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(71) Applicant *(for all designated States except DE, US)*: **KONINKLIJKE PHILIPS ELECTRONICS N.V.** [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(71) Applicant *(for DE only)*: **PHILIPS INTELLECTUAL PROPERTY & STANDARDS GMBH** [DE/DE]; Lübeckertordamm 5, 20099 Hamburg (DE).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **LUHTA, Randall, P.** [CA/US]; c/o 595 Miner Road, Cleveland, Ohio 44143 (US). **MATTSON, Rodney, A.** [US/US]; c/o 595 Miner Road, Cleveland, Ohio 44143 (US). **DORSCHEID, Ralf** [DE/NL]; c/o 595 Miner Road, Cleveland, Ohio 44143 (US). **VOGTMEIER, Gereon** [DE/DE]; c/o 595 Miner Road, Cleveland, Ohio 44143 (US).

(74) Agents: **BEKKERS, Joost, J., J.** et al.; High Tech Campus Building 44, NL-5656 AE Eindhoven (NL).

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[Continued on next page]

(54) Title: ANTI-SCATTER GRID

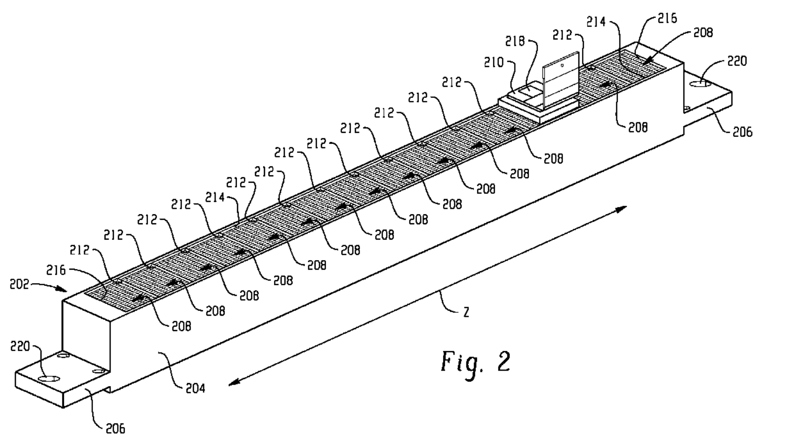

Fig. 2

(57) Abstract: An anti-scatter apparatus (118) of an imaging system (100) including a base (204) with a plurality of detector tile receiving sub-regions (208) consecutively abutted and aligned along a z-axis direction of the imaging system (100). A tile receiving sub-region (208) is configured to receive a individual detector tile (210), which includes a matrix of photosensing pixels. The tile receiving sub-region (208) includes a plurality of channels (306), which are respectively aligned with different ones of the photosensing pixels. A bracket (402) is affixed to the base (204) so that detector tiles (210) installed in the plurality of tile receiving sub-regions (208) are disposed between the bracket (402) and the plurality of tile receiving sub-regions (208), thereby securing the installed detector tiles (210) in the anti-scatter apparatus (118). A fastening portion (206, 1102) fastens to a detector module cradle (120) of the imaging system (100), thereby securing the anti-scatter apparatus (118) to the imaging system. The fastening portion (206, 1102) is fastened to the detector module cradle (120) to focus the channels at a focal spot of a radiation source (110) of the imaging system (100).

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ANTI-SCATTER GRID

DESCRIPTION

The following generally relates to an anti scatter grid, and finds particular application to computed tomography (CT). However, it also amenable to other medical imaging applications and to non-medical imaging applications.

A computed tomography (CT) scanner includes a source of radiation and a radiation detection system. The source of radiation includes an x-ray tube that emits radiation that traverses an examination region. The radiation detection system includes a detector array disposed across from the x-ray tube on an opposite side of the examination region. The detector array includes a scintillator, which converts photon energy into light, and one or more photosensors, which convert the light into a signal indicative of the detected radiation. The radiation detection system also includes an anti-scatter grid, disposed between the detector array and the incoming radiation, which block scatter radiation from striking the detector array. A reconstructor reconstructs the signal to generate volumetric image data thereof, which can be used to generate one or more images of the subject and/or object.

With one CT system, the detector array includes a plurality of detector modules aligned next to each in a cradle other along a transverse direction. Each detector module includes a plurality of two dimensional photosensor blocks, each with a two dimensional array of pixels, aligned next to each other along the z-axis or longitudinal direction, which is perpendicular to the transverse direction. Each photosensor block is a stacked structure, consisting of an anti-scatter grid, which is fixed to a two dimensional scintillator array, which is fixed to the two dimensional photosensor block, which is fixed to a substrate, which is fixed to a heat sink, which is fixed to a base of the detector module. Each two dimensional photosensor block is placed on a curved surface of a corresponding detector module along an arc of a sphere in the base to focus the anti-scatter grid and pixels at the focal spot.

Unfortunately, when two such detector modules are placed next to each other in the cradle, a gap exists therebetween along the z-axis direction due to the spherical geometry. A width of the gap varies in the z-axis direction, and the gap causes a section of missing data that may be difficult to derive via interpolation. Furthermore, the stacking of the individual components of each block may introduce, propagate and/or magnify a stacking error, which may make it difficult to align the anti-scatter grid with the focal spot. Moreover, a particular scanner may include a large number of detector modules (e.g., 42) and each detector module may include multiple (e.g., 16) blocks such that the scanner would need a relatively large number of individual anti-scatter grids (e.g., 672), which may increase labor cost at the anti-scatter grid fabrication facility and/or the CT detector system assembly facility.

Aspects of the present application address the above-referenced matters and others.

According to one aspect, an anti-scatter apparatus of an imaging system including a base with a plurality of detector tile receiving sub-regions consecutively abutted and aligned along a z-axis direction of the imaging system. A tile receiving sub-region is configured to receive a individual detector tile, which includes a matrix of photosensing pixels. The tile receiving sub-region includes a plurality of channels, which are respectively aligned with different ones of the photosensing pixels. A bracket is affixed to the base so that detector tiles installed in the plurality of tile receiving sub-regions are disposed between the bracket and the plurality of tile receiving sub-regions, thereby securing the installed detector tiles in the anti-scatter apparatus. A fastening portion fastens to a detector module cradle of the imaging system, thereby securing the anti-scatter apparatus to the imaging system. The fastening portion is fastened to the detector module cradle to focus the channels at a focal spot of a radiation source of the imaging system.

According to another aspect, an imaging method includes employing a single, unitary anti-scatter grid to concurrently block scatter radiation for a plurality of detector tiles aligned along a z-axis in a detector module of a detector array of an imaging system, wherein the grid includes a plurality of channels and each detector tile includes a matrix of photosensor pixels, and each channel aligns with a different photosensor pixels.

According to another aspect, an anti-scatter apparatus includes a plurality of detector tiles. A detector tile receiving region is configured to concurrently receive the plurality of detector tiles along a z-axis direction of the imaging system. A bracket is affixed to the detector tile receiving region. The plurality of detector tiles is disposed between the detector tile receiving region and the bracket. The anti-scatter apparatus carries the installed detector tiles.

According to another aspect, an anti-scatter apparatus includes at least two detector tiles. A detector tile receiving region extends in a longitudinal direction of an imaging system and is configured to concurrently receive the at least two detector tiles. Each detector tile includes a matrix of photosensor pixels. The detector tile receiving region includes at least one alignment feature that aligns at least one of the at least two detector tiles with the detector tile receiving region.

According to another aspect, an imaging system includes a radiation source that emits radiation, from a focal spot, that traverses an examination region and a detector array, located across from the radiation source opposite the examination region, that detects radiation that traverses the examination region and generates a signal indicative thereof. The detector array includes a plurality of detector modules arranged along a transverse direction, each detector module including a plurality of individual two dimensional detector tiles arranged along a longitudinal direction, and a plurality of anti-scatter grids, each anti-scatter grid extending over a corresponding detector module and the individual detector tiles therein. A reconstructor reconstructs the signal to generate volumetric image data.

The invention may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating the preferred embodiments and are not to be construed as limiting the invention.

FIGURE 1 illustrates an example imaging system.

FIGURE 2 illustrates an example anti-scatter grid.

FIGURE 3 illustrates an example portion of the anti-scatter grid.

FIGURE 4 illustrates an example detector module.

FIGURE 5 illustrates an exploded view of the example detector module.

FIGURE 6 illustrates a cross-sectional view of the example detector module.

FIGURE 7 illustrates another example detector module.

FIGURE 8 illustrates an example detector tile arrangement with respect to the anti-scatter grid.

FIGURE 9 illustrates another example detector tile arrangement with respect to the anti-scatter grid.

FIGURE 10 illustrates detector tile align features of an anti-scatter grid.

FIGURES 11 and 12 illustrate fastening techniques for fastening the anti-scatter grid to the module cradle.

FIGURE 13 illustrates a method.

Discussed herein is an anti-scatter grid. As described in greater detail below, the anti-scatter grid is a single unitary structure having a plurality of receiving regions along the z-axis direction, wherein each receiving region is configured to receive a single different detector tile. The anti-scatter grid is scalable or conformable in that the anti-scatter grid includes at least two tile receiving regions, with the number of receiving regions corresponding to the number of tiles in a particular detector module. The same technology is used to produce the anti-scatter grid regardless of the number of tile receiving regions. The anti-scatter grid includes an alignment feature for accurately aligning the scintillator of each tile with each tile receiving region. The anti-scatter grid includes fasteners for fastening the anti-scatter grid to a detector cradle of the scanner, allowing for accurate alignment of the anti-scatter grid with respect to the focal spot. The anti-scatter grid also includes tile fasteners for fastening the tiles to the anti-scatter grid. When tiles are fastened to the anti-scatter grid, the fasteners holds the tiles in place, the anti-scatter grid behaves as a module carrier. The anti-scatter grid also mounts to a detector cradle of the scanner, allowing for accurate alignment of the anti-scatter grid with respect to the focal spot. The foregoing illustrates examples of non-limiting features of the anti-scatter grid.

FIGURE 1 illustrates a computed tomography (CT) scanner 100 that includes a stationary gantry 102 and a rotating gantry 104, which is rotatably supported by the stationary gantry 102. The rotating gantry 104 rotates around an examination region 106 about a longitudinal or z-axis. A radiation source 112, such as an x-ray tube, is supported by and rotates with the rotating gantry 104 around the examination region 106. The radiation source 112 emits radiation from a focal spot, and a collimator 110 collimates the emitted radiation to produce a generally fan, wedge, or cone shaped radiation beam that traverses the examination region 106.

A radiation sensitive detector array 114 detects radiation that traverses the examination region 106. The radiation sensitive detector array 114 includes a plurality of detector modules 116 aligned in parallel in a transverse (x/y direction). A detector module 116 includes one or more detector mosaics or tiles. Each tile is aligned along the detector module 116 in parallel in the z-axis direction and includes a plurality of photosensors or pixels. In the illustrated example, the detector array 114 is populated with forty-two (42) detector modules 116, each detector module 116 is populated with sixteen (16) tiles, and each tile is populated with a matrix of sixteen (16) by sixteen (16) pixels. In other embodiments, other configurations of detector modules 116, tiles, and pixels can be used.

A tile generally includes a photosensor array (which includes a plurality of photo sensing pixels such as photodiodes or other optical sensors), a scintillator array (in optical communication with a light receiving region of the photosensor array) that converts impingent x-radiation into light such as visible light which is detected by the photosensor array, a substrate to which the photosensor array is supported, and read out electronics. A tile may alternatively include a direct conversion material such as a CZT or CdTe. With the illustrated detector array 114, the tiles are serially abutted together in the longitudinal direction to form a radiation sensitive surface. Any number of tiles can be abutted together. For example, in one instance, two (2) to twenty (20) tiles, such as sixteen (16) tiles, are abutted together in the longitudinal direction. A two-dimensional arrangement of tiles is also contemplated herein. For example, two or more tiles are additionally or alternatively abutted together in the transverse direction.

Examples of suitable tiles are described in US patent 6,510,195 B1 to Chappo et al., filed July 18, 2001, and entitled "Solid State X-Radiation Detector Modules and Mosaics Thereof, and an Imaging Method and Apparatus Employing the Same," which is incorporated herein by reference. Such tiles generally include a relatively low power application specific integrated circuits (ASIC) coupled to a backside of the tile, which is opposite the radiation receiving side of the tile. The tiles are four-side buttable, allowing any number of tiles to be combined to form a one or two dimensional tile configuration. The electronics are routed from the back of the tile to a printed circuit board (PCB) electrically coupled to the ASIC. The detector module 116 is readily scalable as the matrix of pixels can be extended by adding another tile(s) and using a PCB board that electrically contacts the ASIC of the additional tile(s).

The detector array 114 further includes a plurality of anti-scatter grids or apparatuses 118, which are disposed between the detector modules 116 and the incoming radiation. Each anti-scatter grid 118 is configured for and coupled to a single different detector module 116. As described in greater detail below, each anti-scatter grid 118 is a one piece or unitary, single anti-scatter grid 118 that includes individual channels that allow transmission radiation to pass through to corresponding pixels on corresponding tiles while blocking a substantial amount of scatter radiation from illuminating the pixels. The individual channels are focused in two dimensions at the focal spot. The illustrated anti-scatter grid 118 includes sixteen (16) channels in the transverse direction and two-hundred and fifty-six (256) channels in the longitudinal direction. Other embodiments include other numbers of channels, based on the number of detector tiles in the other embodiments.

A cradle 120, which is affixed to the rotating gantry 104, supports the anti-scatter grids 118 and the detector modules 116. As described in greater detail below, in the illustrated embodiment each anti-scatter grid 118 is operatively coupled to a detector module 116, and each anti-scatter grid 118 is operatively coupled to the cradle 120. The channels of the anti-scatter grid 118 are aligned with the focal spot and the pixels of the detector array 114.

A reconstructor 122 reconstructs the projection data and generates volumetric image data indicative of the examination region 106, including a portion of a subject residing therein. A patient support 126, such as a couch, supports the patient for the scan. A general purpose computing system 124 serves as an operator console. Software resident on the console 124 allows the operator to control the operation of the system 100.

As can be appreciated, using a one piece, focused anti-scatter grid 118 for each detector module 116 may reduce cost relative to manufacturing separate, focused anti-scatter blocks for each tile in a detector module 116 as a plurality of the same anti-scatter grid 118 can be manufactured and used with each detector module 116 instead of manufacturing different anti-scatter blocks for each individual tile of a detector module 116. Furthermore, by using focused channels, a straight rather than a curved anti-scatter grid can be used, which may mitigate any gaps between tilted adjacent detector modules, if tilted, as can occur when tilting adjacent curved detector modules. Of course, a curved anti-scatter grid can be used. Moreover, aligning the anti-scatter grid 118 with the focal spot when fastening the anti-scatter grid 118 to the cradle 120 may mitigate stacking alignment errors that can result from stacking an anti-scatter grid on a scintillator array, which is stacked on a photosensor array, which is stacked on a substrate, which is stacked on a heat sink, which is stacked on a module base, which is mounted to a carriage, etc. as with configurations in which the anti-scatter grid 118 is omitted. Furthermore, the anti-scatter grid 118 can be used as a carrier of the detector modules 116 and the detector tiles therein.

FIGURE 2 illustrates an example two-dimensional anti-scatter grid 118. The anti-scatter grid 118 includes a tile receiving region 202 and a base region 204, which supports the tile receiving region 202 and includes at least one fastening portion 206 used to fasten the anti-scatter grid 118 to the cradle 120 and/or other structure. As shown, the anti-scatter grid 118 is an elongate structure that extends in the longitudinal or z-axis direction with a shorter width that extends in the transverse direction. The length of any particular anti-scatter grid 118 depends on the number of detector tiles 210 in the corresponding detector module 116 and the number of tile pixels in the z-axis direction. The width of any particular the anti-scatter grid 118 depends on the number pixels in the corresponding tile along the transverse direction.

The tile receiving region 202 includes a plurality of photon passing channels defined by intersecting walls that extend in the transverse and longitudinal directions. FIGURE 3 illustrates a non-limiting sub-portion of the receiving region 202, showing examples of such walls and channels. In FIGURE 3, first walls 302 extend in the longitudinal direction and second walls 304 extend in the transverse direction. The walls 302 and 304 include a radiation absorbing material such as tungsten, tungsten alloy or other radiation absorbing material or alloy thereof. As shown, the walls 302 and 304 intersect, thereby creating a plurality of channels 306. The thickness of the walls may be about equal or different.

The first and second walls 302, 304 are spaced apart from each other with a pitch in accordance with the pixel footprint on the tiles. In the illustrated embodiment, the first walls 302 are spaced apart from each other with a pitch of about .5 to 3 millimeters (mm), and the second walls 304 are space apart from each other with a pitch of about .5 to

3 mm. A depth of the illustrated walls 302, 304 is about 5 to 50 mm. In other embodiments, other wall configurations and/or wall depths can be used. The walls 302 and 304 are angled along the depth so that each channel 306, when the detector array 114 is installed in the cradle 120 in the scanner 100, is focused at the focal spot.

A suitable wall material includes a tungsten-epoxy composite. A suitable technique for manufacturing such a structure includes Tomo Lithographic Molding™, which is a technology owned by the Mikrosystems Company of Virginia, USA. Other suitable techniques include, but are not limited to, casting with lead or other heavy metal, or laser sintering of metal, etc. As noted above, the anti-scatter grid is scalable or conformable to any number of tile receiving sub-regions 208. Using the foregoing technologies as well as other technologies, the number of tile receiving sub-regions 208 can be scaled for different platforms using the same manufacturing technologies. In one instance, this includes manufacturing the anti-scatter grid 118 to include a tile receiving sub-region 208 for each detector tile 210 in the detector module 116.

Returning to FIGURE 2, the illustrated anti-scatter grid 118 is partitioned into sixteen (16) individual tile receiving sub-regions 208, each configured to receive a single tile 210. In FIGURE 2, a single tile 210 is installed in one of the tile receiving sub-regions 208. In the illustrated example, the tile receiving sub-regions 208 lie substantially flat in a same plane. As noted above, such a configuration is possible as the individual channels 306 are focused at the focal spot as noted in connection with FIGURE 3.

One or more partitions can be created for a tile receiving sub-region 208 by extending outer walls 214 and 216 of the walls 302 and 304 and selective inner walls 212 of the walls 304 above the other walls of the walls 302 and 304 to generate a rim or form a recess into which a tile 210 can be received. By way of example, when each tile 210 includes sixteen (16) pixels in the longitudinal direction, every sixteenth (16) inner wall 304 would extend above the preceding fifteen (15) walls 304 and/or the succeeding fifteen (15) inner walls 304. In one instance, the rim or recess provides an alignment feature that facilitates suitably aligning a tile 210 with the anti-scatter grid 118.

As noted above the illustrated anti-scatter grid 118 is a single, unitary structure for the detector module 116. Stated another way, the walls 302 and 304 form a single, two-dimensional grid for a single detector module 116 having two or more detector tiles attached thereto, wherein the one piece grid is used as the anti-scatter grid 118 for the two or more tiles 210 of the detector module 116. This is in contrast to a configuration in which separate and distinct anti-scatter blocks are respectively attached individual tiles in a detector module.

In this example, the fastening portion 206 protrudes out of the ends of the base member 204 in the longitudinal direction of the grid 118. The fastening portion 206 includes at least one material free region 208 through which a fastener such as a screw, a bolt, a rivet, a pin, or the like may extend through to secure the anti-scatter grid 118 to the cradle 120. For example, a bolt may extend through fastening member 206 and threadably engage a corresponding threaded portion which is part of or affixed to the cradle 120 or a nut on an opposing side of the cradle. The fastening portion 206 can be variously affixed to the cradle, for example, in a matter in which the channels 306 of the anti-scatter grid 118 align with the focal spot. This is in contrast to configurations in which an anti-scatter grid only attaches to the scintillator of a stacked detector tile or otherwise affixed to the tile without being affixed to the cradle 120.

The detector tile 210 can be variously secured to the anti-scatter grid 118. Examples of suitable techniques include clamping, adhering, mounting, etc. the tile 210 to the anti-scatter grid 118. In the illustrated embodiment, a mounting bracket is used to secure the tile 210 to the anti-scatter grid 118. This is shown in connection with FIGURES 4 and 5, where a bracket 402 engages the anti-scatter grid 118 such that the tiles 210 are sandwiched therebetween. The bracket 402 is secured to the anti-scatter grid 118 via a fastener such as a bolt, a screw, a rivet, or the like. In one instance, the bracket 402 is a metal backbone affixed to the anti-scatter grid 118, which in turn secures the tiles 210 to the anti-scatter grid 118. Such a backbone may also provide increased structural support to the module 116. FIGURE 5 shows an exploded view in which fasteners 502 secure the bracket 402 to a fastening member 206.

With further respect to FIGURES 4 and 5, the bracket 402 includes a plurality of material free regions 408. Each of the material free regions 408 is positioned over a tile receiving sub-region 208. A fastener, such as a plug 504 (FIGURE 5), inserts into the at least one of the plurality of material free regions 408 and urges a tile 210 inserted into the tile receiving sub-region 208 towards the tile receiving sub-region 208, which secures the tile 210 in place. In one instance, the material free region 408 and the fastener 504 are threaded and the fastener 504 screws into the material free region 408.

The signals from the read out electronics of the tile 210 are routed off the back of the tile 210 to a first outer side of the anti-scatter grid 118. A circuit board 404 is affixed to the first side via fastener 406 such as a bolt, a screw, a rivet or the like. The circuit board 404 is in electrical communication with the tiles 210, for instance, with the read out electronics of the tiles 210. Attaching the bracket 402 to the anti-scatter grid 118 holds the tiles 210 in place. As such, the ant-scatter grid 118 can be used as a module carrier when the bracket 402 is attached to the anti-scatter grid 118.

FIGURE 6 shows a cross sectional view along line A-A of FIGURE 4. As shown in FIGURE 6, a portion of the tile 210 sits in the recess defined by the outer walls 214, with a scintillator array 602 of the tile 210 positioned up against the channels 306 and walls (302, 204) of the tile receiving sub-region 208. The plug 504 within the material free region 408 of the backbone 402 is up against and urges the tile 210 towards the tile receiving sub-region 208 of the anti-scatter grid 118, thereby securing the tile 210 to the anti-scatter grid 118. Electronics 604 electrically couples read out electronics 606 of the tile 210 and the circuit board 404, which is mounted to the anti-scatter grid 118 in FIGURE 6 via standoffs and the fasteners 406.

Variations and/or alternatives are discussed.

As discussed above, the illustrated anti-scatter grid 118 is a one piece, single unitary structure. In another embodiment, the anti-scatter grid 118 is formed by stacking individual anti-scatter layers, wherein each layer is configured for a single detector module 116. For instance, in the example above the anti-scatter grid 118 is twenty-seven (27) mm. In a stacking embodiment, such an anti-scatter gird 118 can be formed by stacking twenty-seven (27) one (1) mm layers or another combination of two or more anti-scatter layers.

The illustrated example includes forty-two (42) detector modules, each having sixteen (16) tiles. In another embodiment, the anti-scatter grid 118 is a one piece, single unitary block configured for more than one detector module 116, including all or a sub-set of the forty-two (42) detector modules 116, or all or a sub-set of the six hundred and seventy-two (672) tiles 210.

In the above embodiment, the tile 210 includes the scintillator array 602, and the scintillator 602 is aligned with the tile receiving region 202 of the anti-scatter grid 118. In another embodiment, the scintillator 602 is first aligned with and affixed to the anti-scatter grid 118, and then the tile photodiode is aligned with and affixed to the scintillator array 602. The alignment features described herein can also be used with this embodiment.

In the above embodiment, the tiles 210 are mounted to the anti-scatter grid 118 via tile receiving sub-regions 208 that generally lie flat in the same plane. In an alternate embodiment, one or more of the tile receiving sub-regions 208 are angled or tilted toward the focal spot as shown in FIGURE 7. Generally, the magnitude of the tilt angle of a tile receiving sub-region 208 increases with the distance from the center tile receiving sub-regions 208, or the tile receiving sub-regions 208 located in the path of the center ray of the radiation beam.

As a consequence, the tiles 210 affixed to the anti-scatter grid 118 are also angled or tilted toward the focal spot. In one instance, the tile receiving sub-regions 208 are titled such that the radiation sensitive face of one or more of the tiles 210 is substantially normal to a line connecting the center of the tile face and the focal spot. As a result, x-rays traversing paths that are substantially perpendicular to the pixels illuminate the pixels, which may result in a more uniform x-ray responsivity along the z-axis and/or less artifacts relative to the non-tilted configuration.

In another embodiment, the anti-scatter grid 118 is curved along the longitudinal direction. Similar to the tilted tile receiving sub-region 208 configuration, with the curved anti-scatter grid 118, x-rays traversing paths that are substantially perpendicular to the pixels illuminate the pixels, which may result in a more uniform x-ray responsivity along the z-axis and/or less artifacts relative to the non-tilted configuration. One or more of the tiles 210 may or may not be tilted in this embodiment.

FIGURES 8 and 9 respectively show a first anti-scatter grid 118 with substantially flat tile receiving sub-regions 208 and a second anti-scatter grid 118 with tilted tile receiving sub-regions 208. In both examples, tiles 210 are shown in the tile receiving sub-regions 208. Regarding Figure 9, when configured with an even number of receiving sub-regions 208, all or substantially all of the receiving sub-regions 208 are tilted to some extent. In the illustrated embodiment, the tilt angle between adjacent receiving sub-regions 208 is about .5 to 2 degrees. By way of example, in one non-limiting instance the tilt angles for 8 receiving sub-regions 208, from one end to the other, are -3.5, -2.5, -1.5, -0.5, +0.5, +1.5, +2.5 and +3.5 degrees. For an odd number of receiving sub-regions 208, in one instance, at least the receiving sub-region 208 for a center tile is not tilted.

In the above example, the outer walls 302 and 304 and selective inner walls 212 defined a rim or recess around each tile receiving sub-region 208 that can be used to align the anti-scatter grid 118 and the tiles 210. In FIGURE 10, a different set 802 of the walls 302 and 304 for one or more of the tile receiving sub-regions 208 is extended above the other walls 302 and 304. Likewise, the walls 802 can be used to align the anti-scatter grid 118 and the tile 210, for example, where the tiles 210 include a complementary set of grooves. Of course, a different set of the walls 302 and 304, including more or less of the walls 302 and 304 can be used in other embodiments. Additionally or alternatively, other alignment features may be used.

FIGURES 11 and 12 illustrate alternative approaches for fastening the anti-scatter grid 118 to the cradle 120. In FIGURE 11, the anti-scatter grid 118 includes at least one protrusion such as a pin 1102 or other member, which extends into a corresponding material free region not shown is located in the cradle 120 when anti-scatter grid 118 is installed in the cradle 120. The embodiment in FIGURE 12 includes a combination of the material free region 208 and the at least one pin 1102. Examples of these approaches are discussed in US 6,778,637, filed on September 20, 2002, and entitled “Method and apparatus for alignment of anti-scatter grids for computed tomography detector arrays,” the entirety of which is incorporated herein by reference.

FIGURE 13 illustrates a method. At 1302, radiation is emitted from a focal spot of the radiation source 112. At least some of the radiation traverses the examination region 106 and travels towards the detector array 114. At 1304, radiation traversing the examination region 106 is filtered via the anti-scatter grid 118, which is located between the focal spot and the detector array 114. At 1306, radiation traversing through the channels of the anti-scatter grid 118 illuminates the scintillator array 602, which converts the radiation to light. At 1308, the pixels of the detector tiles 210 receive the light and generate electrical signals indicative thereof. At 1310, the signals are transferred off the detector array 114. The signals can be reconstructed to generate volumetric image data, which can be used to generate one or more images indicative of the examination region 106.

The anti-scatter grid described herein is applicable to various imaging applications, including CT scanners and/or other modality scanners. It is well-suited for scanners with more than 40 mm of coverage where two dimensional anti-scatter grids provide suitable scatter reduction. The anti-scatter grid is also well-suited for scanner with less than and more than 40 mm of coverage.

The invention has been described herein with reference to the various embodiments. Modifications and alterations may occur to others upon reading the description herein. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

CLAIMS

We claim:

1. An anti-scatter apparatus (118) of an imaging system (100), comprising:

a base (204) including a plurality of detector tile receiving sub-regions (208) consecutively abutted and aligned along a z-axis direction of the imaging system (100), wherein a tile receiving sub-region (208) is configured to receive a individual detector tile (210), which includes a matrix of photosensing pixels, and the tile receiving sub-region (208) includes a plurality of channels (306), which are respectively aligned with different ones of the photosensing pixels; and

a fastening portion (206, 1102) which fastens to a detector module cradle (120) of the imaging system (100), thereby securing the anti-scatter apparatus (118) to the imaging system (100), wherein the fastening portion (206, 1102) is fastened to the detector module cradle (120) so as to focus the channels (306) at a focal spot of a radiation source (112) of the imaging system (100).

2. The apparatus of claim 1, wherein the channels (306) are substantially parallel to each other and substantially perpendicular to the base (204).

3. The apparatus of claim 1, wherein at least two of the channels (306), along the z-axis direction, are tilted with respect to the base (204) to align with the focal spot.

4. The apparatus of any of claims 1 to 3, wherein the plurality of tile receiving sub-regions (208) lie flat in a substantially same plane of the anti-scatter grid (118).

5. The apparatus of any of claims 1 to 3, wherein at least two of the plurality of tile receiving sub-regions (208) are tilted about a transverse direction at different tilt angles.

6. The apparatus of claim 5, wherein the at least two of the plurality of tile receiving sub-regions (208) are tilted to align with the focal spot.

7. The apparatus of any of claims 1 to 6, wherein at least one of the tile receiving sub-regions (208) includes a tile alignment feature which aligns the tile (210) and the tile receiving sub-region (208).

8. The apparatus of claim 7, wherein the tile alignment feature includes a protrusion (802) which extends into a corresponding material free region in the tile (210).

9. The apparatus of claim 7, wherein the tile alignment feature includes a protrusion (214, 216) which creates a recess which aligns the tile (210) and the tile receiving sub-region (208).

10. The apparatus of any of claims 1 to 9, wherein the anti-scatter grid (118) carries the installed tiles (210).

11. The apparatus of any of claims 1 to 10, wherein the fastening portion (206, 1102) includes at least one of a protrusion (1102) which extends into a corresponding material free region of the cradle (120) or a recess (220) which receives a protruding member to secure the anti-scatter gird (118) to the cradle (120).

12. An imaging method, comprising:

employing an anti-scatter grid (118) to concurrently block scatter radiation for a plurality of detector tiles (210) aligned along a z-axis in a detector module (116) of a detector array (114) of an imaging system (100), wherein the grid (118) includes a plurality of channels (306) and each detector tile (210) includes a matrix of photosensor pixels, and each channel (306) aligns with a different photosensor pixels.

13. The method of claim 12, further including aligning the grid (118) at a focal spot emitting radiation filtered by the grid (118).

14. The method of claim 13, further including focusing the channels of the grid (118) at the focal spot.

15. The method of any of claims 12 to 14, further including using an alignment feature of the grid (118) to align a detector tile (210) with the grid (118).

16. The method of any of claims 12 to 15, further including affixing the grid (118) to the imaging system (100).

17. The method of any of claims 12 to 16, further including affixing the detector module (116) to the grid (118).

18. The method of any of claims 12 to 17, wherein in the anti-scatter grid (118) is a two dimensional one piece anti-scatter grid (118) with a continuous one to one relationship with the plurality of detector tiles (210).

19. An anti-scatter apparatus (118), including:

a plurality of detector tiles (210);

a detector tile receiving region (202) configured to concurrently receive the plurality of detector tiles (210) along a z-axis direction of an imaging system (100); and

a bracket (402) affixed to the detector tile receiving region (202), wherein the plurality of detector tiles (210) are disposed between the detector tile receiving region (202) and the bracket (402),

wherein the anti-scatter apparatus (118) carries the installed detector tiles (210).

20. The apparatus of claim 19, wherein the bracket (402) secures the plurality of detector tiles (210) in the anti-scatter grid (118).

21. The apparatus of any of claims 19 to 20, further including a tile fastener (504), which urges a detector tile (210) toward the detector tile receiving region (202).

22. The apparatus of claim 21, wherein the bracket (402) includes a threaded material free region (408) and the tile fastener (504) includes a threaded portion, and the threaded portion of the tile fastener (504) fixedly engages the threaded material free region (408), thereby holding the tile fastener (504) against the detector tile (210).

23. The apparatus of any of claims 19 to 22, further including a fastening portion (206, 1102) which fastens the anti-scatter grid (118) to the imaging system.

24. An anti-scatter apparatus (118), including:

at least two detector tiles (210); and

a detector tile receiving region (202) extending in a longitudinal direction of an imaging system and configured to concurrently receive the at least two detector tiles (210), wherein each detector tile (210) includes a matrix of photosensor pixels, wherein the detector tile receiving region (202) includes at least one alignment feature (214, 216, 802) that aligns at least one of the at least two detector tiles (210) with the detector tile receiving region (202).

25. The apparatus of claim 24, wherein the tile alignment feature includes a protrusion (802) which extends into a corresponding material free region in the tile (210).

26. The apparatus of claim 24, wherein the tile alignment feature includes a protrusion (214, 216) which creates a recess which aligns the tile (210) and the tile receiving sub-region (202).

27. An imaging system (100), comprising:

a radiation source (112) that emits radiation, from a focal spot, that traverses an examination region (106);

a detector array (114), located across from the radiation source (112) opposite the examination region (106), that detects radiation that traverses the examination region (106) and generates a signal indicative thereof, the detector array (114), including:

a plurality of detector modules (116) arranged along a transverse direction, each detector module (116) including a plurality of individual two dimensional detector tiles (210) arranged along a longitudinal direction; and

a plurality of anti-scatter grids (118), each anti-scatter grid (118) continuously extending over a corresponding detector module (116) and the individual detector tiles (210) therein; and a reconstructor (122) that reconstructs the signal to generate volumetric image data.

28. The imaging system (100) of claim 27, wherein the anti-scatter grid (118) includes a plurality of tile receiving regions (208) that lie flat in a same plane, and each of the tile receiving regions (208) receives an individual tile (210) of the corresponding plurality of tiles (210).

29. The imaging system (100) of claim 27, wherein the anti-scatter grid (118) includes a plurality of tile receiving regions (208) that are focused at the focal spot, and each of the tile receiving regions (208) receives an individual tile (210) of the corresponding plurality of tiles (210).

30. The imaging system (100) of any of claims 27 to 29, wherein at least one of the at least two plurality of tile receiving regions (208) includes a tile alignment feature (214, 216, 802) that facilitates aligning a tile (210) with the at least one of the plurality of tile receiving regions (208).

31. The imaging system (100) of any of claims 27 to 30, wherein the anti-scatter grid (118) includes a mounting member (206, 1102), and the anti-scatter grid (118) is mounted to the scanner, via the mounting member (206, 1102).

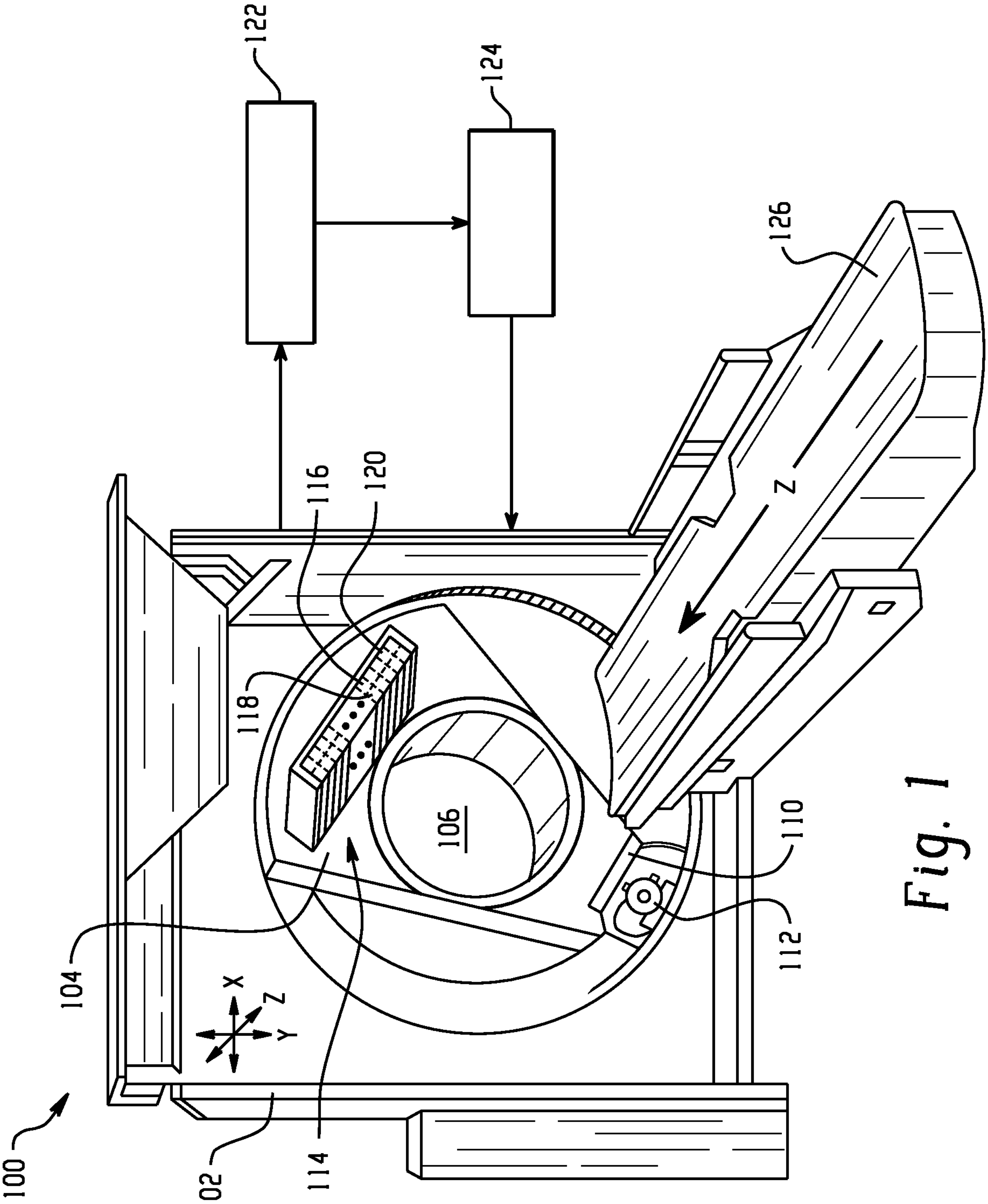

Fig. 1

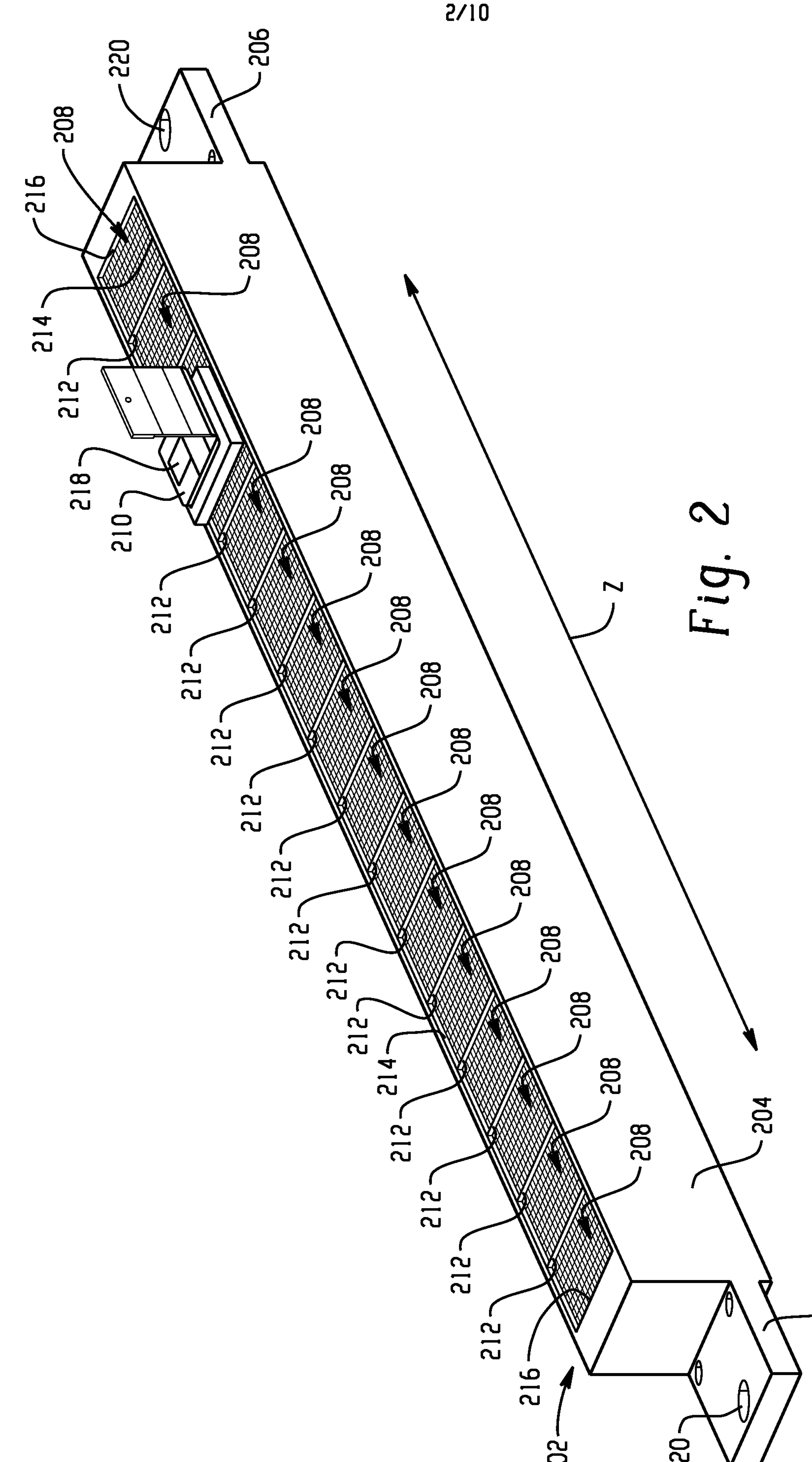

Fig. 2

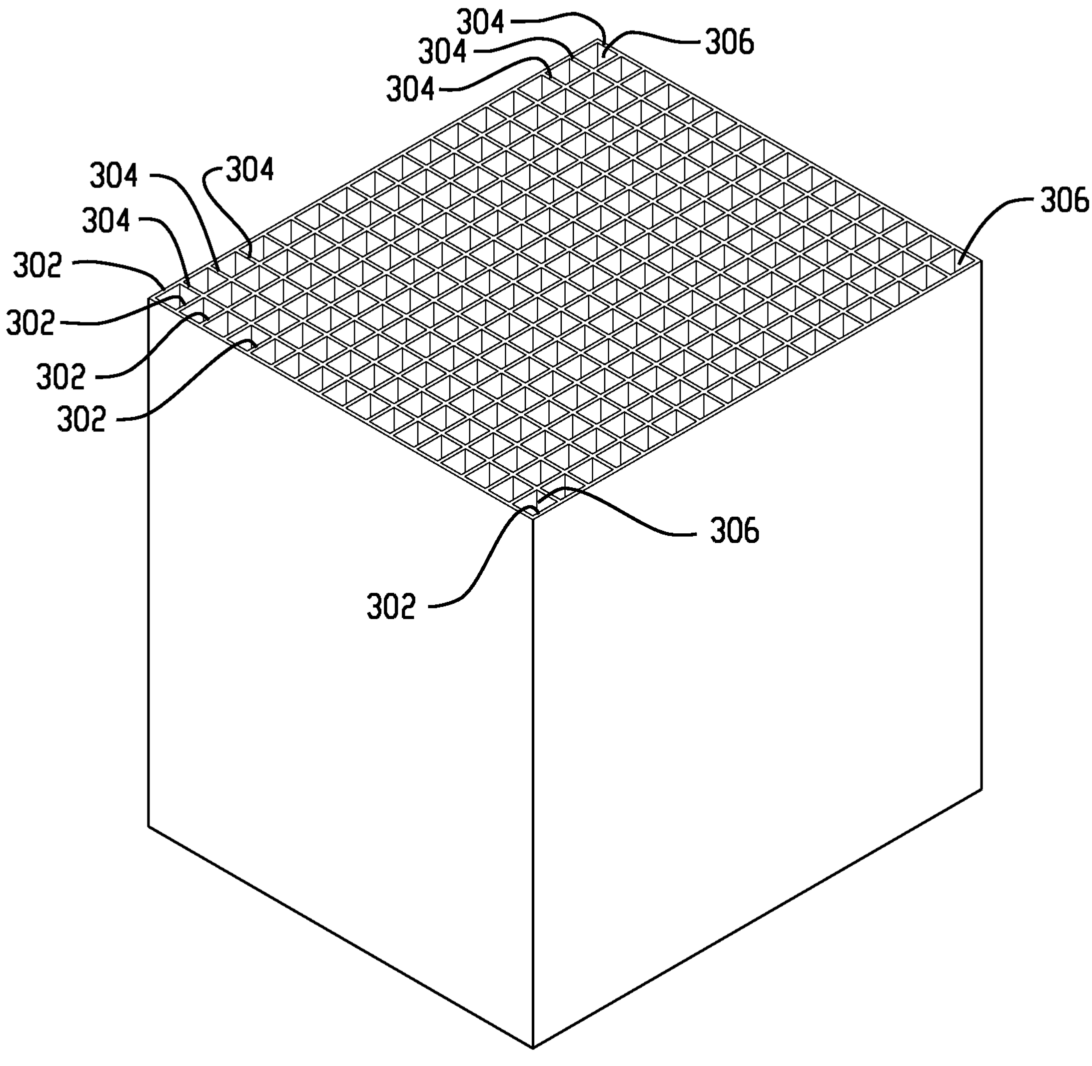

Fig. 3

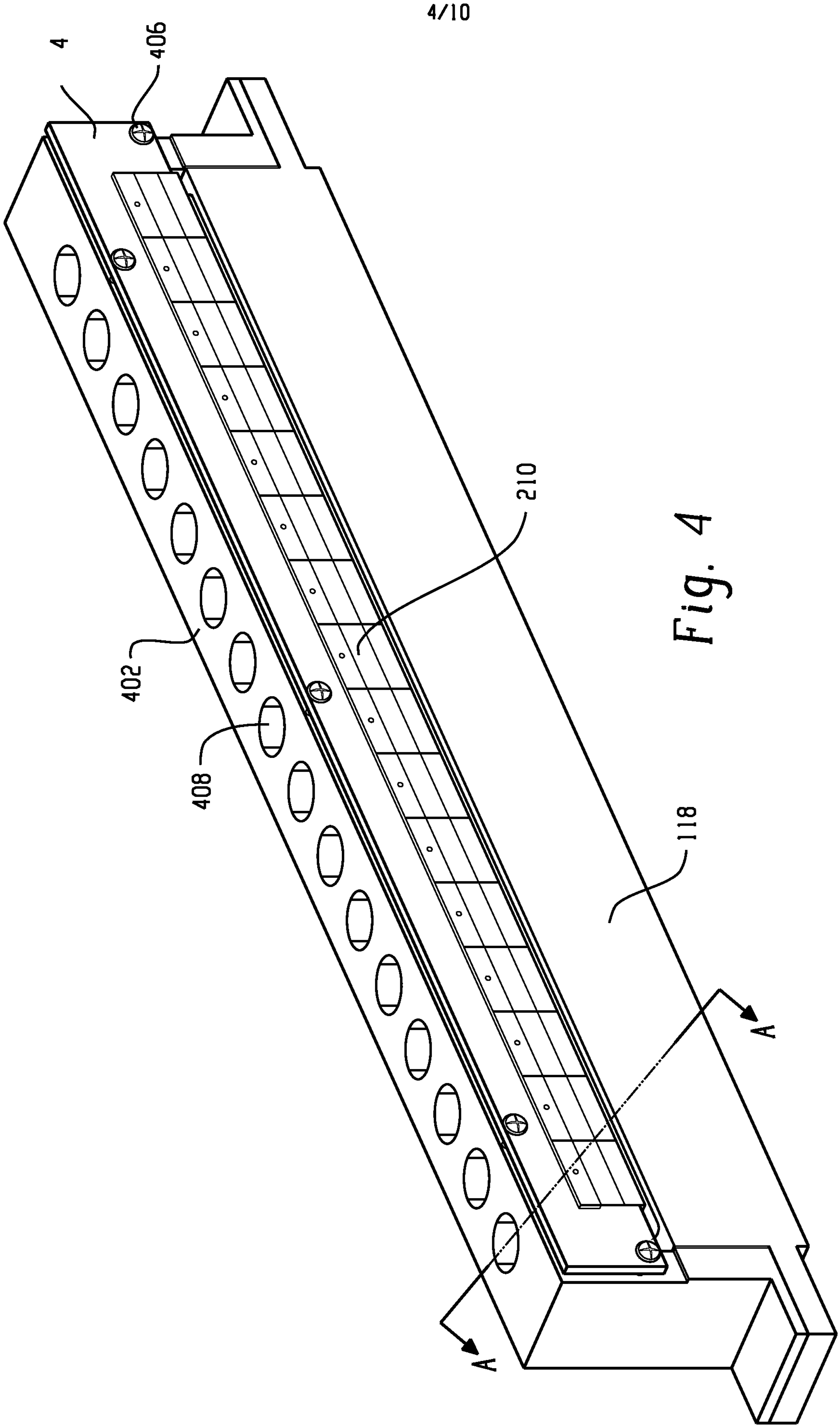

Fig. 4

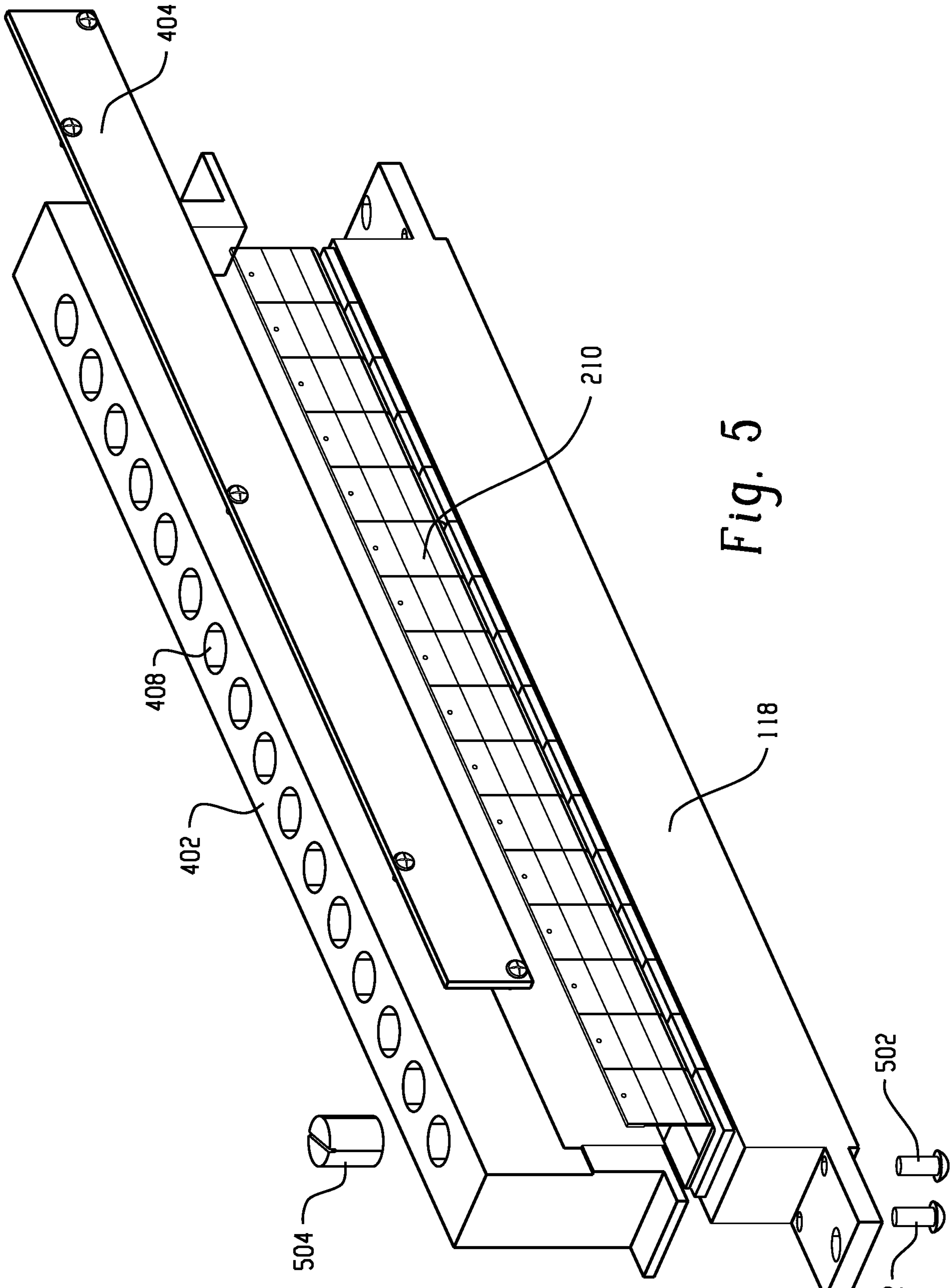

Fig. 5

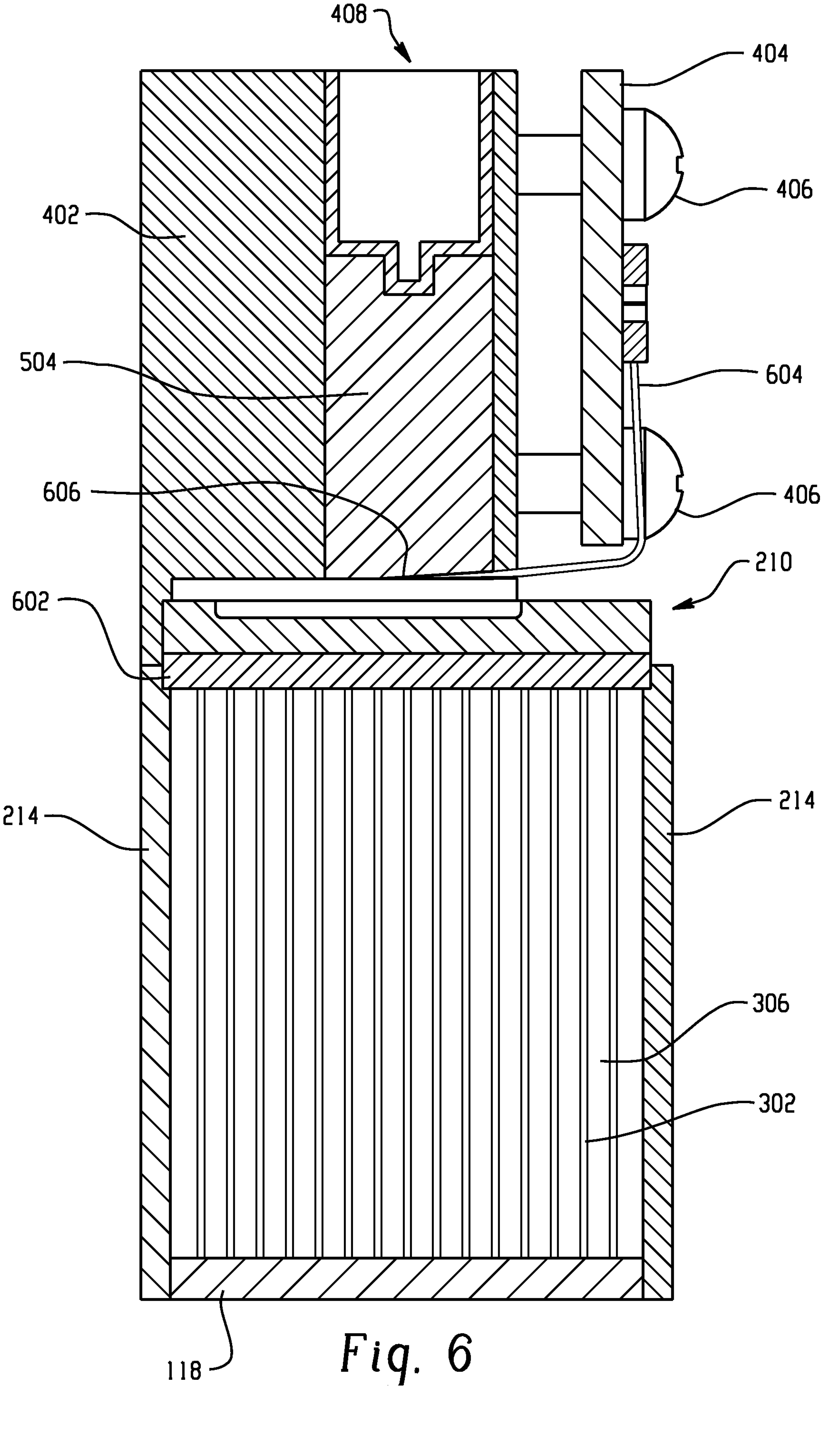

Fig. 6

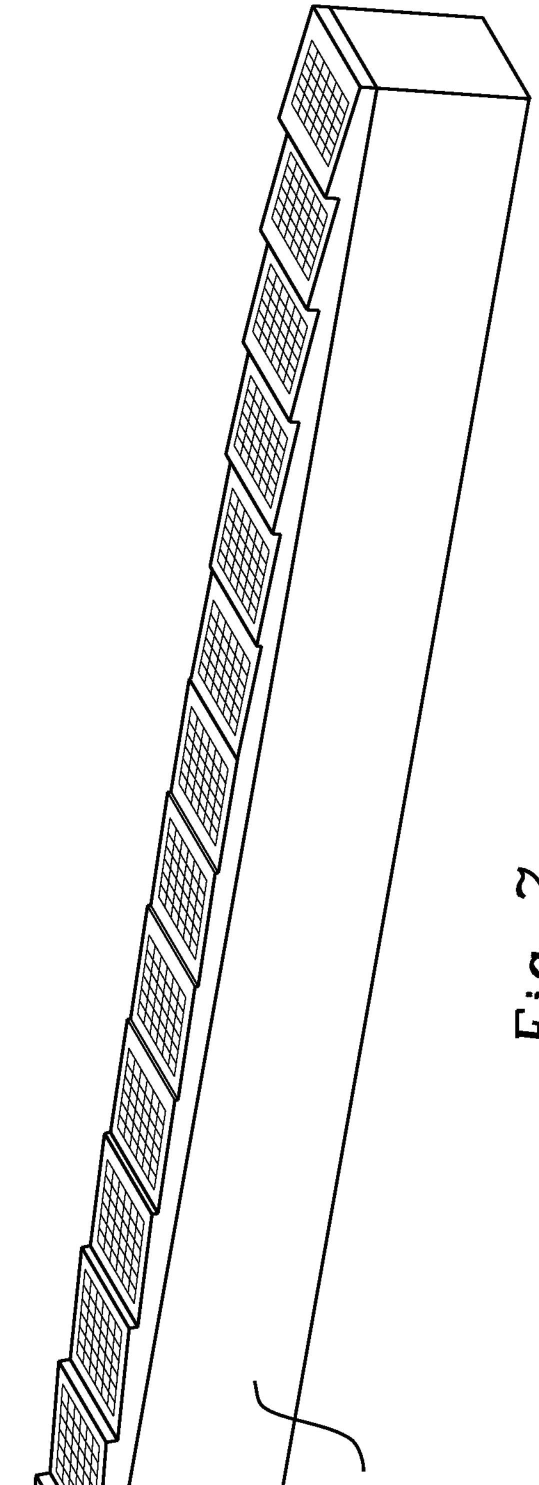

Fig. 7

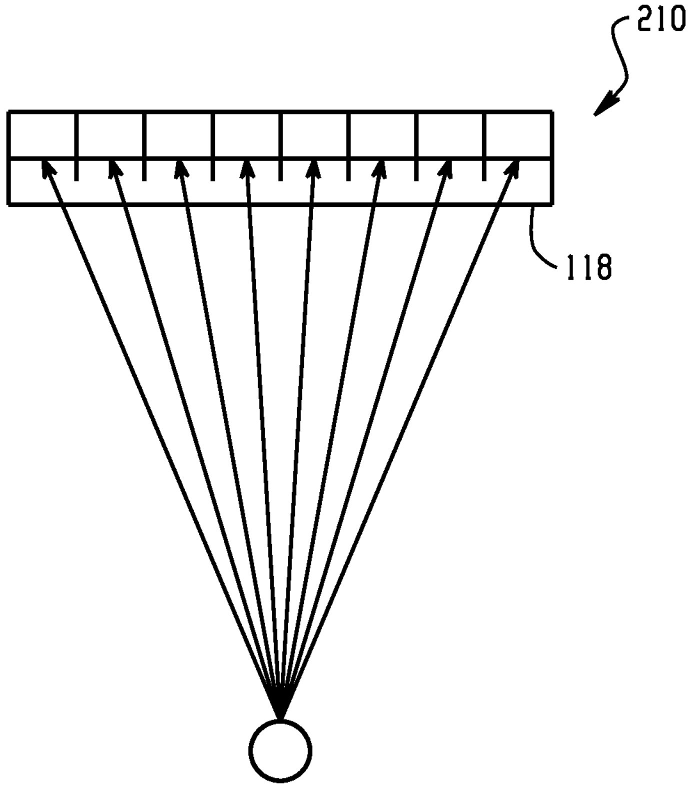

Fig. 8

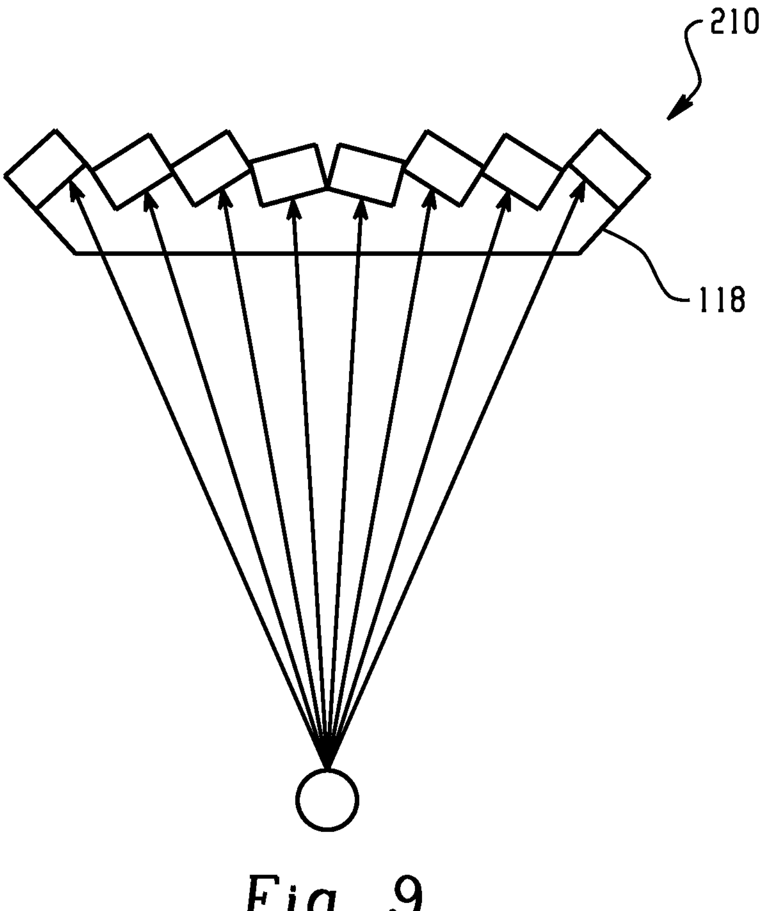

Fig. 9

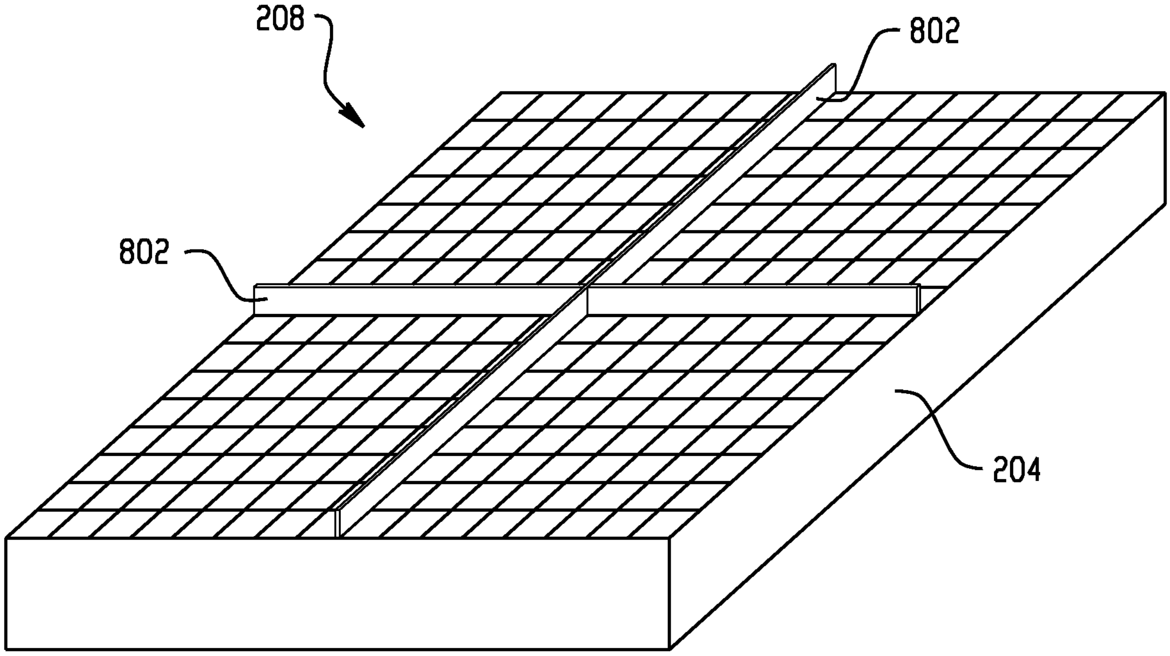

Fig. 10

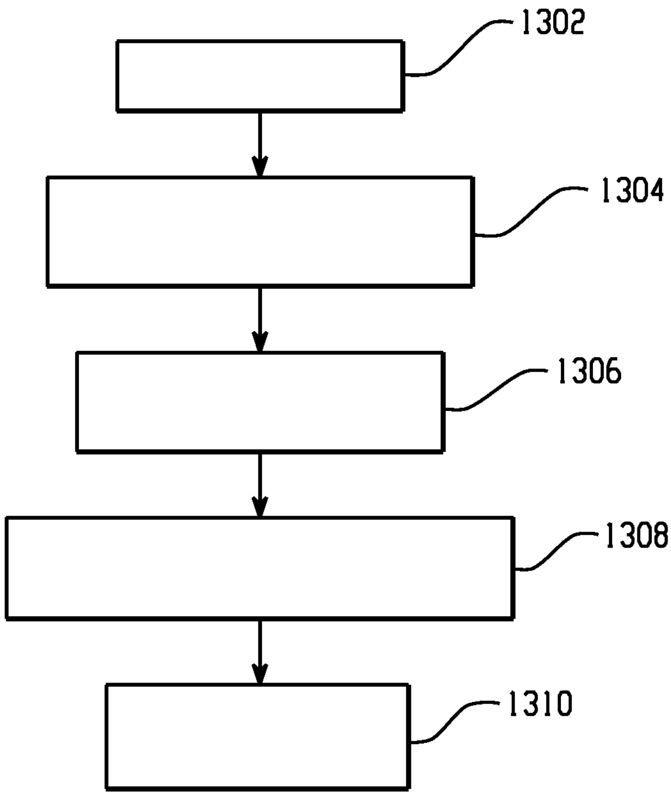

Fig. 13

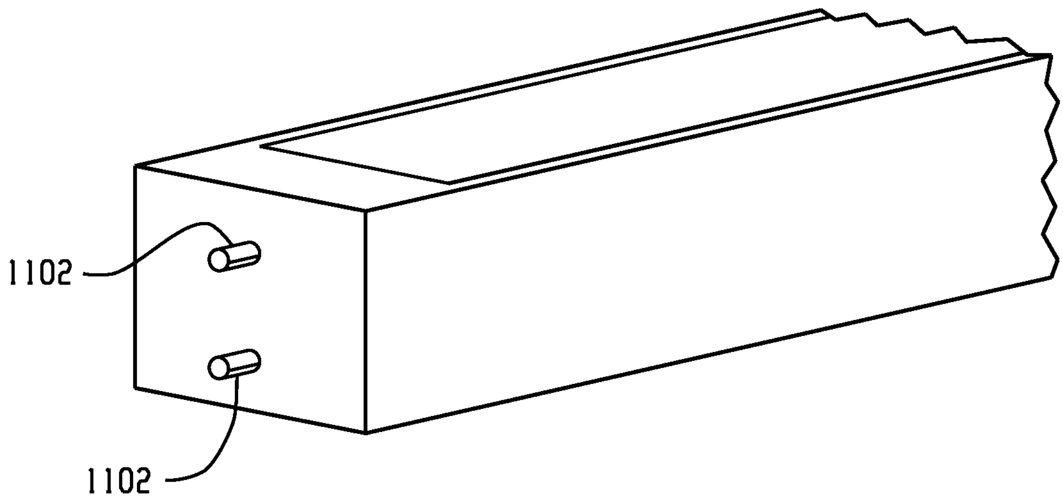

Fig. 11

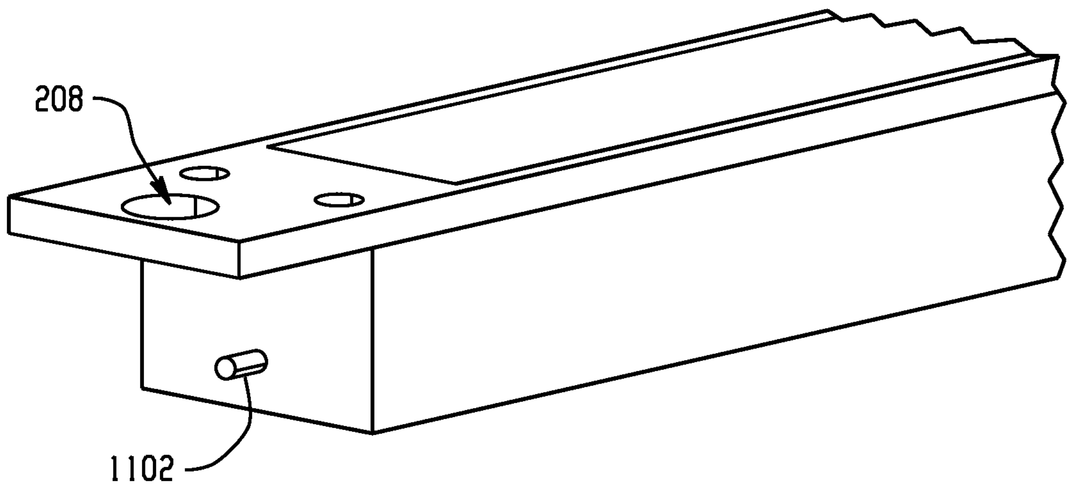

Fig. 12

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/052671

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B6/06 G21K1/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B G21K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2005/161608 A1 (HEISMANN BJOERN [DE]) 28 July 2005 (2005-07-28) the whole document	1-31
X	WO 2005/027143 A (PHILIPS INTELLECTUAL PROPERTY [DE]; KONINKL PHILIPS ELECTRONICS NV [NL) 24 March 2005 (2005-03-24) figures 6,7,9 page 4, line 5 - line 24 page 7, line 19 - page 8, line 20	1-11, 19-31
X	US 6 134 301 A (MRUZEK MICHAEL THOMAS [US] ET AL) 17 October 2000 (2000-10-17) figure 11 column 5, line 45 - line 65 column 9, line 10 - line 35	1-11, 19-31

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 August 2009	02/09/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Bengtsson, Johan

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2009/052671

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007/025518 A1 (LEVENE SIMHA [IL] ET AL) 1 February 2007 (2007-02-01) figures 1,2 paragraphs [0034] - [0037] -----	1-11, 19-31

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2009/052671

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			JP	2006526761	T	24-11-2006