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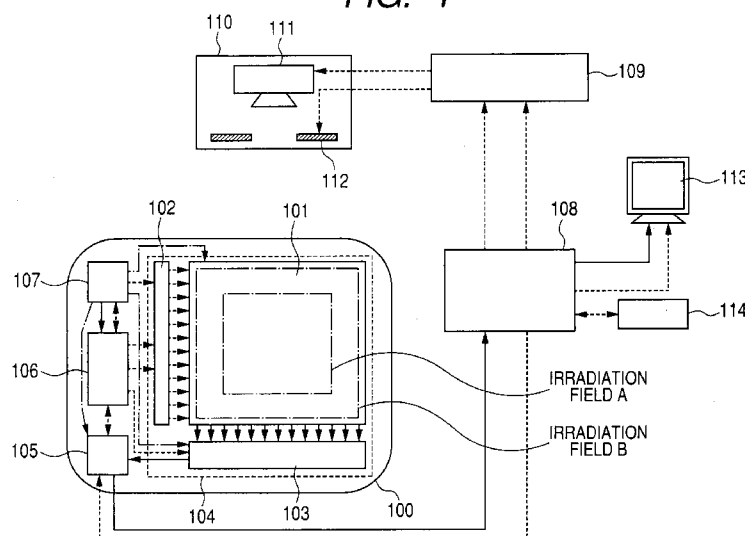
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(54) Title: IMAGING APPARATUS AND IMAGING SYSTEM, AND CONTROL METHOD AND PROGRAM FOR THE SAME

FIG. 1



(57) Abstract: An imaging apparatus 100 includes a detector 104 having a plurality of pixels arranged in a matrix and performing an imaging operation of outputting image data according to the radiation or light emitted in a predetermined irradiation field; and a controller unit 106, and performs a first imaging operation for outputting image data according to the radiation in a narrower irradiation field A corresponding to part of pixels and a second imaging operation for outputting image data according to the radiation in a wider irradiation field B, under controlling the detector to perform an accumulation operation during the second imaging operation so that a step of image is a preliminarily set tolerable quantity.



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DESCRIPTION

IMAGING APPARATUS AND IMAGING SYSTEM, AND CONTROL METHOD
AND PROGRAM FOR THE SAME

5

TECHNICAL FIELD

The present invention relates to an imaging apparatus and an imaging system, and a control method and a program for the same. More specifically, the present invention
10 relates to a radiation imaging apparatus and a radiation imaging system, and a control method and a program for the same preferably used for still image radiographing such as radiography and moving image radiographing such as
fluoroscopic imaging in medical diagnosis. Note that the
15 term radiation according to the present invention should include not only α radiation, β radiation, and γ radiation which are beams composed of particles (including photons) released by radioactive decay but also beams having the
same or more energy such as X rays, particle radiation, and
20 cosmic rays.

BACKGROUND ART

As an imaging apparatus for use in medical image diagnosis and non-destructive inspection using X rays,
25 recent years have seen the practical application of a radiation imaging apparatus using a flat panel detector (FPD) formed of semiconductor materials. For example, in

medical image diagnosis, the radiation imaging apparatus has been used as a digital imaging apparatus for still image radiographing such as radiography and moving image radiographing such as fluoroscopic imaging.

5 With regard to such a radiation imaging apparatus, Patent Citation 1 investigates a radiation imaging apparatus capable of switching the FPD-read area (size of field of view) and the X-ray irradiation area. However, when switching is made so as to widen the irradiation area, 10 the pixel sensitivity and the output under a dark state are different between the irradiated area and the non-irradiated area of the FPD. Consequently, a ghost (step of image) affected by the irradiation area occurs in the acquired image, which may lead to degradation of image 15 quality.

To avoid such a ghost affected by the irradiation area, Patent Citation 2 investigates performing image processing for correction. Specifically, a ghost correction coefficient is calculated for each X-ray 20 irradiation condition based on ghost data obtained by uniform irradiation. The ghost correction coefficient is used to acquire a required ghost correction coefficient corresponding to the X-ray irradiation condition and the elapsed time from the start of the X-ray irradiation when 25 data about the target portion of inspection object, which is the irradiation area, is collected. Then, correction image data is generated by correcting the data about the

target portion of inspection object by the required ghost correction coefficient.

Patent Citation 1: Japanese Patent Application Laid-Open No. H11-128213

5 Patent Citation 2: Japanese Patent Application Laid-Open No. 2008-167846

DISCLOSURE OF THE INVENTION

Technical Problem

10 However, the correction technique disclosed in Patent Citation 2 uses image processing for correction, and thus involves complicated parameter management and correction processing, thereby complicating the entire apparatus. In addition, data acquisition for correction is required in
15 advance, leading to complicated operation. Moreover, in order to obtain stable image quality, strict management needs to be in place for the data collection method, leading to difficult management. Further, the correction technique does not reduce the after-image quantity itself
20 which causes the above ghost and is contained in an image signal obtained from the FPD, and thus it is difficult to obtain an optimal effect under various circumstances.

Solution of Problem

The present inventors have made zealous studies so as
25 to provide an imaging apparatus and a system which can reduce a step of image which may occur in an obtained image and is affected by an irradiation area and can prevent

remarkable degradation of image quality without performing complicated image processing. As a result of zealous studies, the inventors have envisioned the embodiments as described below.

5 According to an aspect of the present invention, an imaging apparatus comprises: a detector including a plurality of pixels arranged in a matrix, wherein each of the pixels includes a conversion element for converting a radiation or a light into an electric charge, such that the
10 detector performs an imaging operation for outputting an image data based on an irradiation with the radiation or the light, and a controller unit for controlling operations of the detector including the imaging operation, wherein the imaging operation includes a first imaging operation
15 for outputting an image data based on the irradiation with the light or the radiation on a first irradiation field of the detector corresponding to a part of the plurality of pixels, and a second imaging operation for outputting an image data based on the irradiation with the light or the
20 radiation on a second irradiation field of an area larger than that of the first irradiation field, and
the controller unit controls the operation of the detector unit so that the detector performs the accumulation operation in the second imaging operation during an
25 accumulation period determined by an arithmetic operation to suppress a step of image within a predetermined tolerable quantity or smaller, based on an information

relating to an integral dose of the radiation or the light during the first imaging operation.

According to another aspect of the present invention, an imaging system comprises: an imaging apparatus
5 comprising a detector including a plurality of pixels arranged in a matrix, wherein each of the pixels includes a conversion element for converting a radiation or a light into an electric charge, such that the detector performs an imaging operation for outputting an image data based on an
10 irradiation with the radiation or the light, and a controller unit for controlling operations of the detector including the imaging operation; and a controlling computer for controlling the imaging apparatus, wherein the imaging operation includes a first imaging operation for outputting
15 an image data based on the irradiation with the light or the radiation on a first irradiation field of the detector corresponding to a part of the plurality of pixels, and a second imaging operation for outputting an image data based on the irradiation with the light or the radiation on a
20 second irradiation field of an area larger than that of the first irradiation field, the controlling computer performs an arithmetic operation so as to suppress a step of image within a predetermined tolerable quantity or smaller, based on an information relating to an integral dose of the
25 radiation or the light during the first imaging operation, and supplying the controller unit with a control signal based on an accumulation period determined by the

arithmetic operation, and the controller unit controls the operation of the detector unit so that the detector performs the accumulation operation in the second imaging operation during the accumulation period determined by the arithmetic operation.

According to a still another aspect of the present invention, a controlling method of an imaging apparatus comprises: a detector including a plurality of pixels arranged in a matrix, wherein each of the pixels includes a conversion element for converting a radiation or a light into an electric charge, such that the detector performs an imaging operation for outputting an image data based on an irradiation with the radiation or the light, wherein the controlling method controls operations of the detector including the imaging operation and comprises: a first imaging operation for outputting an image data based on the irradiation with the light or the radiation on a first irradiation field of the detector corresponding to a part of the plurality of pixels; and a second imaging operation, conducted following to the first imaging operation, for outputting an image data based on the irradiation with the light or the radiation on a second irradiation field of an area larger than that of the first irradiation field, during an accumulation period determined by an arithmetic operation to suppress a step of image within a predetermined tolerable quantity or smaller, based on an information relating to an integral dose of the radiation

or the light during the first imaging operation.

According to a further aspect of the present invention, a program to set a computer to execute a controlling of an imaging apparatus comprises: a detector
5 including a plurality of pixels arranged in a matrix, wherein each of the pixels includes a conversion element for converting a radiation or a light into an electric charge, such that the detector performs an imaging operation for outputting an image data based on an
10 irradiation with the radiation or the light, such that the computer controls operations of the detector including the imaging operation, to perform: a first imaging operation for outputting an image data based on the irradiation with the light or the radiation on a first irradiation field of
15 the detector corresponding to a part of the plurality of pixels; and a second imaging operation, conducted following to the first imaging operation, for outputting an image data based on the irradiation with the light or the radiation on a second irradiation field of an area larger
20 than that of the first irradiation field, during an accumulation period determined by an arithmetic operation to suppress a step of image within a predetermined tolerable quantity or smaller, based on an information relating to an integral dose of the radiation or the light
25 during the first imaging operation.

Advantageous Effects of Invention

The present invention can reduce a ghost (step of

image) which may occur in an obtained image and is affected by an irradiation area and can prevent remarkable degradation of image quality by drive operation of an FPD without performing complicated image processing.

5 Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

10 FIG. 1 is a schematic block diagram of an imaging system including an imaging apparatus according to a first embodiment of the present invention.

 FIG. 2 is a schematic equivalent circuit diagram of the imaging apparatus according to the first embodiment of
15 the present invention.

 FIG. 3 is a flowchart illustrating an operation of the imaging apparatus and the imaging system according to the present invention.

 FIGS. 4A, 4B, 4C, and 4D each are a timing chart
20 describing an operation of the imaging apparatus and the imaging system according to the present invention.

 FIGS. 5A, 5B, and 5C are schematic views illustrating a configuration of a controlling computer of the present invention and a characteristic chart of integral dose
25 versus dark output for describing the concept and advantages of the present invention.

 FIGS. 6A and 6B each are a schematic equivalent

circuit diagram of the imaging apparatus according to a second embodiment of the present invention.

FIGS. 7A, 7B, 7C, and 7D each are a timing chart describing an operation of the imaging apparatus and the imaging system according to the second embodiment of the present invention.

FIGS. 8A, 8B, and 8C each are a timing chart describing an operation according to the second embodiment of the present invention.

10

BEST MODES FOR CARRYING OUT THE INVENTION

Hereinafter, embodiments to which the present invention can be preferably applied will be described in detail by referring to the accompanying drawings.

15 (First Embodiment)

The radiation imaging system of the present embodiment illustrated in FIG. 1 includes an imaging apparatus 100, a controlling computer 108, a radiation control apparatus 109, a radiation generating apparatus 110, a display apparatus 113, and a control console 114. The imaging apparatus 100 has an FPD (flat panel detector) 104 which includes a detector unit 101 having a plurality of pixels each converting radiation or light to electrical signal; a driving circuit 102 driving the detector unit 101; and a read out circuit 103 outputting an electrical signal from the driven detector unit 101 as image data. The imaging apparatus 100 further includes a signal

processing unit 105 which processes and outputs image data from the FPD 104; a controller unit 106 which controls an operation of the FPD 104 by supplying a control signal to each component; and a power source unit 107 which supplies
5 bias to each component. The signal processing unit 105 which receives a control signal from the later described controlling computer 108 and provides the control signal to the controller unit 106. The power source unit 107 includes a power supply circuit such as a regulator which
10 receives voltage from an external power source and a built-in battery (not illustrated) and supplies voltage required for the detector unit 101, the driving circuit 102, and the read out circuit 103.

The controlling computer 108 performs synchronization
15 between the radiation generating apparatus 110 and the imaging apparatus 100; transmission of a control signal for determining a state of the imaging apparatus 100; and image processing for correction, storage, and display on image data from the imaging apparatus 100. In addition, the
20 controlling computer 108 transmits, to the radiation control apparatus 109, a control signal determining a radiation irradiation condition based on information from the control console 114.

In response to a control signal from the controlling
25 computer 108, the radiation control apparatus 109 controls an operation of a radiation source 111 emitting radiation therefrom and an operation of an irradiation field aperture

mechanism 112, which are included in the radiation
generating apparatus 110. The irradiation field aperture
mechanism 112 has a function capable of changing a
predetermined irradiation field which is an area for
5 irradiating the detector unit 101 of the FPD 104 with
radiation or light according to radiation. According to
the present embodiment, the irradiation field aperture
mechanism 112 has a function capable of switching between
an irradiation field A and an irradiation field B. The
10 irradiation field A corresponding to the first irradiation
field of the present invention is irradiated with radiation
corresponding to part of pixels contained in a plurality of
pixels, assuming that, for example, the plurality of pixels
is a total of pixels of about 2800 rows x about 2800
15 columns and the part of pixels is about 1000 rows x about
1000 columns. The irradiation field B corresponding to the
second irradiation field of the present invention is
irradiated with radiation corresponding to all the pixels
wider than the irradiation field A. The control console
20 114 inputs examinee information and imaging conditions as
parameters for various control of the controlling computer
108 and transmits the parameters to the controlling
computer 108. The display apparatus 113 displays image
data undergoing image processing by the controlling
25 computer 108.

Next, by referring to FIG. 2, the imaging apparatus
according to the first embodiment of the present invention

will be described. Note that the same reference numerals or characters are assigned to the same components as those in FIG. 1, and the description thereof is omitted. For ease of description, FIG. 2 illustrates the imaging apparatus including the FPD having pixels of 3 rows × 3 columns. Note that in fact, an actual imaging apparatus has more pixels. For example, a 17-inch imaging apparatus has pixels of about 2800 rows × about 2800 columns.

The detector unit 101 has a plurality of pixels arranged in a matrix form. Each pixel has a conversion element 201 converting radiation or light to electric charge; and a switching element 202 outputting an electrical signal according to the electric charge. According to the present embodiment, as a photoelectric conversion element converting light emitted to a conversion element to electric charge, a PIN photodiode mainly composed of amorphous silicon arranged on an insulating substrate such as a glass substrate is used. As the conversion element, an indirect conversion element having a wavelength converter provided on a radiation incident side of the above described photoelectric conversion element, which converts radiation into light on a wavelength band sensible by the photoelectric conversion element and a direct conversion element which directly converts radiation into an electric charge are preferably used. As the switching element 202, a transistor having a control terminal and two main terminals are preferably used.

According to the present embodiment, a thin-film transistor (TFT) is used. One electrode of the conversion element 201 is electrically connected to one of the two main terminals of the switching element 202, and the other electrode is electrically connected to a bias power source 107a via a common bias line Bs. The control terminals of a plurality of switching elements in rows such as T11 to T13 are electrically connected commonly to a drive line G1 in the first row, and a drive signal for controlling a conducting state of the switching elements is provided from the driving circuit 102 in units of rows via the drive line. The other main terminal of the control terminals of a plurality of switching elements in columns such as T11 to T31 are electrically connected to a signal line Sig 1 in the first column and outputs an electrical signal according to the electric charge of the conversion element to the read out circuit 103 via the signal line while the switching element is in a conducting state. The plurality of signal lines Sig 1 to Sig 3 provided in columns transmit electrical signals outputted from a plurality of pixels to the read out circuit 103 in parallel.

The read out circuit 103 includes an amplifier circuit 207 amplifying an electrical signal outputted in parallel from the detector unit 101, and the amplifier circuit 207 is provided for each signal line. Each amplifier circuit 207 includes an integration amplifier 203 amplifying an outputted electrical signal; a variable

amplifier 204 amplifying the electrical signal from the integration amplifier 203; a sample hold circuit 205 sampling and holding the amplified electrical signal; and a buffer amplifier 206. The integration amplifier 203

5 includes an arithmetic amplifier amplifying and outputting the read electrical signal; an integration capacitor; and a reset switch. The integration amplifier 203 can change the amplification ratio by changing the integration capacitor value. The outputted electrical signal is inputted to an

10 inverting input terminal of the arithmetic amplifier. A reference voltage V_{ref} is inputted to a non-inverting input terminal from the reference power source 107b, and the amplified electrical signal is outputted from the output terminal. The integration capacitor is located between the

15 inverting input terminal and the output terminal of the arithmetic amplifier. The sample hold circuit 205 is provided for each amplifier circuit and includes a sampling switch and a sampling capacitor. The read out circuit 103 includes a multiplexer 208 which sequentially outputs the

20 electrical signal read in parallel from each amplifier circuit 207 and outputs a serial image signal; and a buffer amplifier 209 which performs impedance conversion on the image signal to be outputted. An image signal V_{out} , which is an analog electrical signal outputted from the buffer

25 amplifier 209, is converted to digital image data by the A/D converter 210 and is outputted to the signal processing unit 105. The image data processed by the signal

processing unit 105 illustrated in FIG. 1 is outputted to the controlling computer 108.

In response to the control signals (D-CLK, OE, and DIO) inputted from the controller unit 106 illustrated in FIG. 1, the driving circuit 102 outputs, to each drive line, the drive signal having a conducting voltage V_{com} for placing the switching element in a conducting state and a non-conducting voltage V_{ss} for placing the switching element to a non-conducting state. Thereby, the driving circuit 102 controls the conducting state and the non-conducting state of the switching element and drives the detector unit 101.

The power source unit 107 illustrated in FIG. 1 includes the bias power source 107a and the reference power source 107b of the amplifier circuit illustrated in FIG. 2. The bias power source 107a supplies a bias voltage V_s commonly to the other electrode of each conversion element via the bias line B_s . The bias voltage V_s corresponds to the first voltage of the present invention. The reference power source 107b supplies a reference voltage V_{ref} to a non-inverting input terminal of each arithmetic amplifier.

The controller unit 106 illustrated in FIG. 1 receives control signals from the controlling computer 108 and other external devices via the signal processing unit 105 and controls the operation of the FPD 104 by giving various control signals to the driving circuit 102, the power source unit 107, and the read out circuit 103. The

controller unit 106 controls the operation of the driving circuit 102 by providing the driving circuit 102 with the control signal D-CLK, the control signal OE, and the control signal DIO. Here, the control signal D-CLK is a shift clock for a shift register used as the driving circuit; the control signal DIO is a pulse transferred by the shift register; and the control signal OE is a control signal for controlling an output end of the shift register. The controller unit 106 controls the operation of various components of the read out circuit 103 by providing the read out circuit 103 with a control signal RC, a control signal SH, and a control signal CLK. Here, the control signal RC is a control signal for controlling the operation of the reset switch of the integration amplifier; the control signal SH is a control signal for controlling the operation of the sample hold circuit 205; and the control signal CLK is a control signal for controlling the operation of the multiplexer 208.

Next, by referring to FIGS. 1 to 3, particularly FIG. 3, the entire operation of the imaging apparatus and the imaging system of the present invention will be described. The operator operates the control console 114; the controlling computer 108 determines the irradiation conditions; and imaging starts. Then, a desired dose of radiation is delivered to an examinee from the radiation generating apparatus 110 controlled by the radiation control apparatus 109 under the irradiation conditions.

The imaging apparatus 100 outputs image data according to the radiation transmitted through the examinee. The outputted image data undergoes image processing by the controlling computer 108 and is displayed on the display apparatus 113.

The controlling computer 108 prompts the operator to confirm whether or not to continue imaging. If an instruction of no imaging continuation (NO) is received from the operator, the controlling computer 108 terminates imaging; and if an instruction of imaging continuation (YES) is received from the operator, the controlling computer 108 prompts the operator to confirm whether or not to change the irradiation field. If an instruction of no irradiation field change (NO) is received from the operator, the controlling computer 108 controls the radiation control apparatus 109 and the radiation generating apparatus 110 under the previously determined imaging conditions so that radiation is delivered again under the same conditions. Conversely, if an instruction of irradiation field change (YES) is received from the operator, the controlling computer 108 determines the irradiation conditions where the irradiation field is changed. Based on the determined irradiation conditions, the radiation control apparatus 109 controls the irradiation field aperture mechanism 112 of the radiation generating apparatus 110 so as to determine the changed irradiation field. In addition, the controlling computer 108 performs an arithmetic processing

for determining an accumulation period described in detail later. Subsequently, the controlling computer 108 controls the radiation control apparatus 109 and the radiation generating apparatus 110 under the irradiation conditions including the irradiation field determined by the controlling computer 108 and the irradiation time according to the accumulation period so as to deliver radiation under the changed irradiation conditions. In addition, the controlling computer 108 provides the imaging apparatus 100 with the control signal based on the determined accumulation period and the next imaging is performed under the determined accumulation period.

Next, by referring to FIGS. 4A to 4D, the operation of the imaging system of the present invention will be described. In FIG. 4A, when the bias voltage V_s is supplied to the conversion element 201, the imaging apparatus 100 performs an idling operation in the idling period. Here, the idling operation means an operation for repeatedly performing at least an initialization operation $K1$ a plurality of times in order to stabilize the characteristic variation of the detector 104 caused by the start of applying the bias voltage V_s . The initialization operation means an operation for initializing a conversion element by providing the conversion element with an initial bias before the accumulation operation. Note that in FIG. 4A, as the idling operation, a pair of the accumulation operation $W1$ and the initialization operation $K1$ is

repeatedly performed a plurality of times.

FIG. 4B is a timing chart describing the operation of the imaging apparatus in the period 4B-4B illustrated in FIG. 4A. As illustrated in FIG. 4B, in the accumulation operation W1, the bias voltage V_s is supplied to the conversion element 201; in that state, the non-conducting voltage V_{ss} is supplied to the switching element 202; and thus the switching elements of all the pixels are placed in the non-conducting state. In the initialization operation K1, first, the reset switch causes the integration capacitor of the integration amplifier and the signal line to be reset; then, the conducting voltage V_{com} is supplied to the drive line G1 from the driving circuit 102; and thus the switching elements T11 to T13 of the pixels in the first row are placed in the conducting state. When the switching elements are placed in the conducting state, the conversion elements are initialized. At this time, the electric charge of the conversion element is outputted as an electrical signal by the switching element. However, according to the present embodiment, the circuits following the sample hold circuit are not operated, and thus data according to the electrical signal is not outputted from the read out circuit 103. Subsequently, when the integration capacitor and the signal line are reset again, the outputted electrical signal is processed. Note that in order to use the data for correction and other purpose, the circuits following the sample hold circuit may be operated

in the same manner as an image output operation and a dark image output operation described later. In this manner, the initialization operation of the detector 101 is performed by repeating the control and reset of the

5 conducting state of the switching element in the second row, in the third row, and so on. Here, in the initialization operation, during the period while at least the switching element is in the conducting state, the reset switch may be kept in the conducting state so as to continue reset. In

10 addition, the conducting time of the switching element in the initialization operation may be shorter than the conducting time of the switching element in the image output operation described later. Moreover, in the initialization operation, a plurality of rows of switching

15 elements may be conducted at the same time. By doing so, it is possible to shorten the time required for the entire initialization operation and to hasten stabilization of the characteristic variation of the detector. Note that the initialization operation K1 of the present embodiment is

20 performed in the same period as that of the image output operation included in the fluoroscopic imaging operation performed after the idling operation.

FIG. 4C is a timing chart describing the operation of the imaging apparatus in the period 4C-4C illustrated in

25 FIG. 4A. After the idling operation is performed, the detector 101 enters a state capable of imaging. Then, in response to a control signal from the controlling computer

108, the imaging apparatus 100 performs a fluoroscopic
imaging operation of emitting radiation to the FPD 104 in
an area of the irradiation field A. The fluoroscopic
imaging operation corresponds to the first imaging
5 operation of the present invention. The period while the
imaging apparatus 100 is performing the fluoroscopic
imaging operation is referred to as the fluoroscopic
imaging period. During the fluoroscopic imaging period, so
that the conversion element 201 generates an electric
10 charge according to the emitted radiation, the imaging
apparatus 100 performs an accumulation operation W1
performed in a period according to the time to emit
radiation; and an image output operation X1 of outputting
image data based on the electric charge generated by the
15 accumulation operation W1. As illustrated in FIG. 4C, in
the image output operation, first, the integration
capacitor and the signal line are reset; then, the
conducting voltage Vcom is supplied to the drive line G1
from the driving circuit 102; and thus the switching
20 elements T11 to T13 in the first row are placed in the
conducting state. Thereby, an electrical signal based on
the electric charge generated by the switching elements S11
to S13 in the first row is outputted to each signal line.
Each of the electrical signals outputted in parallel via
25 each signal line is amplified by the arithmetic amplifier
203 and the variable amplifier 204 of each amplifier
circuit 206. Then, the control signal SH causes the sample

hold circuit to be operated and each of the amplified electrical signals is held in parallel in the sample hold circuit 205 inside each amplifier circuit. After being held, the integration capacitor and the signal line are
5 reset. After being reset, in the same manner as in the first row, the conducting voltage Vcom is supplied to the drive line G2 in the second row, and thus the switching elements T21 to T23 in the second row are placed in the conducting state. Within the period while the switching
10 elements T21 to T23 in the second row are placed in the conducting state, the multiplexer 208 sequentially outputs the electrical signal held in the sample hold circuit 205. Thereby, the electrical signals from the pixels in the first row read in parallel are converted to a serial image
15 signal to be outputted. Then, the A/D converter 210 converts the serial image signal to a row of image data to be outputted. The above operation is performed in units of rows from the first row to the third row, and a frame of image data is outputted from the imaging apparatus.

20 Further, according to the present embodiment, so that the conversion element 201 generates an electric charge in a dark state where no radiation is emitted, the imaging apparatus 100 performs the accumulation operation W1 performed in the same period as that of the accumulation
25 operation W1 and a dark image output operation F1 of outputting dark image data based on the electric charge generated by the accumulation operation W1. In the dark

image output operation F1; the same operation as the image output operation X1 is performed by the imaging apparatus 100.

Next, when an irradiation field change instruction is transmitted from the control console 114 to the controlling computer 108, the controlling computer 108 accordingly performs an arithmetic processing to determine the accumulation period. The period while the arithmetic processing is being performed is referred to as the arithmetic period. The arithmetic processing will be described in detail later by referring to FIGS. 5A to 5C.

FIG. 4D is a timing chart describing the operation of the imaging apparatus in the period 4D-4D illustrated in FIG. 4A. After the arithmetic processing, the controlling computer 108 provides the imaging apparatus 100 with a control signal according to the accumulation period determined by the arithmetic processing. Based on the control signal from the controlling computer, the imaging apparatus 100 performs radiography (still image) operation in which radiation is emitted to the FPD 104 in the irradiation field B whose area is wider than the area of the irradiation field A. The radiography operation corresponds to the second imaging operation of the present invention. The period while the imaging apparatus 100 is performing the radiography operation is referred to as the radiography period. In the radiography period, so that the conversion element generates an electric charge according

to the emitted radiation, the imaging apparatus 100 performs an accumulation operation W2 performed in the accumulation period T_w determined by the arithmetic processing and an image output operation X2 of outputting
5 image data based on the electric charge generated by the accumulation operation W2. As illustrated in FIG. 4D, here, according to the present embodiment, the accumulation operation W2 and the image output operation W2 are the same as the accumulation operation W1 and the image output
10 operation W1 respectively, but according to the present embodiment, each operation is different in period, and thus different reference characters are assigned respectively. Note that each operation may be performed in the same period depending on the results of the arithmetic
15 processing. Moreover, according to the present embodiment, so that the conversion element generates an electric charge in a dark state where no radiation is emitted, the imaging apparatus 100 performs the accumulation operation W2 performed in the same period as that of the accumulation
20 operation W2 and a dark image output operation F2 of outputting dark image data based on the electric charge generated by the accumulation operation W2. In the dark image output operation F2, the same operation as the image output operation X2 is performed by the imaging apparatus
25 100. Further, according to the present embodiment, the imaging apparatus 100 performs the initialization operation K2 before each accumulation operation W2. Here, the

initialization operation K2 is the same as the previously described initialization operation K1, but according to the present embodiment, each operation is different in period, and thus different reference characters are assigned. Note
5 that like the above described accumulation period W2, each operation may be performed in the same period depending on the results of the arithmetic processing.

Next, by referring to FIGS. 5A to 5C, the arithmetic processing by the controlling computer which is a control
10 means of the present embodiment will be described. Note that in FIGS. 5B and 5C, the horizontal axis indicates an integral dose of radiation emitted to the FPD 104. The vertical axis indicates output data of a pixel obtained in a dark state as a dark output. Note that according to the
15 present embodiment, an area of the detector to which radiation is emitted in the irradiation field A is referred to as a first area; and an area of the detector to which radiation is emitted in the irradiation field B and which excludes the first area is referred to as a second area.

20 First, by referring to FIGS. 5B and 5C, a mechanism of generating a step of image, which serves as a base of the arithmetic processing of the present invention, will be described. As illustrated in FIG. 5B, the present
inventors have found that the dark output of the flat panel
25 detector depends on a radiation irradiation history, and more specifically, depends on an integral dose of radiation after a bias voltage is applied to a conversion element of

the flat panel detector. According to the present embodiment, the imaging operation is performed in the irradiation field A. Thus, the dark output of a pixel contained in the second area is indicated by A in FIG. 5B; and the dark output of a pixel contained in the first area is indicated by B or C. The dark output of a pixel contained in the first area depends on the integral dose which depends on the length of a fluoroscopic imaging operation period, and thus the dark output thereof is as indicated by B or C in FIG. 5B. Therefore, for example, a difference occurs between the dark output A in the second area and the dark output C in the first area, and the difference in dark output causes a step of image. In particular, the longer the fluoroscopic imaging operation period, the larger the difference in dark output between the first area and the second area, and thus the more apparent the step of image. Thus, the present inventors have found that the dark output of the flat panel detector depends on the radiation irradiation history; accordingly, a difference in dark output occurs between an irradiated area of radiation and a non-irradiated area in the flat panel detector; and the difference causes a step of image to occur.

As illustrated in FIG. 5C, the dark output of the flat panel detector depends on the accumulation period T_w of the conversion element. Thus, the present inventors have found that the step of image depends on the integral

dose of radiation before the irradiation field is changed and the accumulation period T_w of the conversion element in the imaging operation after the irradiation field is changed. In addition, the present inventors have found
5 that if the step of image is a predetermined tolerable quantity or less, no step of image is recognized and thus the image obtained from the imaging apparatus can be used. Note that the predetermined tolerable quantity is a value specific to the detector, and thus can be preliminarily
10 acquired and set before inspection at shipping. In particular, if the step of image is equal to or less than the random noise of the flat panel detector, the step of image generally is lost in the random noise and cannot be recognized as the step of image; and thus it is desirable
15 that the tolerable quantity is equal to or less than the random noise output.

As described above, based on the information about the integral dose of radiation in the imaging operation before the irradiation field is changed, the controlling
20 computer 108 performs an arithmetic processing to determine the accumulation period in the imaging operation after the irradiation field is changed so that the step of image is equal to or less than a preliminarily set tolerable quantity. Thereby, the upper limit of the accumulation
25 period is the same time as the preliminarily set tolerable quantity of the step of image. Note that the radiation generating apparatus 112 must emit a dose of radiation

required for imaging in the time width within the accumulation period. If the accumulation period is made too short, in some cases, the dose of radiation required for imaging cannot be secured unless the imaging is

5 performed in an extremely short time or with an extremely strong intensity exceeding the limit of the radiation generating apparatus. In other words, the time period when the radiation generating apparatus 112 can emit a dose of radiation required for imaging is the lower limit of the

10 accumulation period. For this reason, the controlling computer 108 determines the accumulation period so that the step of image is equal to or less than the preliminarily set tolerable quantity within a range in which the radiation generating apparatus can emit a dose of radiation

15 required for imaging operation after the irradiation field is changed. Note that if the result obtained by the arithmetic processing is a significantly shorter time than the limit of the radiation generating apparatus, the lower limit of the accumulation period is the shortest

20 irradiation time which is the time limit allowing the radiation generating apparatus to generate radiation. In that case, in order to secure a dose of radiation required for imaging, the controlling computer 108 controls the radiation generating apparatus so as to increase the

25 radiation to be emitted. Specifically, the controlling computer 108 controls the radiation intensity by controlling a tube current of the radiation source of the

radiation generating apparatus.

Then, the controlling computer 108 provides the controller unit of the imaging apparatus with a control signal based on the determined accumulation period, and controls the driving circuit so that the controller unit performs an accumulation operation of the detector in the determined accumulation period. In addition, the controlling computer 108 provides the radiation control apparatus with a control signal based on the determined accumulation period, and controls the radiation generating apparatus so that the radiation generating apparatus emits a dose of radiation required for imaging operation after the irradiation field is changed according to the determined accumulation period.

Next, by referring to FIG. 5A, a configuration for performing the arithmetic processing of the present invention and a specific arithmetic processing will be described. The controlling computer 108 includes an image data processing unit 501, a dose detection unit 502, an accumulation period determining unit 503, and a characteristic storage unit 504. Here, the characteristic storage unit 504 stores data about the integral dose, the accumulation period, and the dark output indicating characteristics of the detector, and a lookup table containing these kinds of data is preferably used. In addition, information about the shortest irradiation time and the maximum output intensity of the radiation

generating apparatus is stored in the characteristic storage unit 504. According to the present invention, the arithmetic processing unit 505 includes the accumulation period determining unit 503 and the characteristic storage unit 504.

The image data outputted from the imaging apparatus 100 undergoes image processing by the image data processing unit 501, and is transmitted to the display apparatus 113. Of the image data, the image data corresponding to a pixel contained in the first area is transmitted to the dose detection unit 502 as dose detection data. The dose detection unit 502 calculates the radiation dose for each frame based on the dose detection data to be accumulated. Here, as the dose detection data, image data corresponding to a specific pixel contained in the first area may be used or an average value of the image data outputted from a plurality of pixels contained in the first area may be used. Instead of image data, data from a photo timer (not illustrated) provided in the imaging apparatus separately from the detector unit may be used. The dose detection unit 502 obtains information about the integral dose in the imaging operation by adding the accumulated radiation dose for each frame and outputs the information to the accumulation period determining unit 503.

When the operator inputs an instruction to change the irradiation field to the control console 114, the control console 114 outputs, to the accumulation period determining

unit 503, a control signal instructing the irradiation field to be changed and information about the radiation dose required for imaging after the irradiation field is changed. The accumulation period determining unit 503
5 which receives the control signal from the control console 114 determines the accumulation period T_w based on the information about the inputted integral dose, information about the required radiation dose, and data stored in the characteristic storage unit 504.

10 The determined accumulation period T_w is outputted from the accumulation period determining unit 503 to the controller unit 106 of the imaging apparatus 100. The controller unit 106 controls the driving circuit so as to perform an accumulation operation of the detector in the
15 inputted accumulation period T_w . In addition, the accumulation period T_w and the information about the required radiation dose are transmitted from the accumulation period determining unit 503 to the radiation control apparatus 109. The radiation control apparatus 109
20 controls the radiation generating apparatus 112 so that the radiation generating apparatus 112 emits a dose of radiation required for imaging according to the accumulation period T_w .

25 As described above, the imaging operation after the irradiation field is changed is performed in the accumulation period determined based on the integral dose of radiation in the imaging operation before the

irradiation field is changed, which can reduce a step of image affected by the irradiation area and can prevent remarkable degradation of image quality without performing complicated image processing. Note that according to the present embodiment, the accumulation period T_w is determined, but the present invention is not limited to this. For example, a control may be made in such a manner that the accumulation period T_w and the period of the initialization operation K2 performed immediately before the accumulation period T_w are combined; both the accumulation period T_w and the period of the initialization operation K2 are calculated and determined; and the output operation X2 and the like may be performed according to the initialization operation K2. Note also that according to the present embodiment, the controlling computer 108 performs the arithmetic processing, but the present invention is not limited to this. For example, in response to a control signal from the controlling computer, the controller unit 106 of the imaging apparatus 100 may perform the arithmetic processing.

(Second Embodiment)

Next, by referring to FIGS. 6A and 6B, the imaging apparatus according to the second embodiment of the present invention will be described. Note that the same reference numerals or characters are assigned to the same components as those in the first embodiment, and the detailed description thereof is omitted. For ease of description,

FIG. 6A illustrates the imaging apparatus including the FPD having pixels of 3 rows \times 3 columns in the same configuration as in FIG. 2, but in fact, an actual imaging apparatus has more pixels.

5 According to the detector unit 101 of the first embodiment, a PIN photodiode is used in the conversion element 201, while according to the detector unit 101' of the present embodiment, an MIS photoelectric conversion element is used in the conversion element 601 as the MIS
10 conversion element. According to the first embodiment, a switching element for outputting is provided for each pixel; while according to the present embodiment, in addition to the switching element 602 for outputting, a switching element 603 for refreshing is provided. One of
15 the main terminals of the switching element 603 for refreshing is electrically connected to a first electrode 604 of the conversion element 601 and one of the two main terminals of the switching element 602. The other one of the main terminals of the switching element 603 is
20 electrically connected to a refreshing power source 107c contained in the power source unit 107 via a common line. The control terminals of a plurality of switching elements 603 in rows are electrically connected commonly to a refreshing drive line Gr, and a drive signal is supplied
25 from the refreshing driving circuit 102r in units of rows via the refreshing drive line Gr.

As illustrated in FIG. 6B, the conversion element 601

is configured such that a semiconductor layer 606 is provided between the first electrode 604 and a second electrode 608; an insulating layer 605 is provided between the first electrode 604 and the semiconductor layer 606; and an impurity semiconductor layer is provided between the semiconductor layer 606 and the second electrode 608. The second electrode 608 is electrically connected to a bias power source 107a' via the bias line Bs. In the same manner as the conversion element 201, the conversion element 601 is configured such that a bias voltage Vs is supplied to the second electrode 608 from the bias power source 107a'; a reference voltage Vref is supplied to the first electrode 604 via the switching element 602; and thus accumulation operation is performed. Here, in the fluoroscopic imaging operation and the radiography operation, a refreshing voltage Vt is supplied to the first electrode 604 via the switching element 603, and the conversion element 601 is refreshed by the bias $|V_s - V_t|$.

Next, by referring to FIGS. 7A to 7D, the operation of the imaging apparatus and the imaging system of the present embodiment will be described. According to the present embodiment illustrated in FIG. 7A, instead of the initialization operation K1, the image output operation X1, and the dark image output operation F1 of the first embodiment illustrated FIG. 4A, an initialization operation K1', an image output operation X1', and a dark image output operation F1' are performed respectively. In addition,

instead of the image output operation X2 and the dark image output operation F2 of the first embodiment illustrated FIG. 4A, the image output operation X2' and the dark image output operation F2' are performed respectively. Further, according to the present embodiment, the imaging apparatus 100 performs a change operation described in detail later during the arithmetic period. The operation other than the above is the same as that of the first embodiment, and the detailed description thereof is omitted. Hereinafter, the different operations will be described by referring to FIGS. 7B to 7D.

According to the present embodiment, the configuration of a pixel includes not only the switching element 602 for outputting but also the switching element 603 for refreshing. For this reason, the initialization operation K1' in the idling operation of the present embodiment illustrated in FIG. 7B is different from the initialization operation K1 operated by one switching element 202 provided for one pixel. In the same manner as in the first embodiment, the initialization operation K1' is performed such that the conducting voltage Vcom is supplied to the drive line G from the driving circuit 102; then, the switching element 602 is placed in the conducting state; and the electric charge of the conversion element 601 is outputted as an electrical signal by the switching element 602. Subsequently, when the conducting voltage Vcom is supplied to the drive line Gr from the driving

circuit 102r, the switching element 603 for refreshing is placed in the conducting state. At this time, a refreshing voltage V_t is supplied from the refreshing power source 107c. Thereby, the bias $|V_s - V_t|$ is applied to the
5 conversion element 601, and the residual charge in the conversion element is erased so as to refresh the conversion element. Then, the integration capacitor and the signal line are reset, and the switching element 602 is placed in the conducting state again. Then, an initial
10 bias $|V_s - V_{ref}|$ is applied to the conversion element, and the conversion element is initialized. The initialization operation K1' is achieved by sequentially performing the above operation in units of rows. The operation other than the above is the same as that of the first embodiment, and
15 the detailed description thereof is omitted.

In addition, the difference between the image output operation X1' in the fluoroscopic imaging operation of the present embodiment illustrated in FIG. 7C and the image output operation X1, and the difference between the dark
20 image output operation F1' and the dark image output operation F1 are the same as the above described difference between the initialization operation K1' and the initialization operation K1. The operation other than the above is the same as that of the first embodiment, and the
25 detailed description thereof is omitted.

In the same manner as in the first embodiment, an image output operation X2' and a dark image output

operation F2' in the radiography operation of the present embodiment illustrated in FIG. 7D are performed in such a manner that the conducting voltage Vcom is supplied to the drive line G from the driving circuit 102 and then the
5 switching element 602 is placed in the conducting state. Thereby, the electric charge of the conversion element 601 is outputted in units of rows as an electrical signal by the switching element 602, and image data is outputted from the imaging apparatus via the read out circuit 103.

10 Subsequently, when the conducting voltage Vcom is supplied to the drive line Gr from the driving circuit 102r, the switching element 603 for refreshing is placed in the conducting state. At this time, a refreshing voltage Vt is supplied from the refreshing power source 107c. Thereby,
15 the bias $|V_s - V_t|$ is applied to the conversion element 601, and the residual charge in the conversion element is erased so as to refresh the conversion element. Then, the integration capacitor and the signal line are reset, and the switching element 602 is placed in the conducting state
20 again. Then, an initial bias $|V_s - V_{ref}|$ is applied to the conversion element, and the conversion element is initialized. The image output operation X2' and the dark image output operation F2' are achieved by sequentially performing the above operation in units of rows. Note that
25 according to the present embodiment, the period of the image output operation X2' is longer and different than the period of the image output operation X1', and thus

different reference characters are assigned to each operation, but the operation may be performed in the same period.

Next, by referring to FIGS. 8A to 8C, the change operation of the present embodiment will be described.

According to the change operation illustrated in FIG. 8A, the FPD 104 performs the initialization operation K2' once or a plurality of times in the same manner as in the initialization operation F1' in the same length of period as the output operations W2' and F2' of the radiography operation. In other words, the FPD 104 performs the initialization operation K2' once or a plurality of times corresponding to the output operations W2' and F2' of the radiography operation performed after the irradiation field is changed. According to the initialization operation K2', the change operation is performed by the initialization operation corresponding to an imaging operation performed after change, and thus excellent image data with few artifacts can be acquired. Since no accumulation operation is performed, the characteristics of the conversion element can be stabilized in a short time. In particular, as the change operation performed by a plurality of times of initialization operations, it is preferable that an initialization operation corresponding to an imaging operation performed after change is performed at least once immediately before the imaging operation performed after change.

According to the change operation illustrated in FIG. 8B, first, the FPD 104 performs a refresh operation R at least once as described later. Subsequently, the FPD 104 performs the initialization operation K2' once or a plurality of times corresponding to the output operations W2' and F2' of the radiography operation performed after the irradiation field is changed. In addition to the effect of the change operation illustrated in FIG. 8A, this change operation allows the refresh operation R to erase the residual charge in the conversion element, and thus can further reduce the step of image. Hereinafter, the refresh operation will be described by referring to FIG. 8C.

In the refresh operation illustrated in FIG. 8C, first, the driving circuit 102 does not supply the conducting voltage Vcom to the switching element 602, and thus the switching element 602 maintains the non-conducting state. In this state, the driving circuit 102r supplies the conducting voltage Vcom in units of rows to the switching element 603, and thus the switching element 603 is placed in the conducting state accordingly. Thereby, the bias $|V_s - V_t|$ is applied to the conversion element 601, and the residual charge in the conversion element is erased so as to refresh the conversion element. The refresh operation R is achieved by sequentially performing the above operation in units of rows.

After the refresh operation R, the integration capacitor and the signal line are reset. Then, the

conducting voltage V_{com} is supplied to the drive line G from the driving circuit 102, and the switching element 602 is placed in the conducting state. Then, the electric charge of the conversion element 601 is outputted as an electrical signal by the switching element 602.

Subsequently, when the conducting voltage V_{com} is supplied to the drive line G_r from the driving circuit 102r, the switching element 603 for refreshing is placed in the conducting state. At this time, a refreshing voltage V_t is supplied from the refreshing power source 107c. Thereby, the bias $|V_s - V_t|$ is applied to the conversion element 601, and the residual charge in the conversion element is erased so as to refresh the conversion element again. Then, the integration capacitor and the signal line are reset, and the switching element 602 is placed in the conducting state again. Then, an initial bias $|V_s - V_{ref}|$ is applied to the conversion element, and the conversion element is initialized. The initialization operation $K2'$ is achieved by sequentially performing the above operation in units of rows.

Note that in the same manner as in the first embodiment, in the present embodiment, the second imaging operation may also include the initialization operation.

According to the present embodiment, in addition to performing the imaging operation after the irradiation field is changed in the accumulation period determined based on the integral dose of radiation in the imaging

operation before the irradiation field is changed, the imaging apparatus 100 performs the change operation in the arithmetic period. Therefore, in addition to the effect of the first embodiment, the second embodiment can reduce the amount of step of image contained in the image data outputted from the imaging apparatus 100 and thus can further reduce the step of image.

It should be noted that each embodiment of the present invention can be implemented by programs to be executed by a computer such as the controller unit 106. Moreover, means for supplying the programs to the computer such as a computer-readable recording medium containing the programs such as a CD-ROM and a transmission medium for transmitting the programs such as the Internet can be applied as embodiments of the present invention. The above programs can also be applied as an embodiment of the present invention. The above programs, recording media, transmission media, and program products are included into the category of the present invention. In addition, any invention by a combination easily imaginable from the first or second embodiment is also included into the category of the present invention.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to

encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application No. 2009-112052, filed May 1, 2009, which is hereby incorporated by reference herein in its entirety.

CLAIMS

1. An imaging system comprising:

an imaging apparatus comprising a detector including
5 a plurality of pixels arranged in a matrix, wherein each of
the pixels includes a conversion element for converting a
radiation or a light into an electric charge, such that the
detector performs an imaging operation for outputting an
image data based on an irradiation with the radiation or
10 the light, and a controller unit for controlling operations
of the detector including the imaging operation; and

a controlling computer for controlling the imaging
apparatus, wherein

the imaging operation includes a first imaging
15 operation for outputting an image data based on the
irradiation with the light or the radiation on a first
irradiation field of the detector corresponding to a part
of the plurality of pixels, and a second imaging operation
for outputting an image data based on the irradiation with
20 the light or the radiation on a second irradiation field of
an area larger than that of the first irradiation field,

the controlling computer performs an arithmetic
operation so as to suppress a step of image within a
predetermined tolerable quantity or smaller, based on an
25 information relating to an integral dose of the radiation
or the light during the first imaging operation, and
supplying the controller unit with a control signal based

on an accumulation period determined by the arithmetic operation, and

the controller unit controls the operation of the detector unit so that the detector performs the accumulation operation in the second imaging operation during the accumulation period determined by the arithmetic operation.

2. The imaging system according to claim 1, wherein the imaging system further comprises a radiation generator apparatus irradiating the imaging apparatus with the radiation,

the radiation generator apparatus includes a mechanism having an irradiation function switchable between irradiations of the first and second irradiation fields, responsive to the control signal from the controlling computer, and

the controlling computer performs the arithmetic operation, and supplies the controller unit and the radiation generator apparatus with the control signal based on the accumulation period determined by the arithmetic operation.

3. The imaging system according to claim 2, wherein the controlling computer includes a characteristic storage unit, a dosage detector unit, and an accumulation period determining unit,

the characteristic storage unit stores data relating to the integral dose, the accumulation period and an output

under a dark condition indicating characteristic of the detector unit, and stores an information relating to shortest irradiation period and a maximum output intensity of the radiation generator apparatus,

5 the dosage detector unit outputs to the accumulation period determining unit an information relating to the integral dose during the first imaging operation calculated based on an image data or data derived from a photo-timer provided separately from the detector, and

10 the accumulation period determining unit determines the accumulation period based on an information relating to the integrating dosage and based on the data and the information stored in the characteristic storage unit.

4. The imaging system according to claim 3, wherein
15 the imaging system further comprises a control console for outputting to the controlling computer an information relating the dosage of the radiation necessary for the second imaging operation, and

 the accumulation period determining unit determines
20 the accumulation period further based on the information relating the dosage of the radiation necessary for the second imaging operation.

5. The imaging system according to any one of claims 2 to 4, wherein

25 the arithmetic operation determines the accumulation period within a range of which lower limit is shortest irradiation period of the radiation generator apparatus.

6. The imaging system according to any one of claims 1 to 5, wherein

the pixel further includes a switch element for outputting an electric signal based on the electric charge,

5 the detector includes a detecting unit including the plurality of pixels arranged in the matrix, a driving circuit for controlling a conducting state of the switch element to drive the detecting unit and a read out circuit for outputting, as an image data, the electric signal
10 derived from the detecting unit through a signal wiring connected to the switch element,

the read out circuit includes a reset switch for reset of the signal wiring, and

the controller unit controls the driving circuit and
15 the reset switch such that the detector performs an initializing operation for initializing the conversion element during a period between the first and second imaging operations, responsive to the switching from the irradiation on the first irradiation fields to the
20 irradiation on the second irradiation fields.

7. The imaging system according to claim 6, wherein the conversion element is a MIS type conversion element,

the imaging system further comprises a power source
25 unit including a reference power source for supplying a reference voltage through the switch element to one electrode of the conversion element, a refreshment power

source for supplying a refreshment voltage through a refresh switch element to the one electrode of the conversion element, and a bias power source for supplying a bias voltage to the other electrode of the conversion element, and

the detector performs a refreshment operation such that, under a condition of maintaining the switch element at a non-conducting state and setting the refresh switch element at a conducting state, the other electrode is supplied with the bias voltage and the one electrode is supplied with the refreshment voltage through the refresh switch element, to refresh the conversion element.

8. An imaging apparatus comprising:

a detector including a plurality of pixels arranged in a matrix, wherein each of the pixels includes a conversion element for converting a radiation or a light into an electric charge, such that the detector performs an imaging operation for outputting an image data based on an irradiation with the radiation or the light, and

a controller unit for controlling operations of the detector including the imaging operation, wherein

the imaging operation includes a first imaging operation for outputting an image data based on the irradiation with the light or the radiation on a first irradiation field of the detector corresponding to a part of the plurality of pixels, and a second imaging operation for outputting an image data based on the irradiation with

the light or the radiation on a second irradiation field of
an area larger than that of the first irradiation field,
and

the controller unit controls the operation of the
5 detector unit so that the detector performs the
accumulation operation in the second imaging operation
during an accumulation period determined by an arithmetic
operation to suppress a step of image within a
predetermined tolerable quantity or smaller, based on an
10 information relating to an integral dose of the radiation
or the light during the first imaging operation.

9. A controlling method of an imaging apparatus
comprising:

a detector including a plurality of pixels arranged
15 in a matrix, wherein each of the pixels includes a
conversion element for converting a radiation or a light
into an electric charge, such that the detector performs an
imaging operation for outputting an image data based on an
irradiation with the radiation or the light, wherein the
20 controlling method controls operations of the detector
including the imaging operation and comprises:

a first imaging operation for outputting an image
data based on the irradiation with the light or the
radiation on a first irradiation field of the detector
25 corresponding to a part of the plurality of pixels; and

a second imaging operation, conducted following to
the first imaging operation, for outputting an image data

based on the irradiation with the light or the radiation on a second irradiation field of an area larger than that of the first irradiation field, during an accumulation period determined by an arithmetic operation to suppress a step of
5 image within a predetermined tolerable quantity or smaller, based on an information relating to an integral dose of the radiation or the light during the first imaging operation.

10. A program to set a computer to execute a controlling of an imaging apparatus comprising:

10 a detector including a plurality of pixels arranged in a matrix, wherein each of the pixels includes a conversion element for converting a radiation or a light into an electric charge, such that the detector performs an imaging operation for outputting an image data based on an
15 irradiation with the radiation or the light, such that the computer controls operations of the detector including the imaging operation, to perform:

a first imaging operation for outputting an image data based on the irradiation with the light or the
20 radiation on a first irradiation field of the detector corresponding to a part of the plurality of pixels; and

a second imaging operation, conducted following to the first imaging operation, for outputting an image data based on the irradiation with the light or the radiation on
25 a second irradiation field of an area larger than that of the first irradiation field, during an accumulation period determined by an arithmetic operation to suppress a step of

image within a predetermined tolerable quantity or smaller, based on an information relating to an integral dose of the radiation or the light during the first imaging operation.

FIG. 1

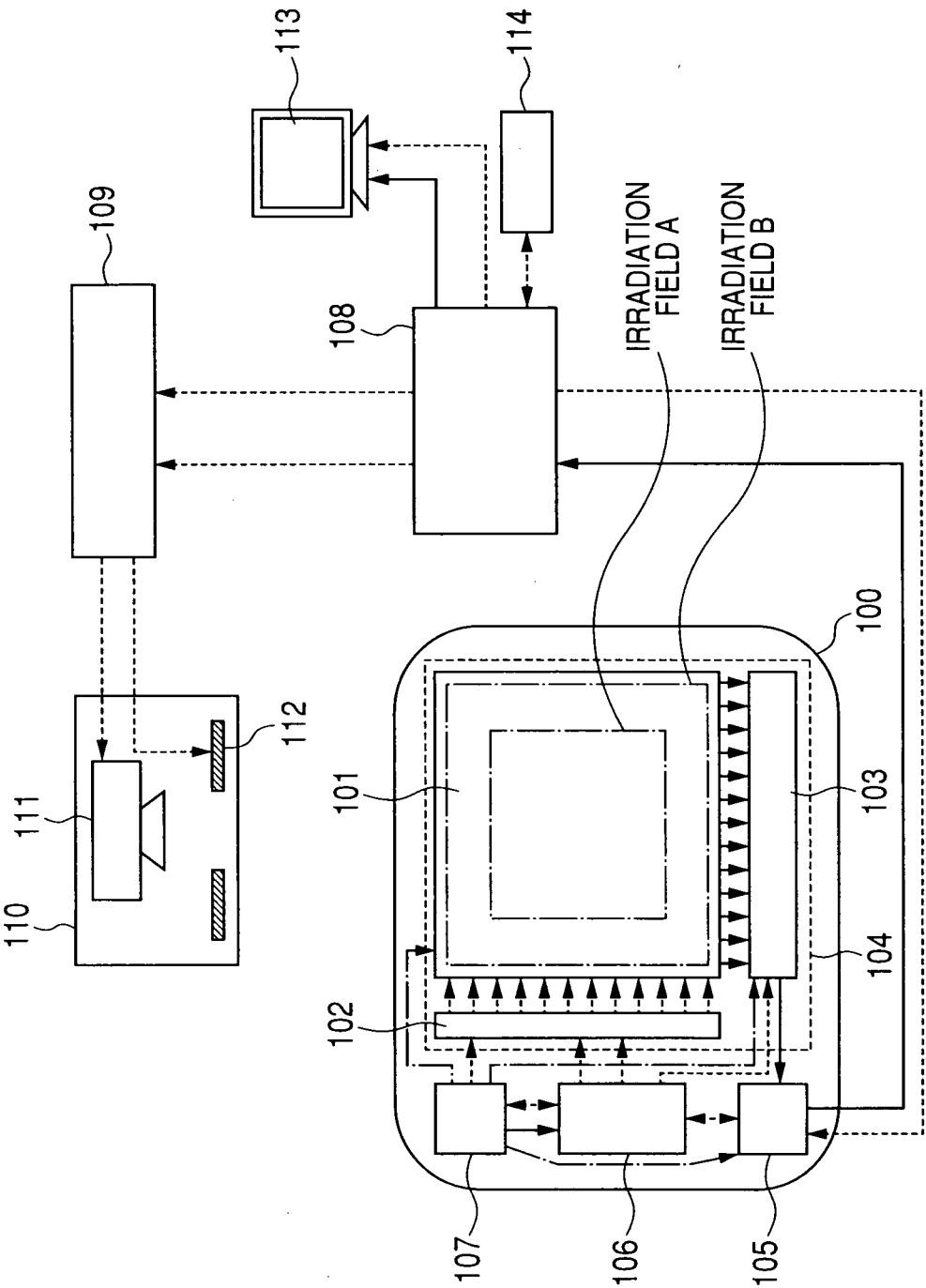


FIG. 2

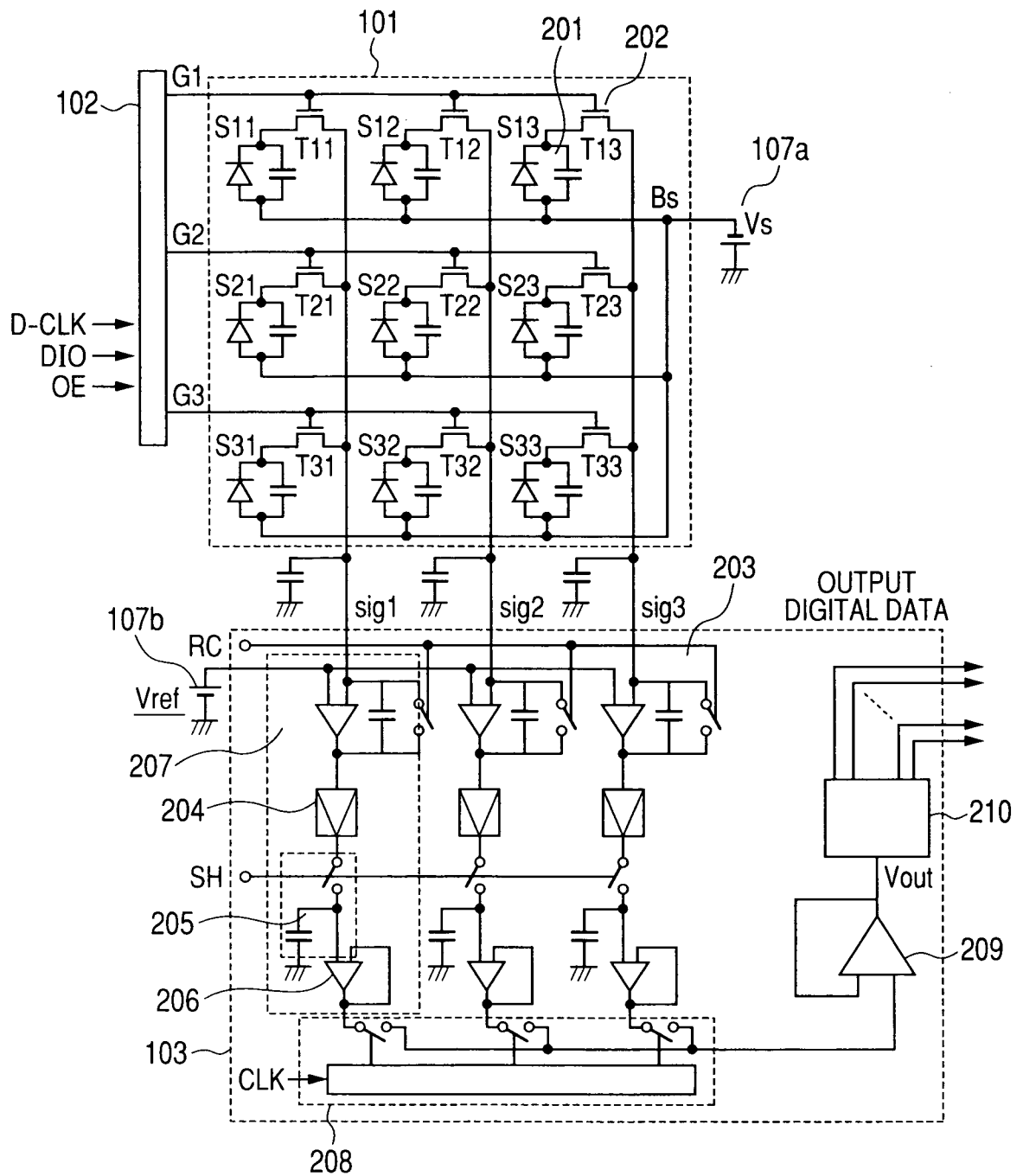


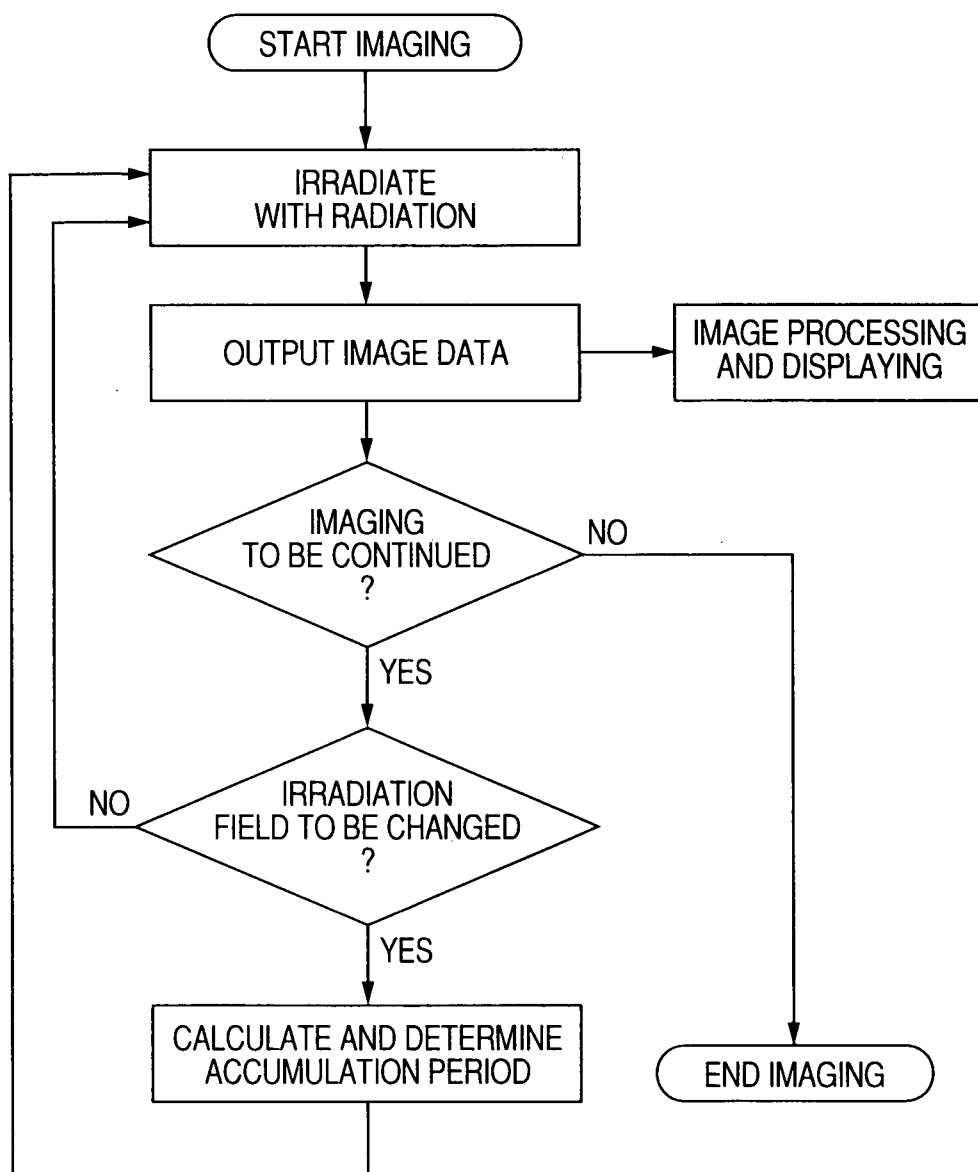
FIG. 3

FIG. 4A

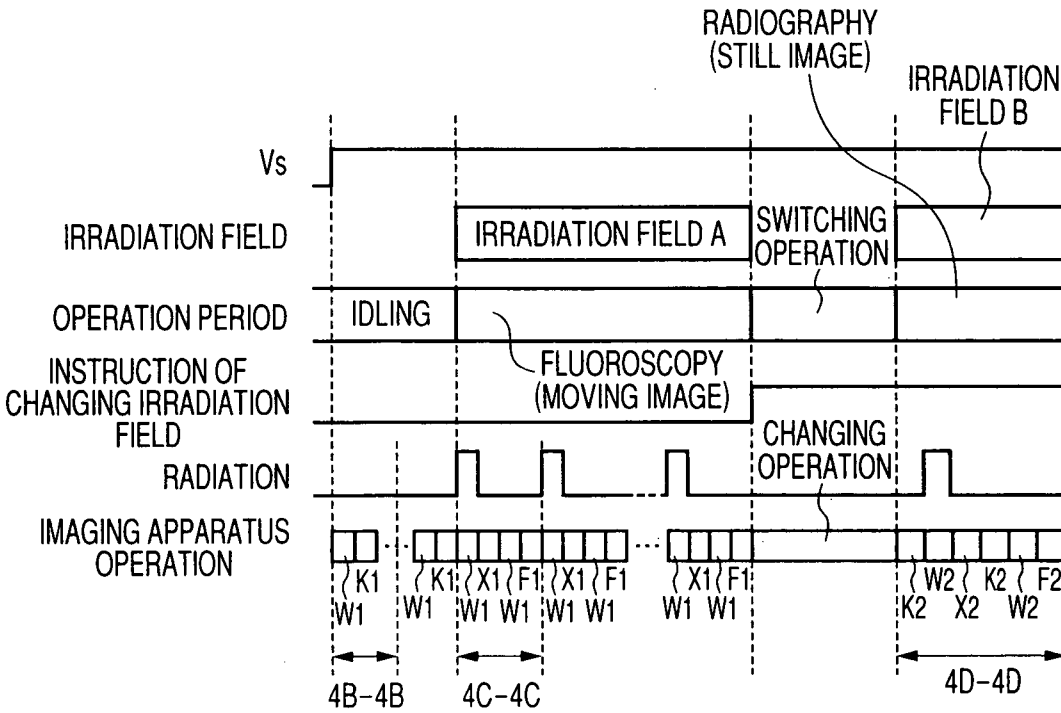


FIG. 4B

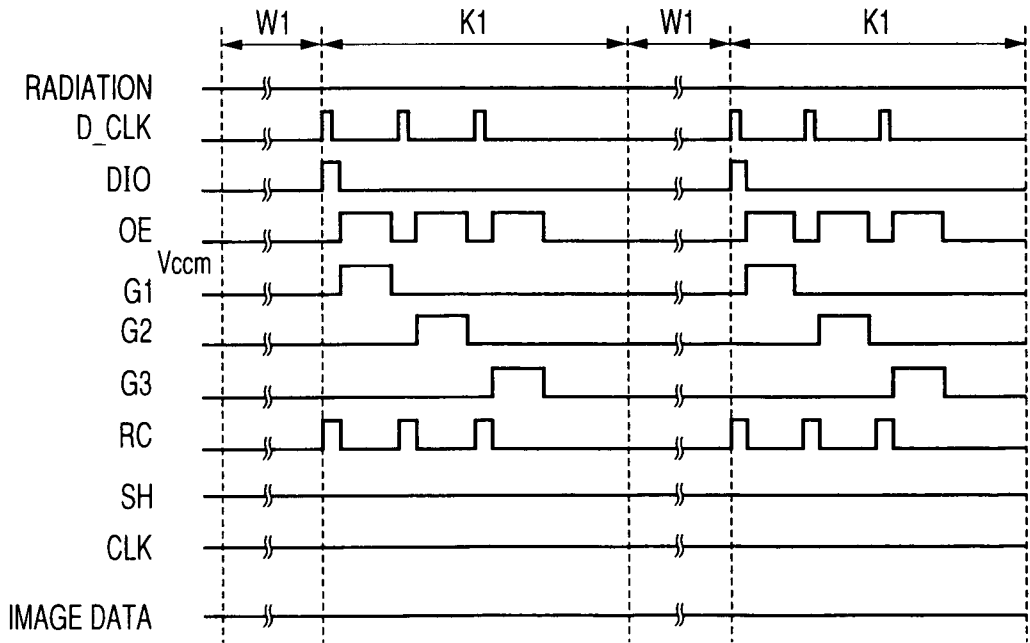


FIG. 4C

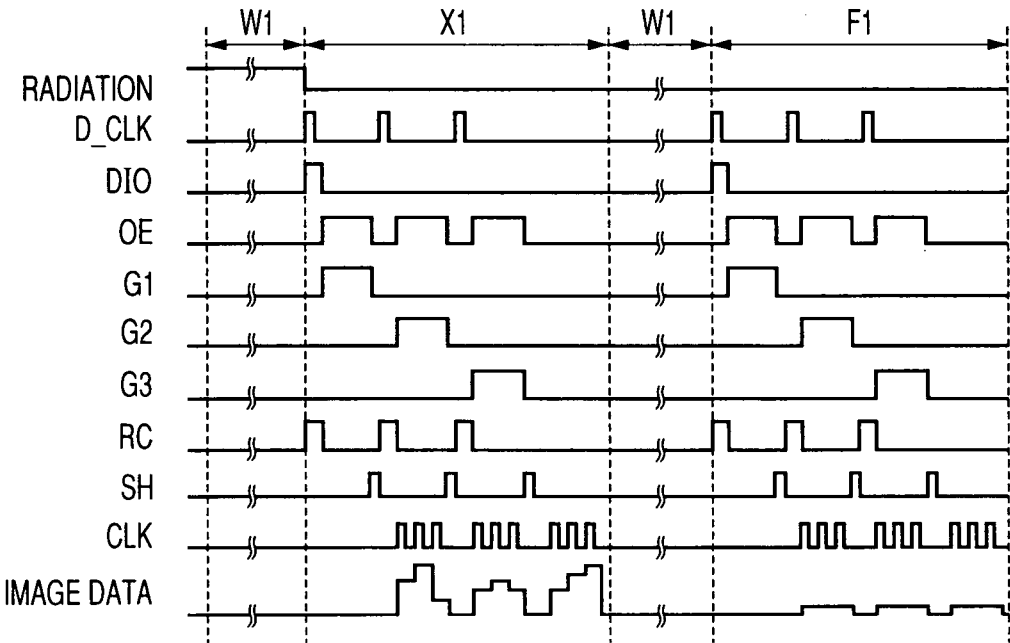


FIG. 4D

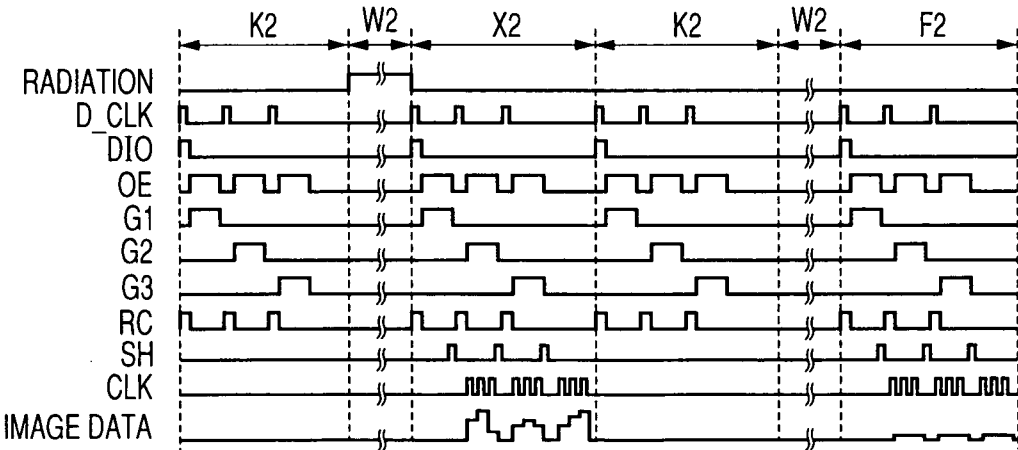
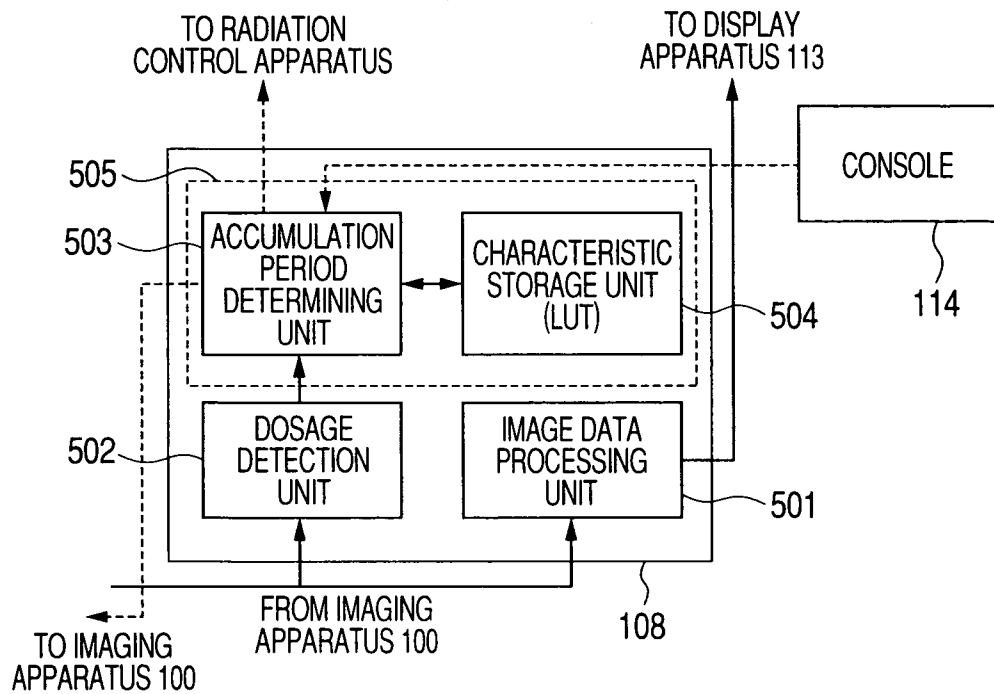
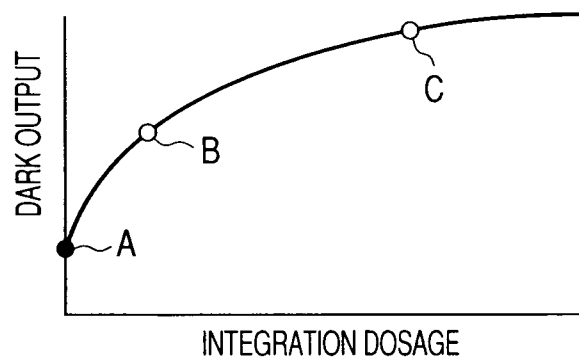
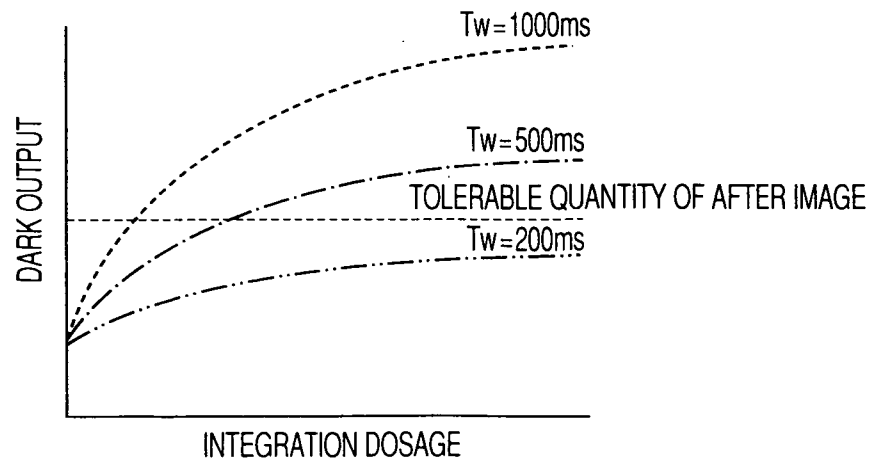


FIG. 5A**FIG. 5B****FIG. 5C**

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FIG. 6A

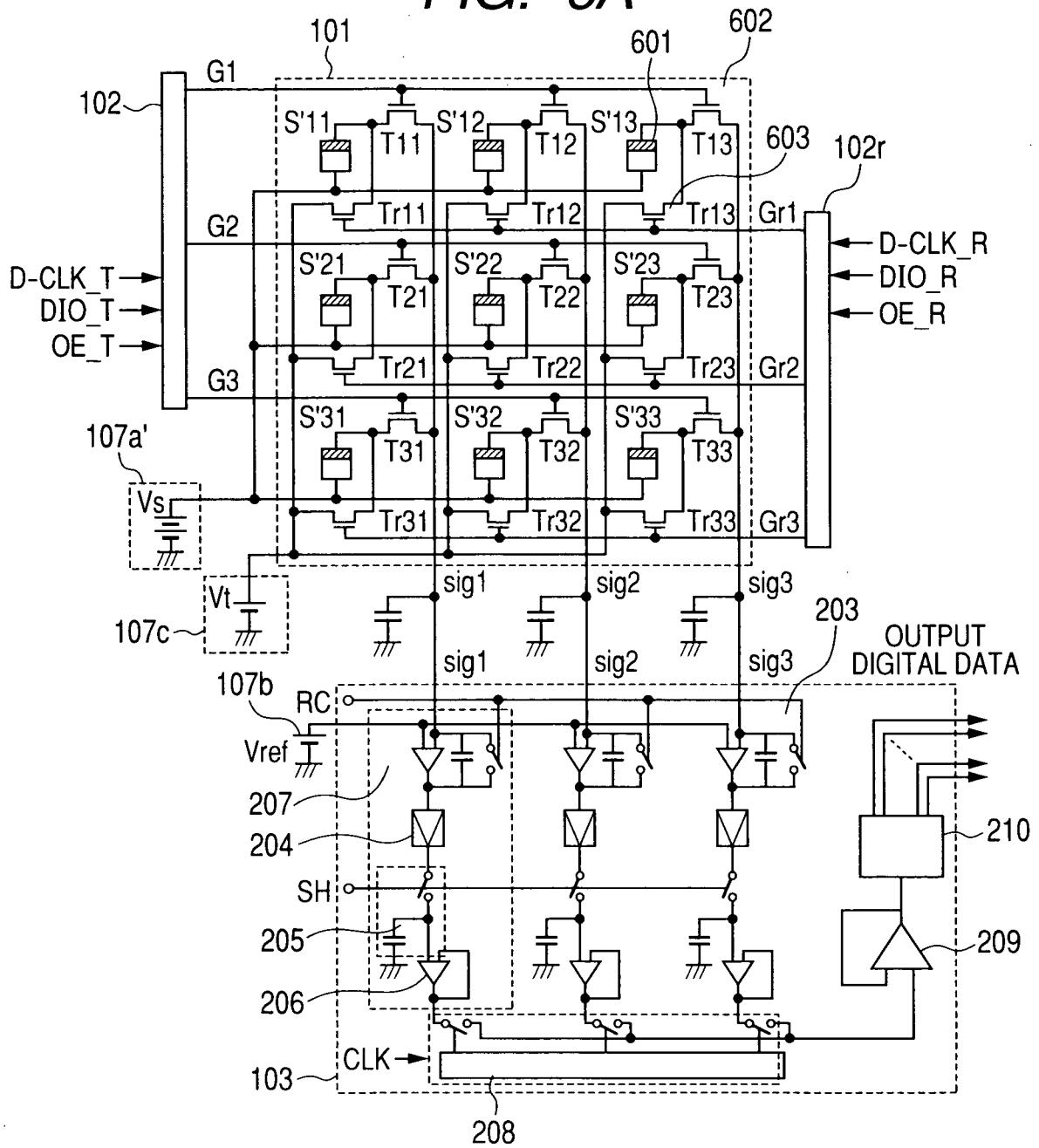


FIG. 6B

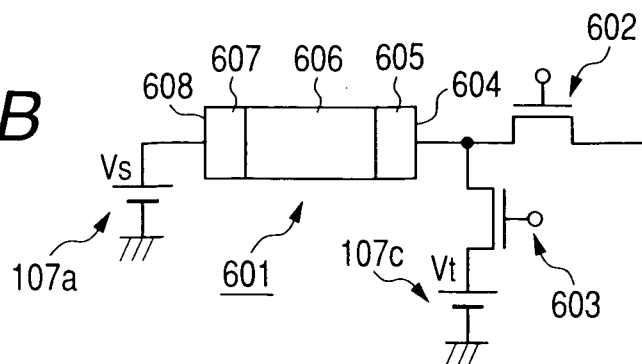


FIG. 7A

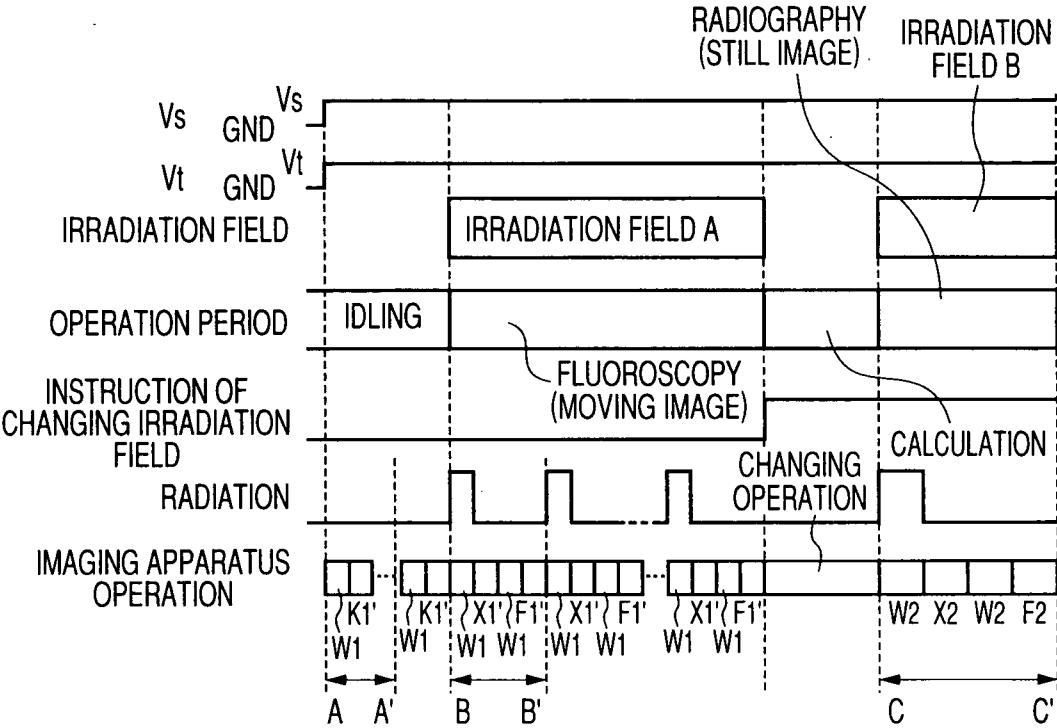


FIG. 7B

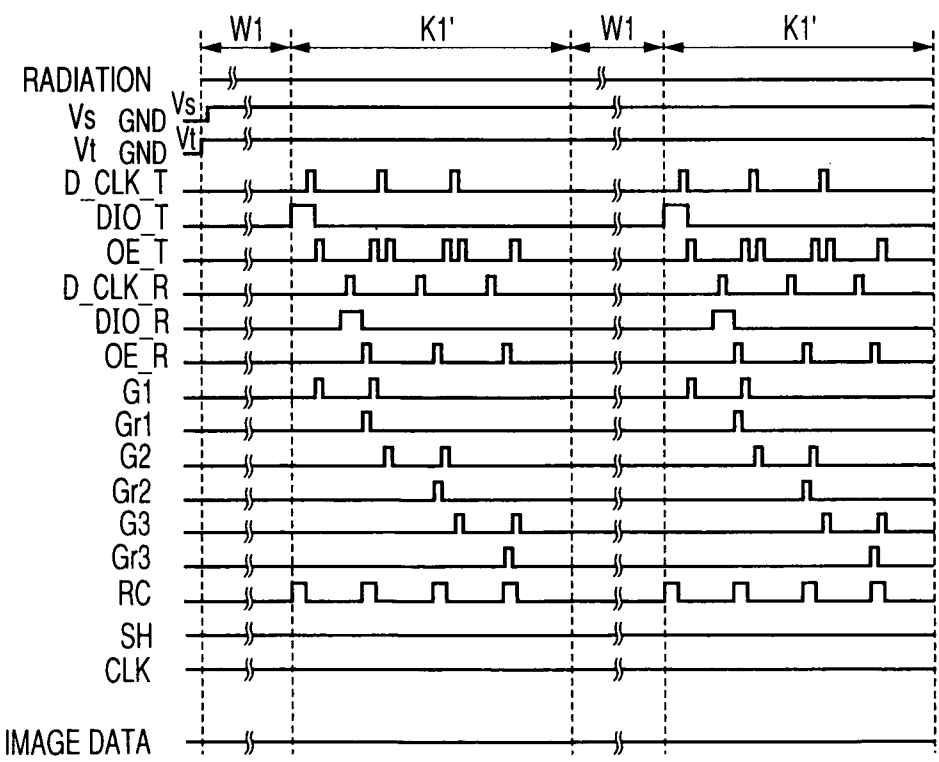


FIG. 7C

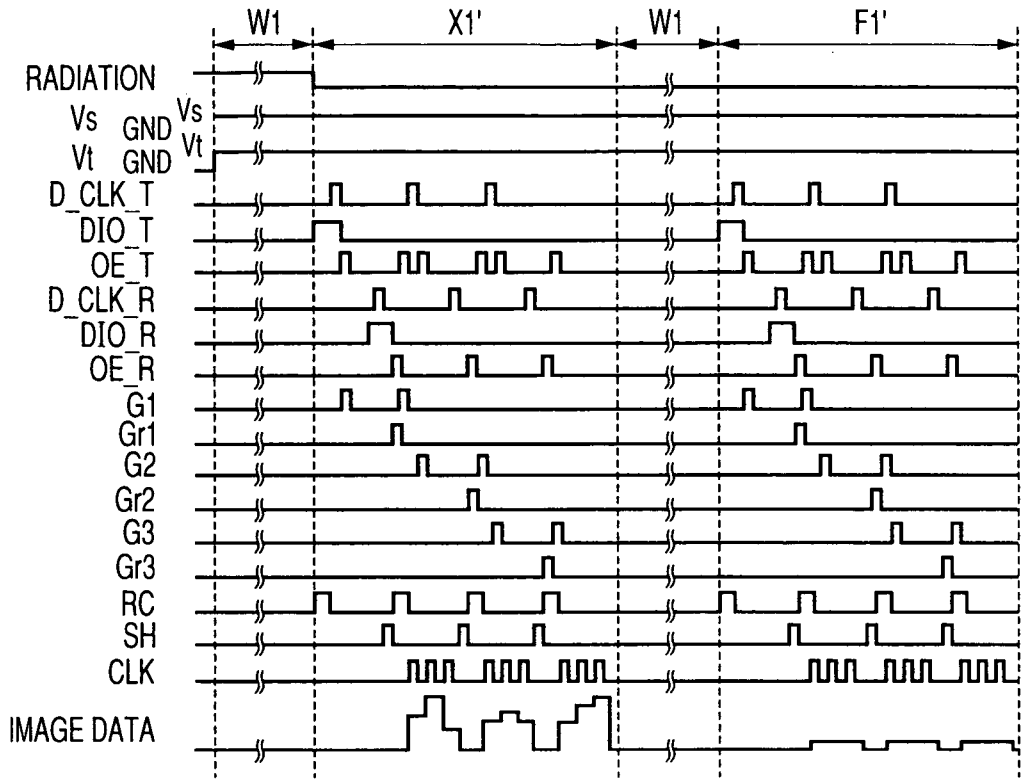
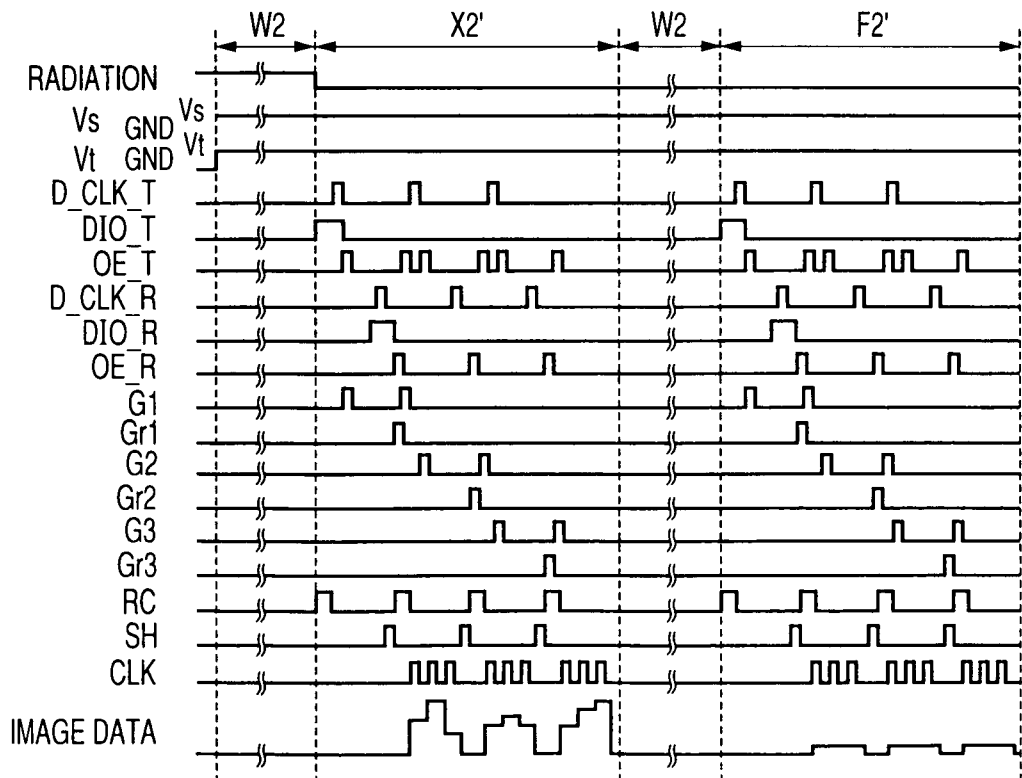
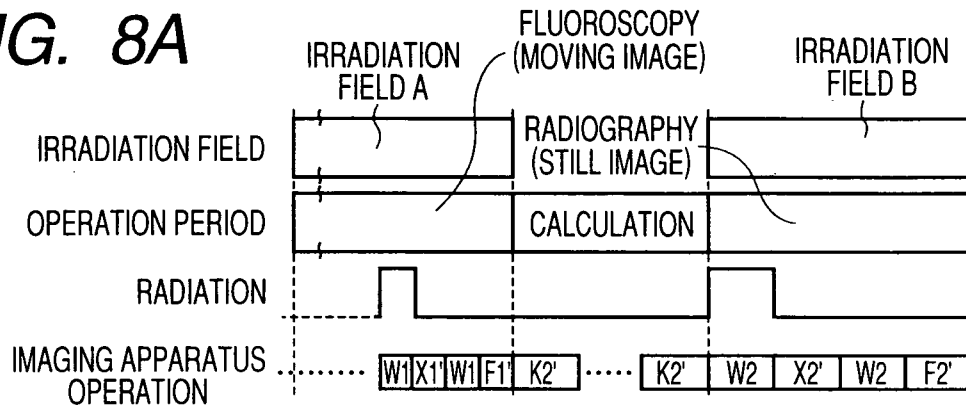
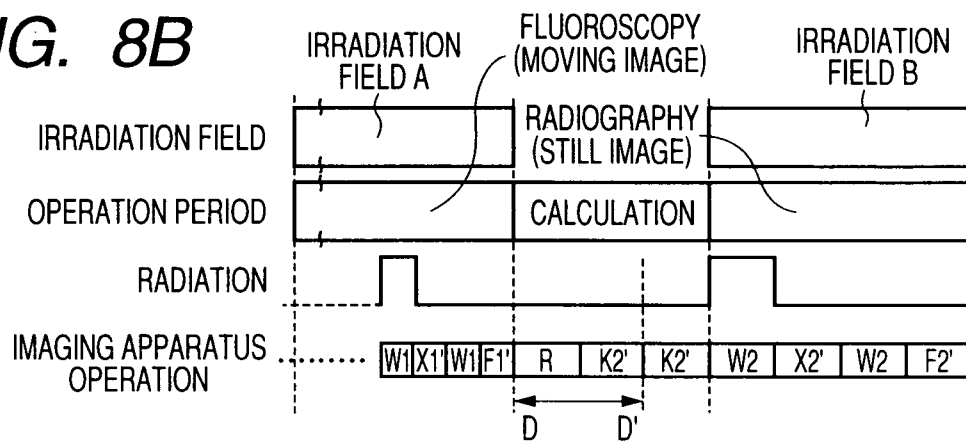
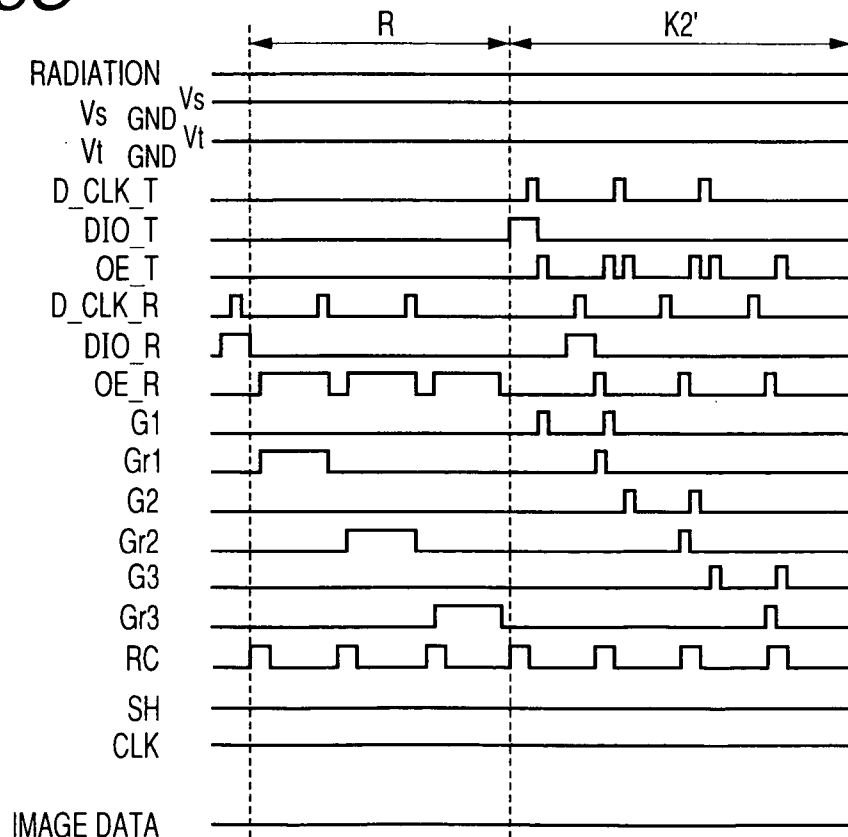


FIG. 7D



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FIG. 8A**FIG. 8B****FIG. 8C**

INTERNATIONAL SEARCH REPORT

International application No
PCT/JP2010/054716

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B6/03 G01T1/20
ADD.

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 G01T H04N

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 11 128213 A (SHIMADZU CORP) 18 May 1999 (1999-05-18) cited in the application * abstract	1-10
A	US 2005/175254 A1 (GRANFORS PAUL R [US] ET AL GRANFORS PAUL RICHARD [US] ET AL) 11 August 2005 (2005-08-11) * abstract paragraph [0012] paragraph [0021] paragraph [0022]	1-10
A	US 6 343 112 B1 (PETRICK SCOTT WILLIAM [US] ET AL) 29 January 2002 (2002-01-29) * abstract; figures 1, 4, 5, 6 paragraph [0021] paragraph [0033] - paragraph [0037]	1-10
	-/--	

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

22 June 2010

Date of mailing of the international search report

29/06/2010

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Sonntag, Anne

INTERNATIONAL SEARCH REPORT

International application No

PCT/JP2010/054716

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 2008/237507 A1 (ENOMOTO JUN [JP]) 2 October 2008 (2008-10-02) * abstract; figures 1,2	1
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/JP2010/054716

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