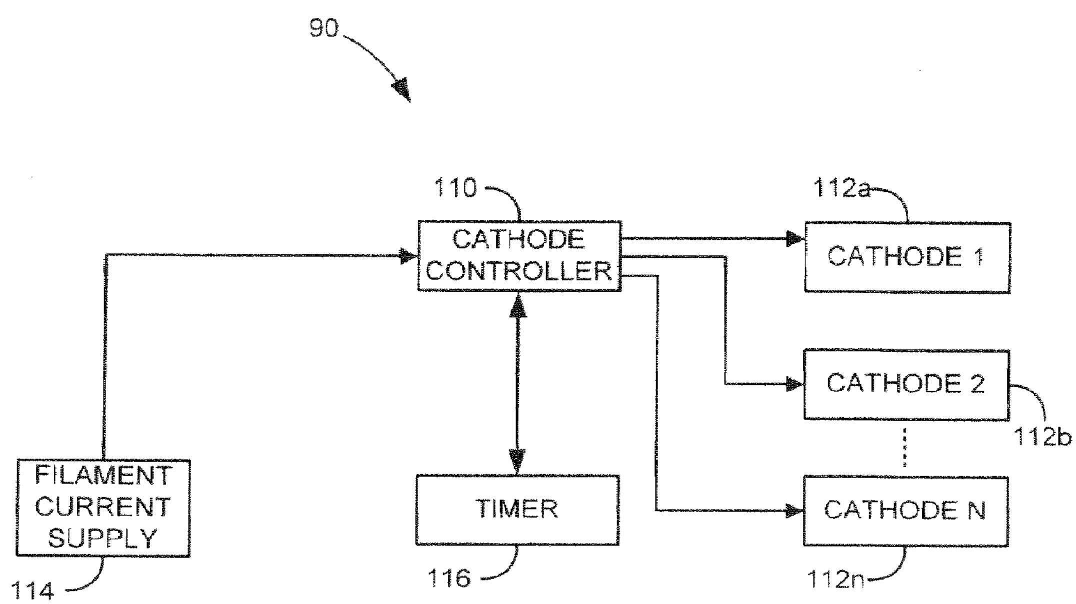
(57) **ABSTRACT**

An anode assembly having multiple target electrodes is disclosed. Each target electrode produces an x-ray fan beam for radiographic data acquisition. The target electrodes are designed to sequentially generate an x-ray fan beam and therefore operate at a proportional duty cycle per scan. Power output capabilities of the anode assembly is increased without an increase in the size or thermal overloading of the anode assembly.

14 Claims, 6 Drawing Sheets



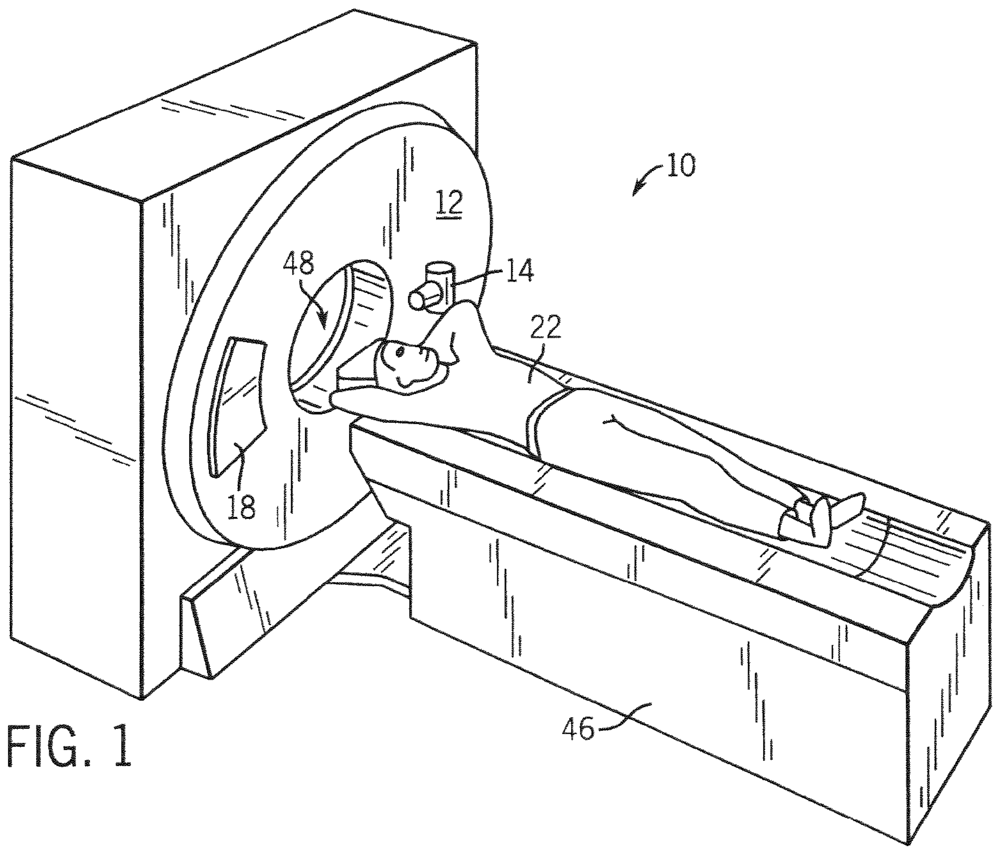

10
12
48
14
22
18
46

FIG. 1

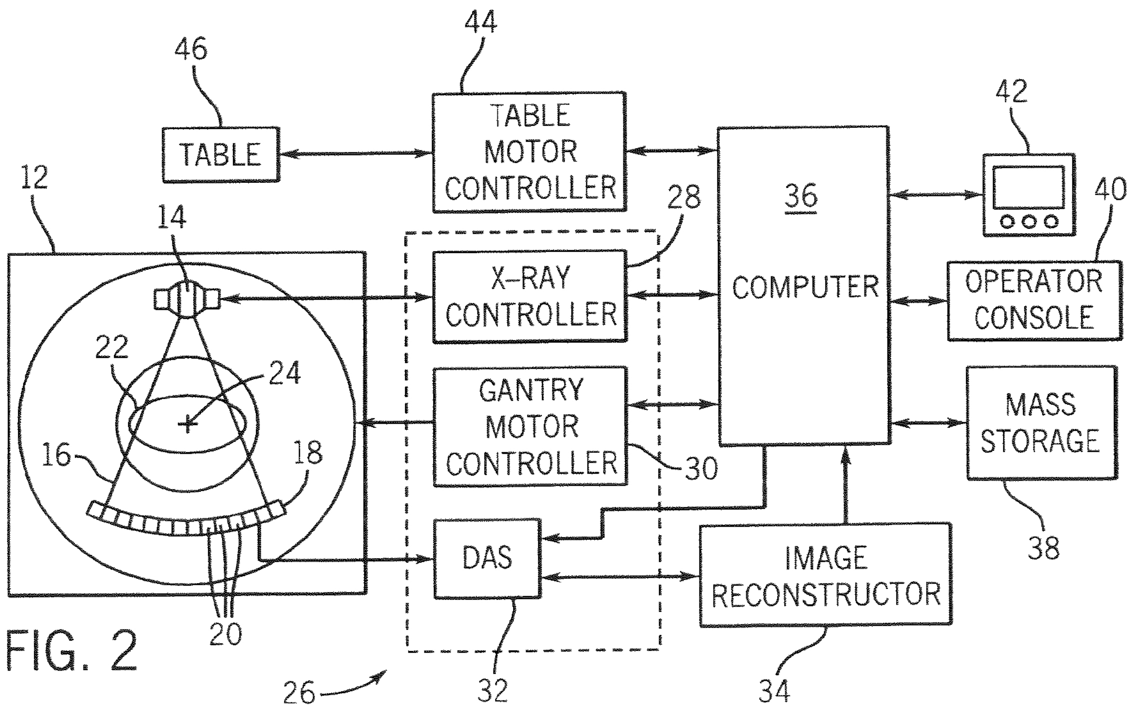

46
TABLE
44
TABLE MOTOR CONTROLLER
36
COMPUTER
42
40
OPERATOR CONSOLE
12
14
28
X-RAY CONTROLLER
22
24
GANTRY MOTOR CONTROLLER
30
MASS STORAGE
16
18
38
DAS
IMAGE RECONSTRUCTOR
20
26
32
34

FIG. 2

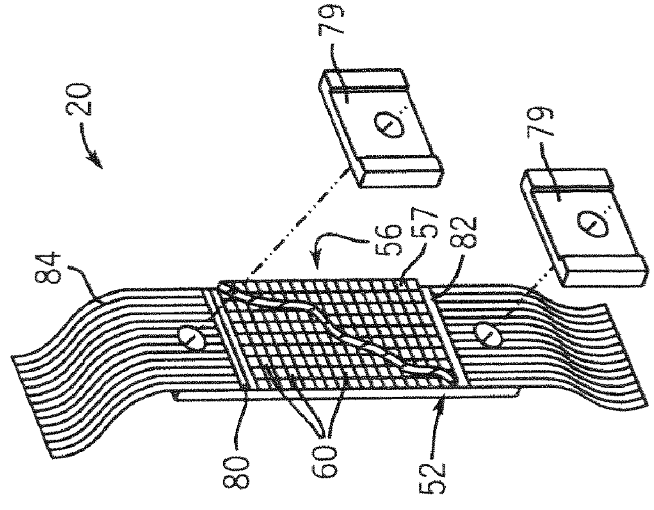


FIG. 4

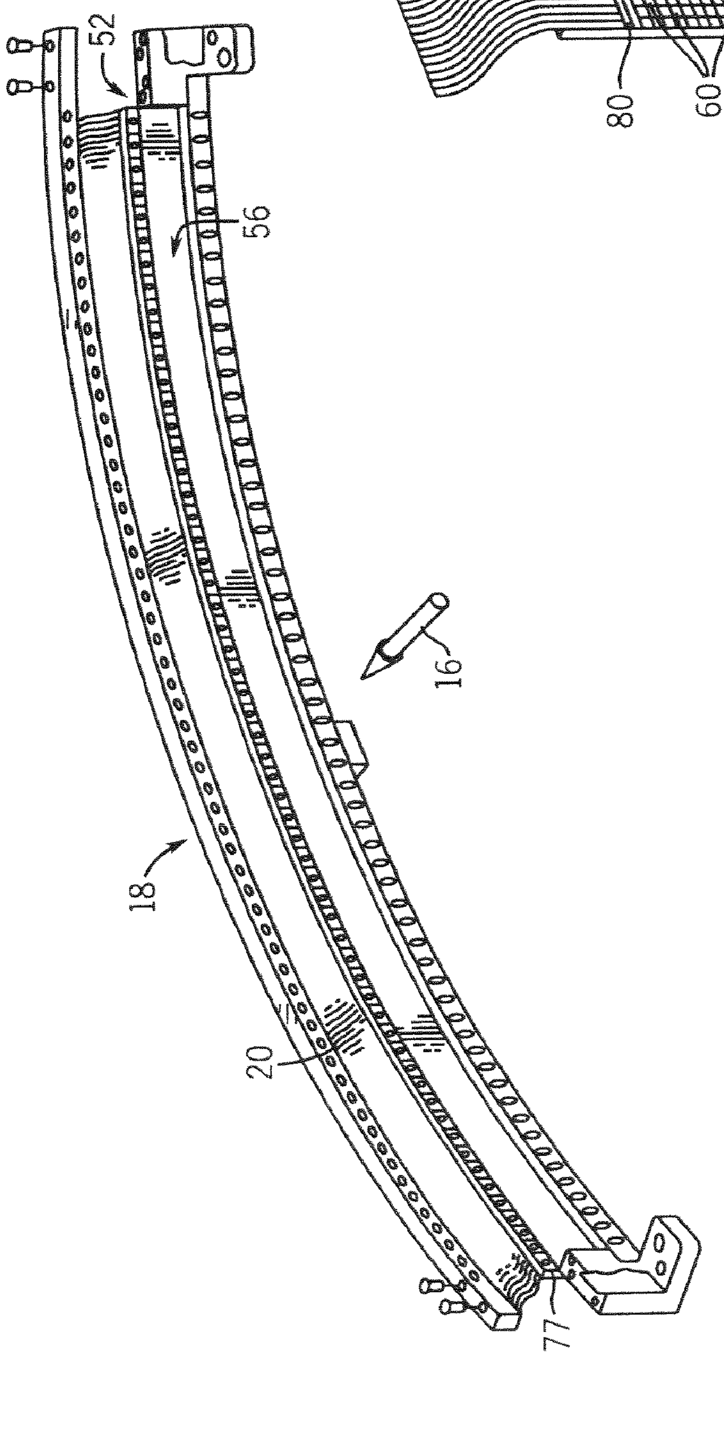
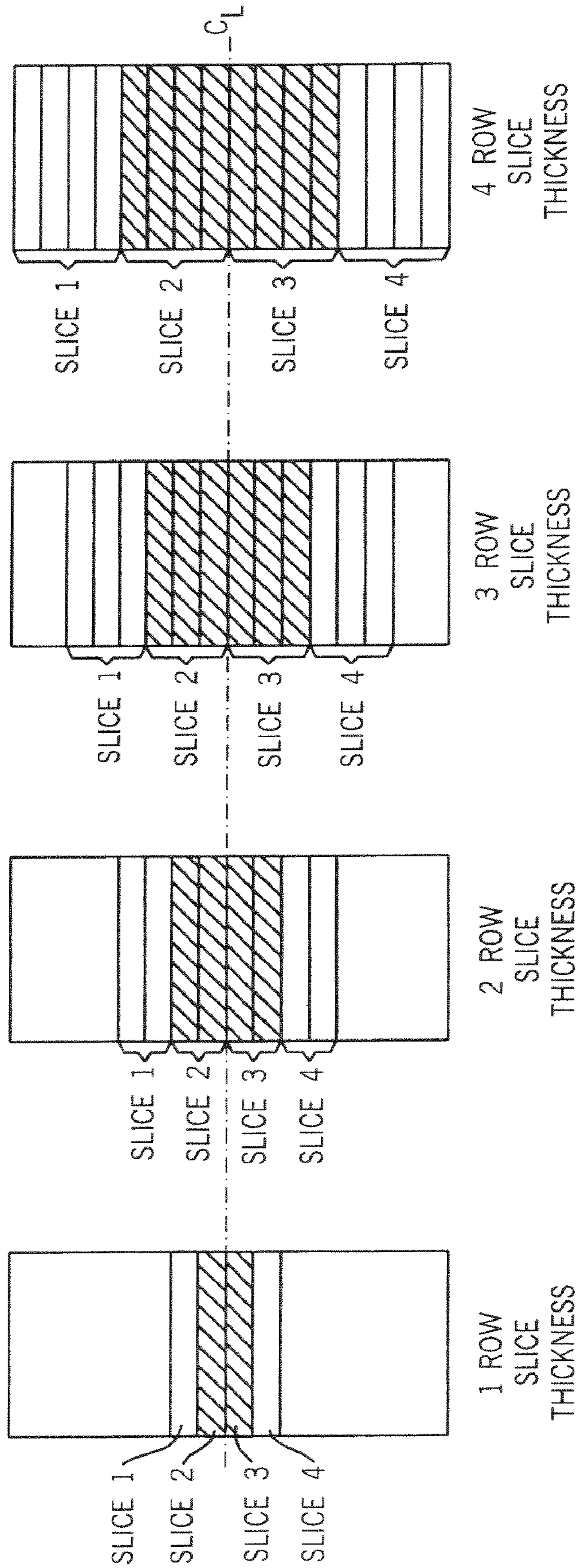


FIG. 3



C_L
SLICE 1
SLICE 2
SLICE 3
SLICE 4
4 ROW SLICE THICKNESS
SLICE 1
SLICE 2
SLICE 3
SLICE 4
3 ROW SLICE THICKNESS
SLICE 1
SLICE 2
SLICE 3
SLICE 4
2 ROW SLICE THICKNESS
SLICE 1
SLICE 2
SLICE 3
SLICE 4
1 ROW SLICE THICKNESS

FIG. 5

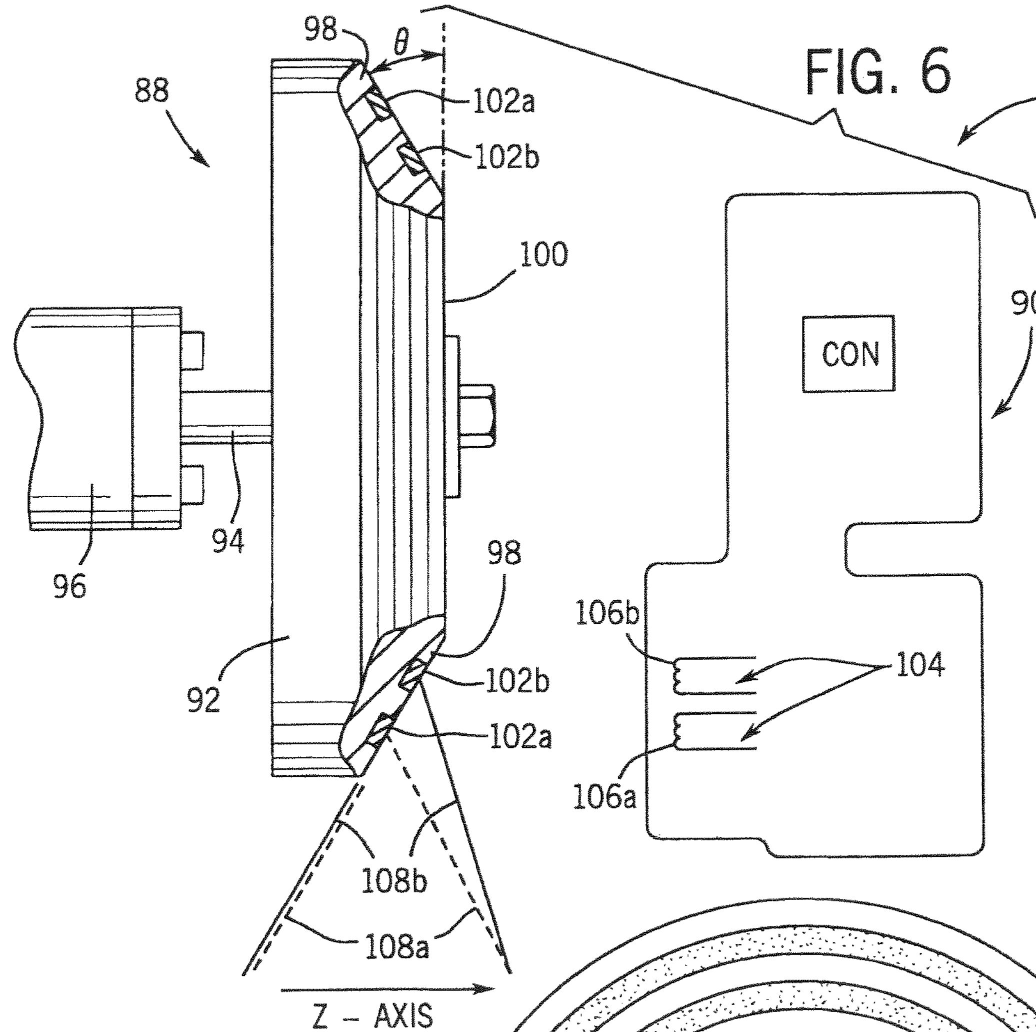

98
θ
102a
102b
88
86
100
90
CON
94
96
98
106b
104
102b
92
102a
106a
108b
108a
Z – AXIS

FIG. 6

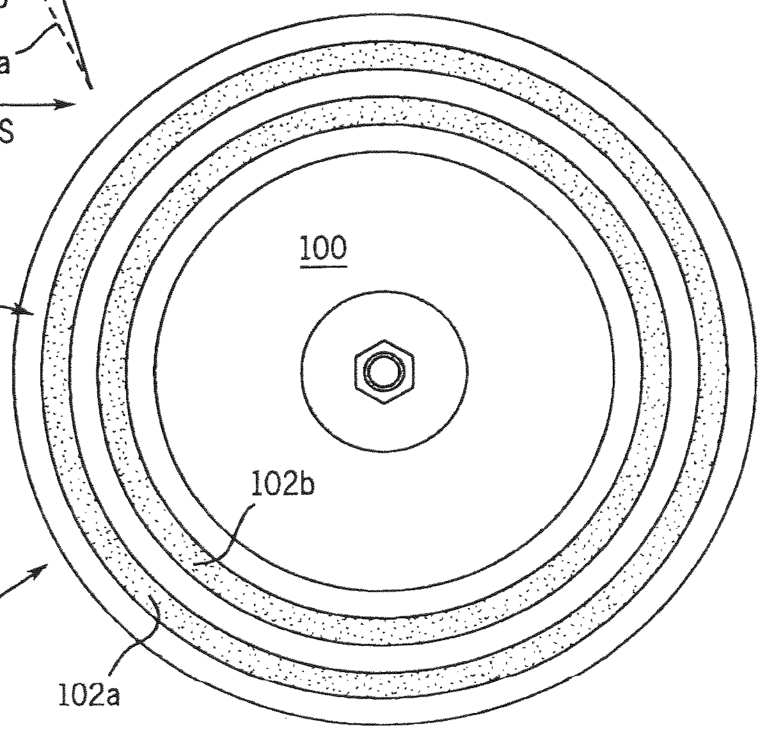

100
98
102b
92
102a

FIG. 7

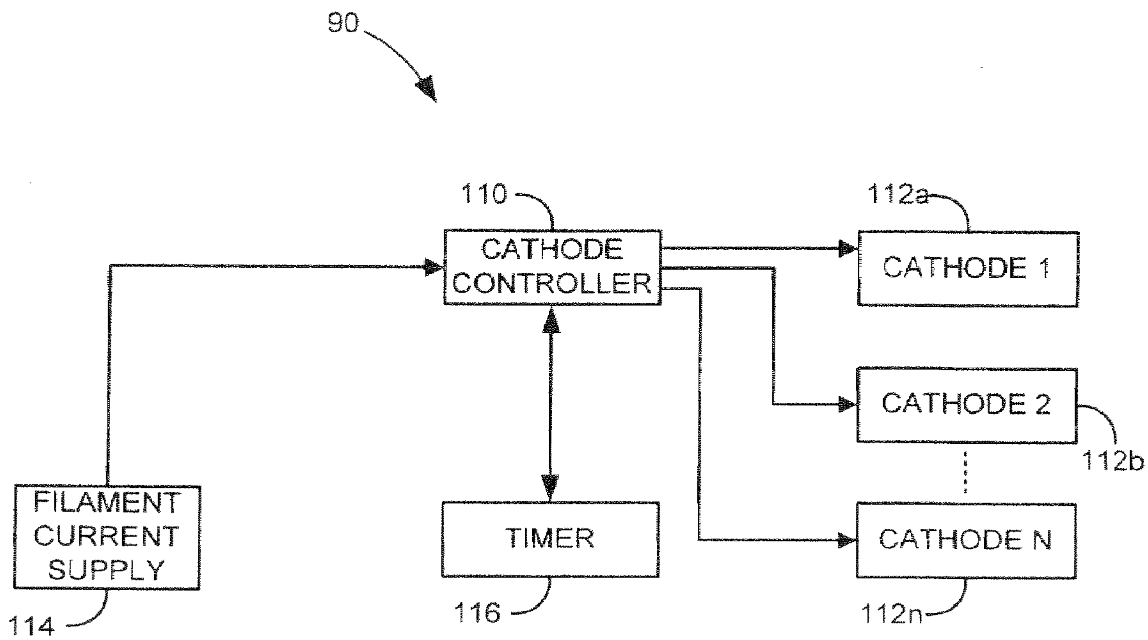

90
110
CATHODE CONTROLLER
112a
CATHODE 1
CATHODE 2
112b
CATHODE N
112n
FILAMENT CURRENT SUPPLY
114
TIMER
116

FIG. 8

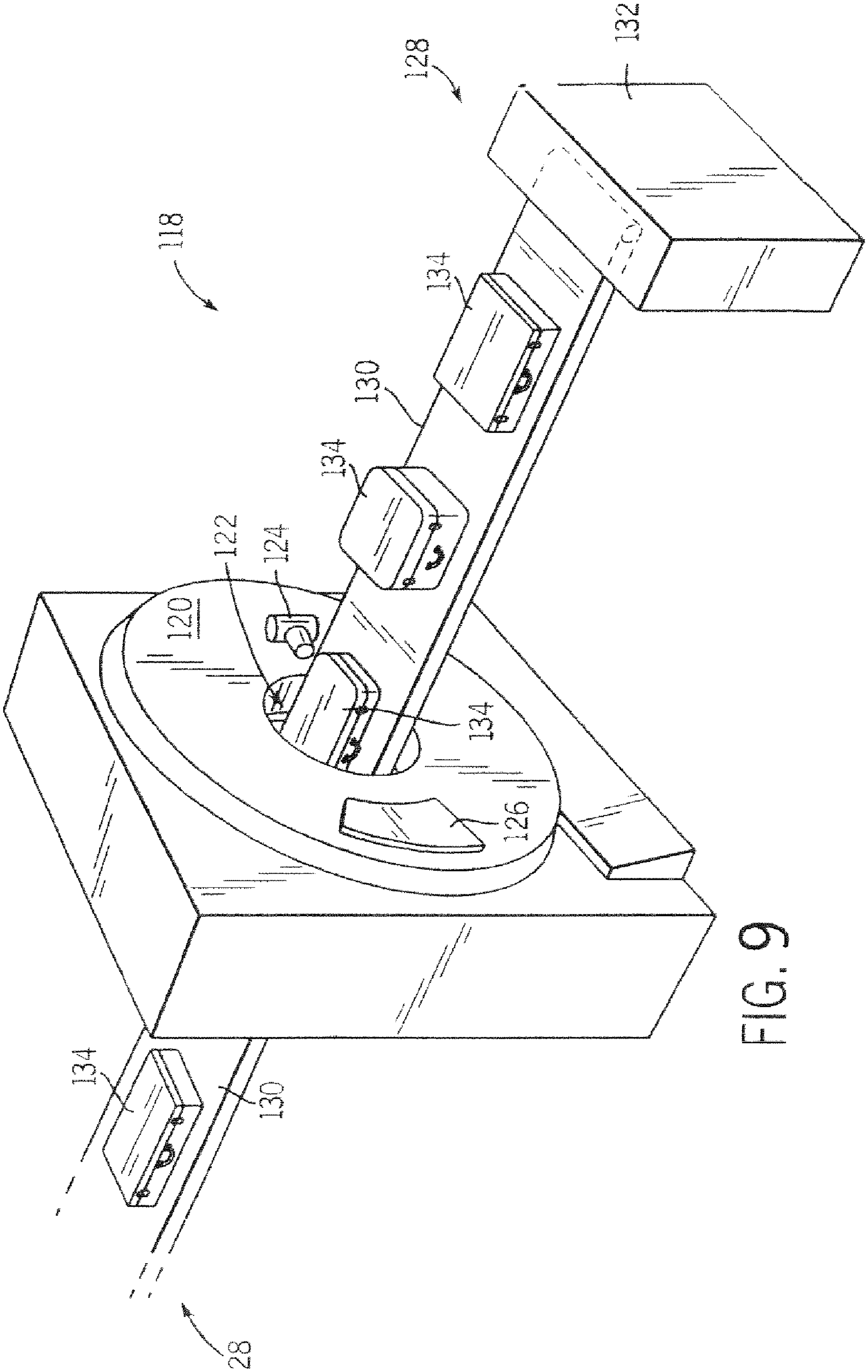


FIG. 9

MULTIPLE TARGET ANODE ASSEMBLY AND SYSTEM OF OPERATION

BACKGROUND OF INVENTION

The present invention relates generally to diagnostic imaging and, more particularly, to an x-ray tube assembly having multiple x-ray sources. The present invention further relates to an anode assembly having multiple electron targets such that multiple x-ray fan beams may be produced.

X-ray or radiographic imaging is the basis of a number of diagnostic imaging systems. Computed tomography (CT) is one example of such a system that is predicated upon the acquisition of data using the principles of radiography. Typically, in CT imaging systems, a single x-ray source emits a single fan-shaped beam toward a subject or object, such as a patient or a piece of luggage. Hereinafter, the terms “subject” and “object” shall include anything capable of being imaged. The beam, after being attenuated by the subject, impinges upon an array of radiation detectors. The intensity of the attenuated beam radiation received at the detector array is typically dependent upon the attenuation of the x-ray beam by the subject. Each detector element of the detector array produces a separate electrical signal indicative of the attenuated beam received by each detector element. The electrical signals are transmitted to a data processing system for analysis which ultimately produces an image.

Generally, the x-ray source and the detector array are rotated about the gantry within an imaging plane and around the subject. X-ray sources typically include x-ray tubes, which emit the x-ray beam at a focal point. X-ray detectors typically include a collimator for collimating x-ray beams received at the detector, a scintillator for converting x-rays to light energy adjacent the collimator, and photodiodes for receiving the light energy from the adjacent scintillator and producing electrical signals therefrom.

Typically, each scintillator of a scintillator array converts x-rays to light energy. Each scintillator discharges light energy to a photodiode adjacent thereto. Each photodiode detects the light energy and generates a corresponding electrical signal. The outputs of the photodiodes are then transmitted to the data processing system for image reconstruction.

CT systems, as well as x-ray systems, typically utilize a rotating anode during the data acquisition process. Rotating the anode helps fan the x-ray fan beam, but, more importantly, reduces the thermal load on the anode. That is, the anode typically includes a single target electrode that is mounted or integrated with an anode disc. The anode disc is rotated by an induction motor during data acquisition. Since the electrons striking the anode deposit most of their energy as heat, with a small fraction emitted as x-rays, producing x-rays in quantities sufficient for acceptable image quality generates a large amount of heat. A number of techniques have been developed to accommodate the thermal load placed on the anode during the x-ray generate process.

For example, advancements in the detection of x-ray attenuation has allowed for a reduction in x-ray dose necessary for image acquisition. X-ray dose and tube current are directly related and, as such, a reduction in tube current results in a reduction in x-ray dosage. A drop in tube current, i.e. reduction in the number of striking electrons on the anode target, reduces the thermal load placed on the anode target during data acquisition. Simply, less power is needed to generate the x-rays necessary for data acquisition. X-rays are generated as a result of electrons emitted from a cathode striking a target electrode mounted to or integrated with the anode disc. The number of electrons emitted depends in part of the voltage potential placed across the cathode and anode. Increasing the voltage potential increases the number of emitted electrons. Since a minimum number of electrons must be generated for meaningful data acquisition, a mere reduction in tube current is insufficient to address the thermal load on the anode resulting from x-ray generation.

Another approach is predicated upon the spreading of the generated heat across the surface and mass of the anode disc. By rotating the anode disc as electrons are striking the target electrode, the heat generated therefrom may be spread across the anode disc rather than across the target electrode alone. This rotation of the anode disc effectively reduces the thermal load placed on the target electrode. As a result, tube current may be increased without thermal overloading of the anode. Generally, the faster the anode disc is rotated the higher the tube current that may be used.

Increasing the tube current and effectively the power levels of the x-ray tube assembly is particularly desirable for short duration high power reconstruction protocols. With these protocols, the gantry is caused to rotate at significantly fast rotational speeds. Through increased rotational gantry speed, the overall exam time may be decreased. Decreasing the overall exam or scan time improves patient throughput and reduces patient discomfort which reduces patient-induced motion artifacts in the reconstructed image. To support faster gantry speeds, the x-ray tube must output sufficiently more instantaneous power which is required for short duration protocols.

To provide the requisite instantaneous power needed for short duration protocols, the x-ray tube must output more power without exceeding the thermal load of the target electrode. As mentioned above, rotating the anode disc during x-ray generation reduces the thermal load on the electrode target. Known CT systems utilize a rotating anode disc and due to material strength limitations, it is not feasible to simply increase the rotational speed of the anode disc or its size. Another means to increase the power output of the x-ray tube is to simply increase its size. Increasing the tube size and mass however is also not a feasible solution. The gantry must support rotation of the x-ray tube and any increase in x-ray tube size and weight increases the support burden placed on the gantry. As a result, the size of the gantry would have to be increased yielding a much larger CT scanner.

It would therefore be design a method and system for increasing the power output of an x-ray tube assembly without increasing its size or mass.

BRIEF DESCRIPTION OF INVENTION

The present invention is a directed method and system of x-ray generation for radiographic and CT data acquisition and image reconstruction that overcomes the aforementioned drawbacks. An x-ray tube assembly is disclosed and includes an anode disc having multiple target electrodes. Each target electrode receives electrons emitted by multiple cathodes and, as such, each target electrode operates as an x-ray source. The multiple cathodes are controlled such that a particular cathode does not fire until each other cathode is sequentially fired. In this regard, the duty cycle of each target electrode is based on the number of target electrodes incorporated with the anode disc.

Therefore, in accordance with one aspect, the present invention includes an anode assembly having an anode disc and a first x-ray source connected to the anode disc and configured to emit a first fan beam of x-rays. The anode assembly further includes a second x-ray source connected to the anode disc and configured to emit a second fan beam of x-rays. The first x-ray source has a distance from a center of the anode disc different than that of the second x-ray source.

In accordance with another aspect of the present invention, an x-ray tube assembly includes a plurality of independently controllable electron sources configured to emit electrons. A plurality of target electrodes are provided and configured to receive electrons emitted by the plurality of electron sources and emit a plurality of fan beams of radiographic energy in response thereto.

According to another aspect, the present invention includes a CT system having a rotatable gantry comprising a bore centrally disposed therein and a table movable fore and aft through the bore and configured to position a subject for CT data acquisition. A detector array is disposed within the rotatable gantry and configured to detect high frequency electromagnetic energy attenuated by the subject. Multiple high frequency electromagnetic energy projection sources are positioned within the rotatable gantry and configured to project multiple high frequency electromagnetic energy fan beams toward the subject. Each projection source is configured to operate at a proportional duty cycle per scan.

Various other features, objects and advantages of the present invention will be made apparent from the following detailed description and the drawings.

BRIEF DESCRIPTION OF DRAWINGS

The drawings illustrate one preferred embodiment presently contemplated for carrying out the invention.

In the drawings:

FIG. **1** is a pictorial view of a CT imaging system.

FIG. **2** is a block schematic diagram of the system illustrated in FIG. **1**.

FIG. **3** is a perspective view of one embodiment of a CT system detector array.

FIG. **4** is a perspective view of one embodiment of a detector.

FIG. **5** is illustrative of various configurations of the detector in FIG. **4** in a four-slice mode.

FIG. **6** is a side elevational view of a anode assembly in accordance with the present invention.

FIG. **7** is an end view of the anode disc illustrated in FIG. **6**.

FIG. **8** is a schematic diagram of an x-ray tube assembly in accordance with the present invention.

FIG. **9** is a pictorial view of a CT system for use with a non-invasive package inspection system.

DETAILED DESCRIPTION

The operating environment of the present invention is described with respect to a four-slice computed tomography (CT) system. However, it will be appreciated by those skilled in the art that the present invention is equally applicable for use with single-slice or other multi-slice configurations. Moreover, the present invention will be described with respect to the detection and conversion of x-rays. However, one skilled in the art will further appreciate that the present invention is equally applicable for the detection and conversion of other high frequency electromagnetic energy. The present invention will be described with respect to a "third generation" CT scanner, but is equally applicable with other CT systems. The present invention may also be applicable to x-ray or other radiographic imaging systems.

Referring to FIGS. **1** and **2**, a computed tomography (CT) imaging system **10** is shown as including a gantry **12** representative of a "third generation" CT scanner. Gantry **12** has an x-ray source **14** that projects a beam of x-rays 16 toward a detector array **18** on the opposite side of the gantry **12**. Detector array **18** is formed by a plurality of detectors **20** which together sense the projected x-rays that pass through a medical patient **22**. Each detector **20** produces an electrical signal that represents the intensity of an impinging x-ray beam and hence the attenuated beam as it passes through the patient **22**. During a scan to acquire x-ray projection data, gantry **12** and the components mounted thereon rotate about a center of rotation **24**.

Rotation of gantry **12** and the operation of x-ray source **14** are governed by a control mechanism **26** of CT system **10**. Control mechanism **26** includes an x-ray controller **28** that provides power and timing signals to an x-ray source **14** and a gantry motor controller **30** that controls the rotational speed and position of gantry **12**. A data acquisition system (DAS) **32** in control mechanism **26** samples analog data from detectors **20** and converts the data to digital signals for subsequent processing. An image reconstructor **34** receives sampled and digitized x-ray data from DAS **32** and performs high speed reconstruction. The reconstructed image is applied as an input to a computer **36** which stores the image in a mass storage device **38**.

Computer **36** also receives commands and scanning parameters from an operator via console **40** that has a keyboard. An associated cathode ray tube display **42** allows the operator to observe the reconstructed image and other data from computer **36**. The operator supplied commands and parameters are used by computer **36** to provide control signals and information to DAS **32**, x-ray controller **28** and gantry motor controller **30**. In addition, computer **36** operates a table motor controller **44** which controls a motorized table **46** to position patient **22** and gantry **12**. Particularly, table **46** moves portions of patient **22** through a gantry opening **48**.

As shown in FIGS. **3** and **4**, detector array **18** includes a plurality of scintillators **57** forming a scintillator array **56**. A collimator (not shown) is positioned above scintillator array **56** to collimate x-ray beams 16 before such beams impinge upon scintillator array **56**.

In one embodiment, shown in FIG. **3**, detector array **18** includes 57 detectors **20**, each detector **20** having an array size of 16×16. As a result, array **18** has 16 rows and 912 columns (16×57 detectors) which allows 16 simultaneous slices of data to be collected with each rotation of gantry **12**.

Switch arrays **80** and **82**, FIG. **4**, are multi-dimensional semiconductor arrays coupled between scintillator array **56** and DAS **32**. Switch arrays **80** and **82** include a plurality of field effect transistors (FET) (not shown) arranged as multi-dimensional array. The FET array includes a number of electrical leads connected to each of the respective photodiodes **60** and a number of output leads electrically connected to DAS **32** via a flexible electrical interface **84**. Particularly, about one-half of photodiode outputs are electrically connected to switch **80** with the other one-half of photodiode outputs electrically connected to switch **82**. Additionally, a reflector layer (not shown) may be interposed between each scintillator **57** to reduce light scattering from adjacent scintillators. Each detector **20** is secured to a detector frame **77**, FIG. **3**, by mounting brackets **79**.

Switch arrays **80** and **82** further include a decoder (not shown) that enables, disables, or combines photodiode outputs in accordance with a desired number of slices and slice resolutions for each slice. Decoder, in one embodiment, is a decoder chip or a FET controller as known in the art. Decoder includes a plurality of output and control lines coupled to switch arrays **80** and **82** and DAS **32**. In one embodiment defined as a 16 slice mode, decoder enables switch arrays **80** and **82** so that all rows of the photodiode array **52** are activated, resulting in 16 simultaneous slices of data for processing by DAS **32**. Of course, many other slice combinations are possible. For example, decoder may also select from other slice modes, including one, two, and four-slice modes.

As shown in FIG. **5**, by transmitting the appropriate decoder instructions, switch arrays **80** and **82** can be configured in the four-slice mode so that the data is collected from four slices of one or more rows of photodiode array **52**. Depending upon the specific configuration of switch arrays **80** and **82**, various combinations of photodiodes **60** can be enabled, disabled, or combined so that the slice thickness may consist of one, two, three, or four rows of scintillator array elements **57**. Additional examples include, a single slice mode including one slice with slices ranging from 1.25 mm thick to 20 mm thick, and a two slice mode including two slices with slices ranging from 1.25 mm thick to 10 mm thick. Additional modes beyond those described are contemplated.

Referring now to FIG. **6**, a portion of an x-ray tube assembly **86** is shown in side elevation. The x-ray tube assembly generally forms the x-ray projection source **14** of FIGS. **1** and **2**. X-ray tube assembly **86** includes an anode assembly **88** and a cathode assembly **90**. The anode assembly **88** includes a rotatable anode disc **92** supported by an anode stem **94** that is operationally connected to a rotor and bearing assembly **96**. A stator assembly (not shown) together with rotor and bearing assembly **96** induces rotation of stem **94** that supports rotation of anode disc **92**. Preferably, anode stem **94** is formed of poor heat conducting material so that heat generated during the generation of x-rays is not passed to the rotor and bearing assembly **96**.

Anode disc **92** includes a bevel or tapered region **98** that extends from face **100**. Mounted to or integrally formed within the bevel region **98** are multiple electrode target tracks **102** that extend circumferentially around the anode disc **92**. The multiple electrode target tracks are preferably formed of tungsten but other materials high in melting point temperature and atomic number may also be used. Each electrode target track is designed to emit an x-ray fan beam in response to electrons striking thereon. Angle θ corresponds to an anode target angle and defines the amount of taper from anode disc face **100**. Angle θ is selected based on the desired spatial coverage of the fan beam generated by each electrode target **102**. For large field area coverage, the anode disc is constructed to have a larger anode target angle θ. In contrast, for smaller coverage, a more acute beveling is used. Additionally, a smaller anode angle provides a smaller effective focal spot for the same actual focal area. One skilled in the art will readily appreciate that a smaller effective focal spot size provides better spatial resolution. However, a smaller or more acute anode target angle limits the size of the usable x-ray field due to cut-off of the x-ray fan beam.

Still referring to FIG. **6**, cathode assembly **90** includes multiple electron sources **104** that emit electrons toward electrode targets **102** of the anode assembly **88** when a voltage potential is placed across the anode and cathode assemblies **88**, **90**. The number of electrons increases as the voltage placed across the assemblies increases. Since the amount of x-ray generation is a function of the number of electrons emitted from the electron sources **104** that strike target electrodes **102**, an increase in current causes an increase in x-ray dose. As discussed above, increasing the tube current increases heat generation and, as such, anode disc **92** is rotated during data acquisition.

Electron sources **104**, whose number corresponds to the number of target electrode tracks **102**, e.g. two in the illustrated example, are formed of helical filament of tungsten wire **106** surrounded by a focusing cup (not shown) that are connected to a filament circuit, FIG. **8**. The filament circuit provides a voltage to the filaments thereby producing a current through the filament. Electrical resistance heats the filament and, through thermionic emission, the filament releases electrons that are directed toward the target electrodes **102**. As will be described, the electron sources are caused to sequentially "fire" and, as such, a particular electron source is not caused to emit electrons until every other electron source has fired. In this regard, the respective electrode targets operate at a proportional duty cycle. For instance, in the illustrated example of two electrode tracks **102***a,b* and two electron sources **104***a, b*, the electron sources alternately fire which causes each track **102***a,b* to operate at a 50 percent duty cycle per scan. Operating at this proportional duty cycle effectively reduces the thermal burden placed on each electrode target and supports an increase in overall total power output without an increase in anode size or increase in anode disc rotational speed.

Each electrode target track **102***a,b* produces a respective x-ray fan beam **108***a,b*. The x-ray beams are generated when electrons from the electron sources **104***a,b* strike target electrodes **102***a,b*. As shown in FIG. **6**, the anode target angle **0** and the orientation of target electrode tracks **102***a,b* with respect to one another are selected such that each fan beam has a similar spatial coverage. Additionally, the fan beams are generated such that the respective penumbra of each fan extends along the z- or patient long axis. Since the target electrodes **102** operate at a proportional duty cycle, fan beams **108** are generated based on the duty cycle of a respective target electrode. That is, while multiple fan beams are shown as occurring at a singular point in time, only one fan beam is preferably generated at a particular moment in time. The depiction of multiple fan beams is to illustrate the similar spatial coverage of each fan beam. However, it is contemplated that for some protocols more than one or all of the target electrodes may be caused to generate a fan beam simultaneously at a particular point in time.

Referring now to FIG. **7**, an end view of anode disc **92** illustrates the concentric orientation of each target electrode track **102***a,b* relative to one another. While this distance is exaggerated in FIG. **7**, it is preferred that the electrode tracks are spaced apart so that the distance between the respective focal sports is approximately one millimeter in the z- or patient long axis direction. Since the focal spots are approximately one millimeter apart in the z-direction, the image reconstruction algorithm may inhibit any image artifacts by effectively considering the respective focal spots as a single focal spot. Additionally, the relative orientation of each target electrode **102***a,b* on the anode disc bevel **98** is such that the separation in the y-direction may also be taken into account during the image reconstruction process. In addition, the electrode target tracks may be spatially separated along the x- or patient width axis which supports implementation of the x-ray tube assembly in a "wobble" mode to improve spatial resolution. It should be noted that for longer scan protocols, the conductivity of the anode disc would allow the temperature between the target electrode tracks to equalize. In this regard, the proportionality of the duty cycles for the respective target electrode tracks is lost for longer scan protocols.

Referring now to FIG. **8**, cathode assembly **90** is schematically shown as including a cathode controller **110** that is operationally connected to each electron source or cathode **112***a*, **112***b* . . . **112***n*. Controller **110** is electrically connected between the cathodes **112** and filament current supply **114**. As noted above, the electron sources are configured to sequentially fire before a particular source is re-fired. To this end, controller **110** is also connected to a timer **116** that monitors the firing times of each electron source and provides control feedback to the controller **110** regarding the firing of the electron sources. One skilled in the art will readily appreciate that the firing of the electron sources may also be controlled based on other inputs such as the thermal load on each target electrode. That is, the temperature of each electrode target may be monitored and provided as feedback to the controller **110** to determine which electron source should be fired. Accordingly, the controller **110** may compare the feedback to a look-up table of values or determine in real-time if a particular target electrode is being thermally stressed. In this regard, a particular electron source may be fired repeatedly or out of order depending on the particular thermal loads on the target electrodes or the specifics of the particular scan. In another embodiment, the controller may be programmed to fire the electron sources according to a particular pattern to carry out a particular imaging protocol.

FIG. **9** illustrates a package/baggage inspection system **118** that may incorporate the present invention. The inspection system includes a rotatable gantry **120** having an opening **122** therein through which packages or pieces of baggage may pass. The rotatable gantry **120** houses a high frequency electromagnetic energy source **124** as well as a detector assembly **126**. A conveyor system **128** is also provided and includes a conveyor belt **130** supported by structure **132** to automatically and continuously pass packages or baggage pieces **134** through opening **122** to be scanned. Objects **134** are fed through opening **122** by conveyor belt **130**, imaging data is then acquired, and the conveyor belt **130** removes the packages **134** from opening **122** in a controlled and continuous manner. As a result, postal inspectors, baggage handlers, and other security personnel may non-invasively inspect the contents of packages **134** for explosives, knives, guns, contraband, etc.

Therefore, in accordance with one embodiment, the present invention includes an anode assembly having an anode disc and a first x-ray source connected to the anode disc and configured to emit a first fan beam of x-rays. The anode assembly further includes a second x-ray source connected to the anode disc and configured to emit a second fan beam of x-rays. The first x-ray source has a distance from a center of the anode disc different than that of the second x-ray source.

In accordance with another embodiment of the present invention, an x-ray tube assembly includes a plurality of independently controllable electron sources configured to emit electrons. A plurality of target electrodes are provided and configured to receive electrons emitted by the plurality of electron sources and emit a plurality of fan beams of radiographic energy in response thereto.

According to another embodiment, the present invention includes a CT system having a rotatable gantry comprising a bore centrally disposed therein and a table movable fore and aft through the bore and configured to position a subject for CT data acquisition. A detector array is disposed within the rotatable gantry and configured to detect high frequency electromagnetic energy attenuated by the subject. Multiple high frequency electromagnetic energy projection sources are positioned within the rotatable gantry and configured to project multiple high frequency electromagnetic energy fan beams toward the subject. Each projection source is configured to operate at a proportional duty cycle per scan.

The present invention has been described in terms of the preferred embodiment, and it is recognized that equivalents, alternatives, and modifications, aside from those expressly stated, are possible and within the scope of the appending claims.

What is claimed is:

1. An x-ray tube assembly comprising:

a plurality of independently controllable electron sources configured to emit electrons;

an anode disc;

a plurality of target electrodes disposed on the anode disc and configured to receive electrons emitted by the plurality of independently controllable electron sources and emit a plurality of fan beams of radiographic energy in response thereto;

a thermal feedback loop operably connected to provide feedback indicative of thermal conditions of at least one target electrode; and

an electron firing controller operably connected to the thermal feedback loop and configured to selectively fire the plurality of independently controllable electron sources to maintain a thermal load on the at least one target electrode below a given threshold.

2. The assembly of claim **1** wherein the thermal feedback loop provides feedback indicative of a thermal load on each target electrode and wherein the controller is configured to disable an electron source corresponding to a given target electrode if the thermal load of the given target electrode exceeds the given threshold.

3. The assembly of claim **1** wherein the thermal feedback loop provides feedback regarding a firing duration of the at least one target electrode and wherein the controller is configured to determine a temperature of the at least one target electrode from the firing duration.

4. The assembly of claim **1** wherein the controller is configured to determine a thermal stress on the at least one target electrode in near real-time.

5. The assembly of claim **1** wherein the controller is configured to fire each of the plurality of independently controllable electron sources in a sequential manner before re-firing of an electron source if no target electrode is under an unacceptable thermal stress.

6. The assembly of claim **1** wherein the plurality of independently controllable electron sources includes a first target electrode at a first radial distance from a center of the anode disc to produce a first spatial coverage and a second target electrode at a second radial distance from the center of the anode disc that is different than the first radial distance to produce a second spatial coverage that is substantially similar to the first spatial coverage.

7. The assembly of claim **1** wherein the plurality of target electrodes is oriented with respect to one another such that each fan beam has a similar spatial coverage.

8. The assembly of claim **1** wherein each fan beam extends along a z-axis.

9. The assembly of claim **1** wherein the plurality of electron sources includes a plurality of tungsten targets integrated in a beveled portion of the anode disc.

10. A CT system comprising:

a rotatable gantry having a bore centrally disposed therein;

a table movable fore and aft through the bore and configured to position a subject for CT data acquisition;

a detector array disposed within the rotatable gantry and configured to detect x-radiation attenuated by the subject;

an anode disc positioned within the rotatable gantry;

multiple x-ray sources extending circumferentially about the anode disc and configured to project x-ray fan beams toward the subject; and

a controller operably connected to the multiple x-ray sources and configured to selectively fire the multiple x-ray sources based on respective thermal stresses on the multiple x-ray sources;

wherein the controller determines the respective thermal stresses on the multiple x-ray sources.

11. The CT system of claim **10** wherein each x-ray source includes a tungsten electrode that generates an x-ray fan beam when bombarded with electrons from an electron source, and the controller operably connected to receive thermal feedback of each tungsten electrode to determine a thermal stress of each tungsten electrode.

12. The CT system of claim **11** wherein the controller causes x-ray emission of each tungsten electrode based on a proportional duty cycle if no tungsten electrode is under an unacceptable thermal stress.

13. The CT system of claim **12** wherein each tungsten electrode has a respective electron source, and wherein the controller disables a given electron source as long as the corresponding tungsten electrode is under an unacceptable thermal stress.

14. The CT system of claim **10** wherein the multiple x-ray sources includes:

a rotatable anode disc having a beveled face;

a first tungsten electrode track disposed on the beveled face and extending circumferentially about the disc at a first radius; and

a second tungsten electrode track disposed on the beveled face and extending circumferentially about the disc at a second, different from the first, radius.

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