

**(12) Patent Application Publication**  
**Rogers et al.**

(43) **Pub. Date:** **Jul. 6, 2006**

### Publication Classification

(51) **Int. Cl.**  
**G01N 23/04** (2006.01)

(52) **U.S. Cl.** ..... **250/588**

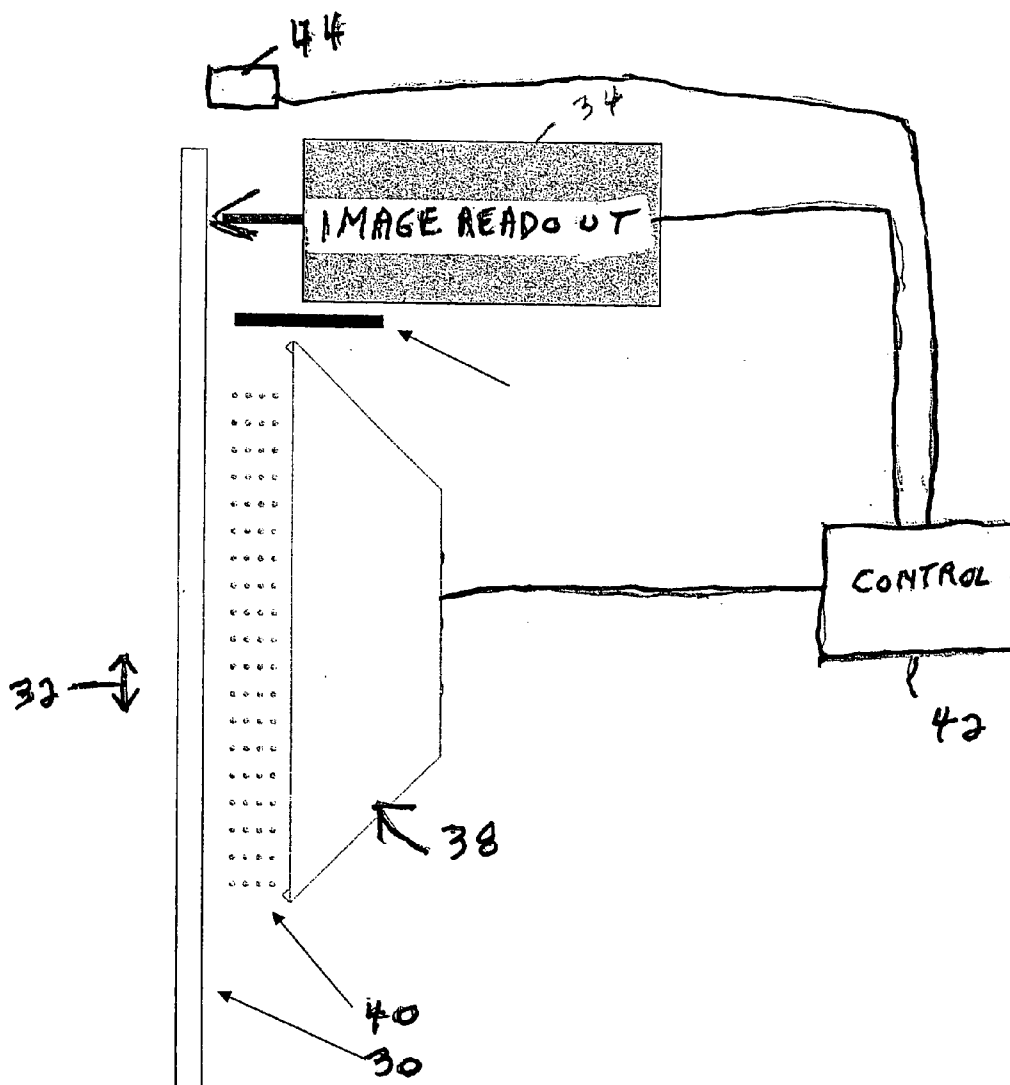
(57) **ABSTRACT**

(22) Filed: **Dec. 28, 2005**

### Related U.S. Application Data

(63) Continuation-in-part of application No. 10/625,923, filed on Jul. 24, 2003.

A storage phosphor erase apparatus for selectively erasing storage phosphors having different lateral dimensions transported along a first direction. The apparatus includes an array of point sources of erasing radiation spanning at least the greatest lateral dimension of a storage phosphor to be erased; and a control for actuating all of the array of point sources when a storage phosphor of the greatest lateral dimension is to be erased, and for actuating less than all of the array of point sources when a storage phosphor of a lateral dimension less than the greatest lateral dimension is to be erased.



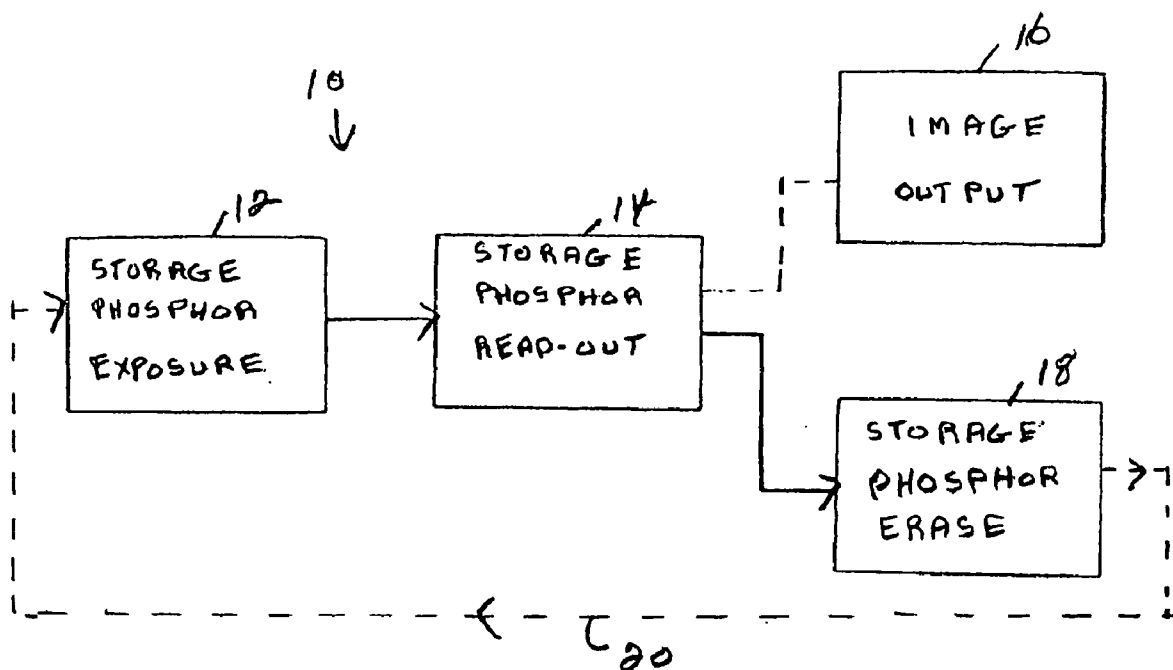


FIG. 1

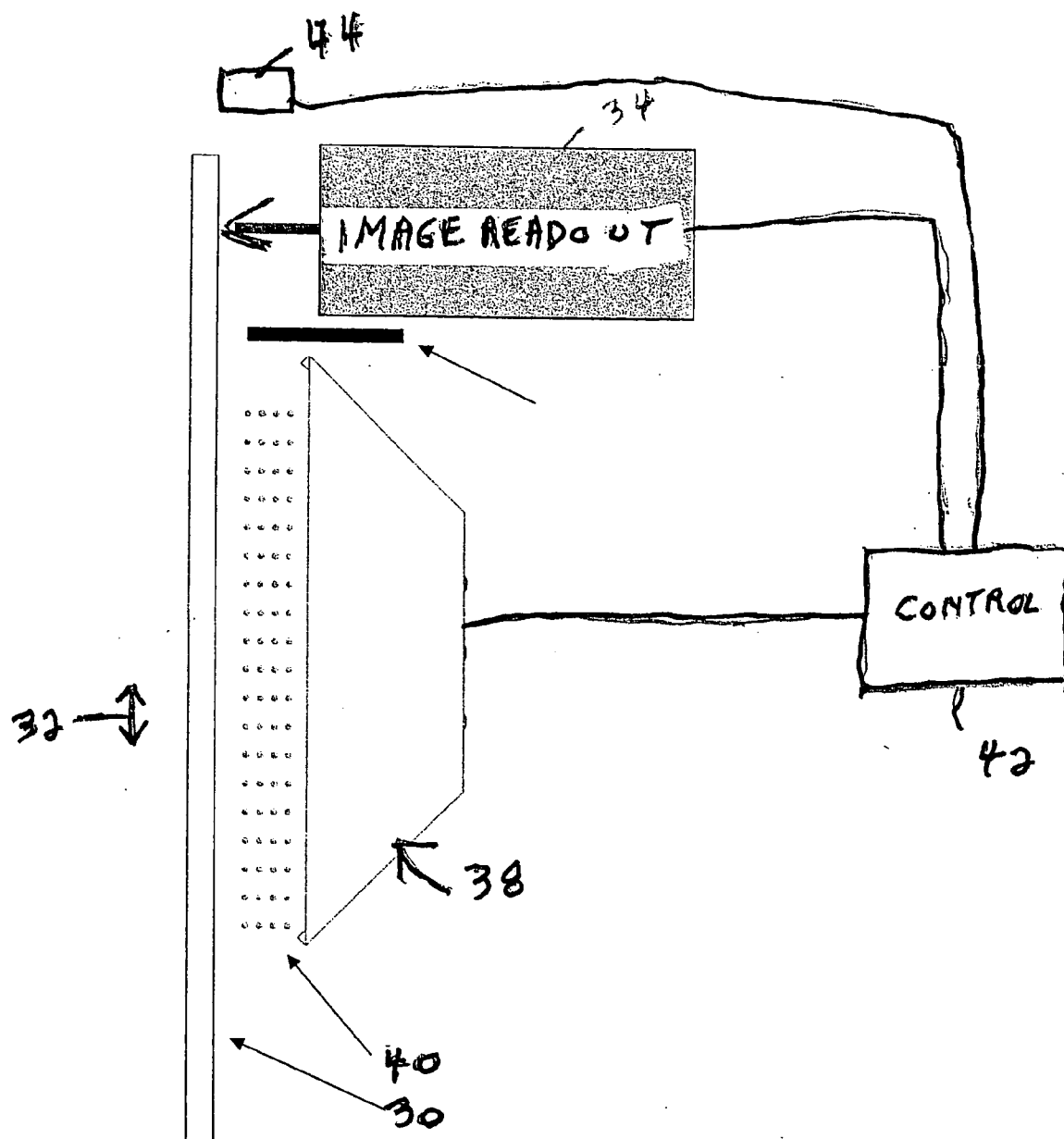
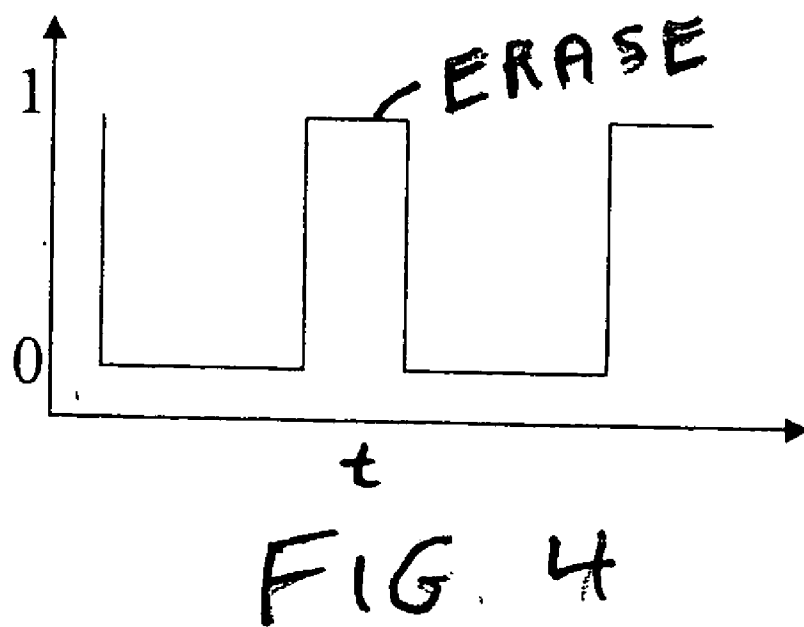
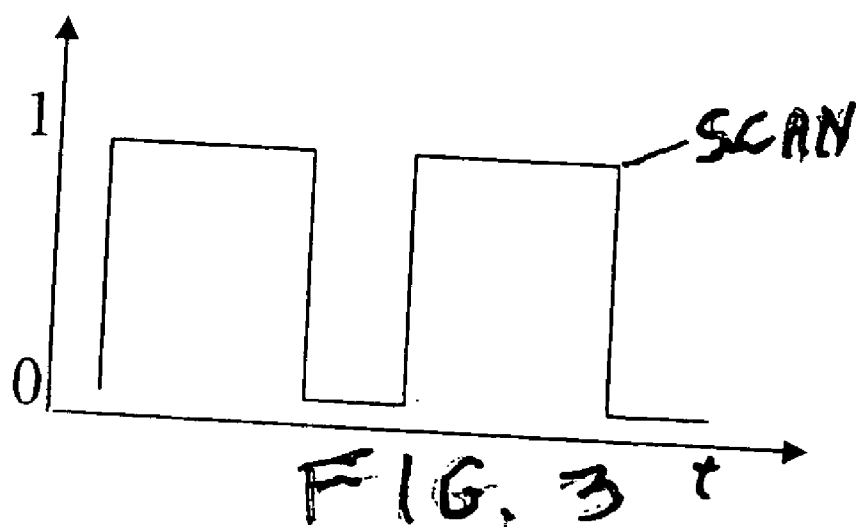
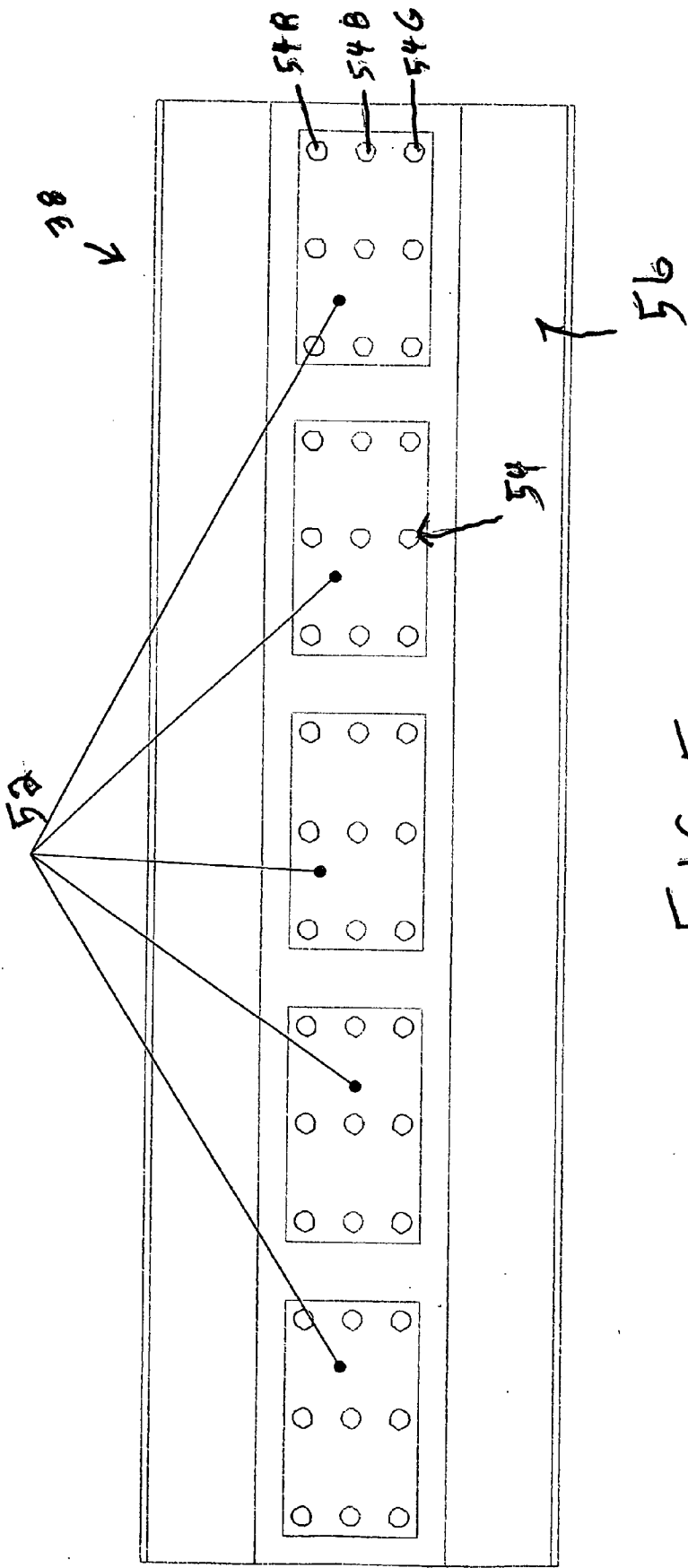
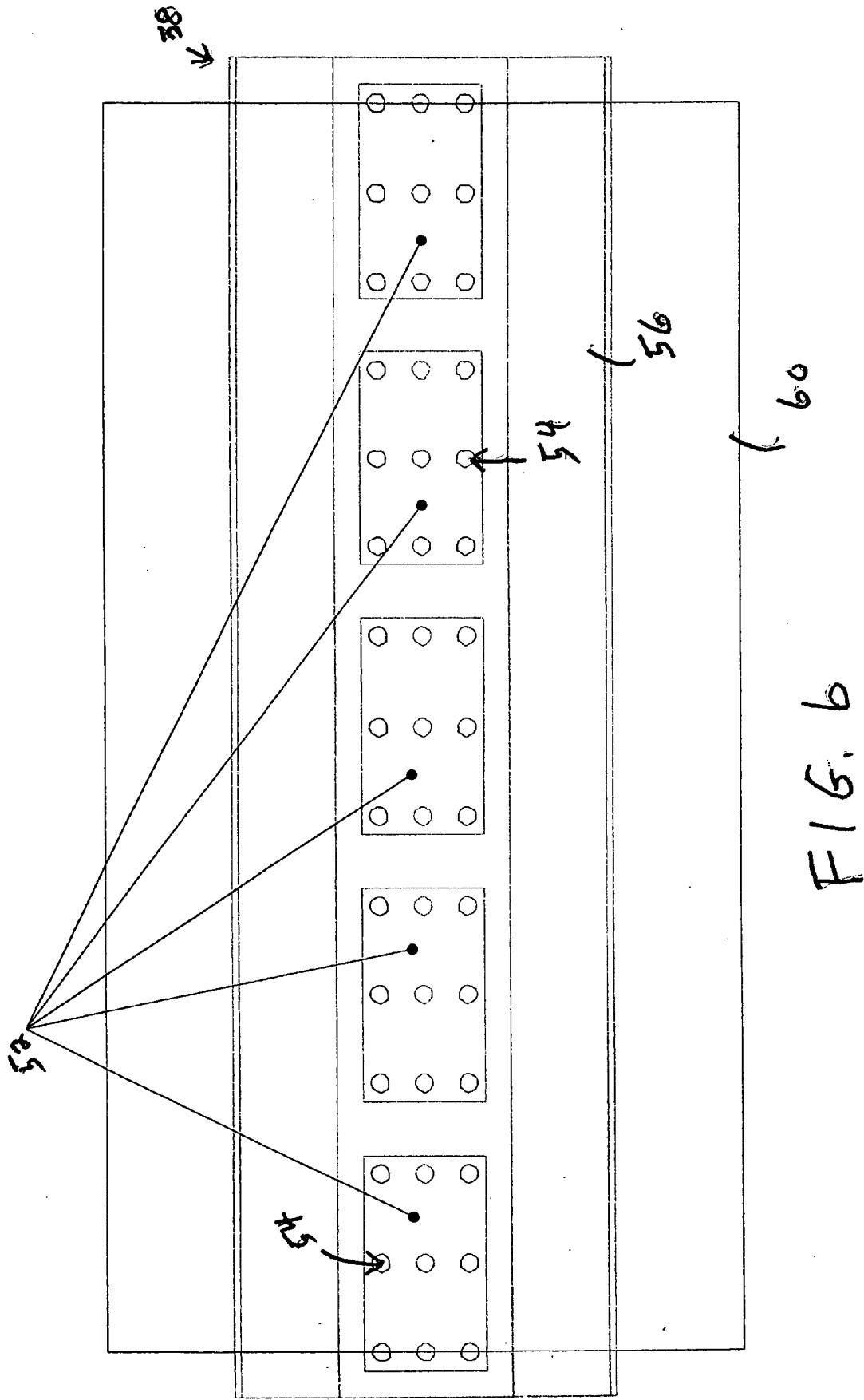
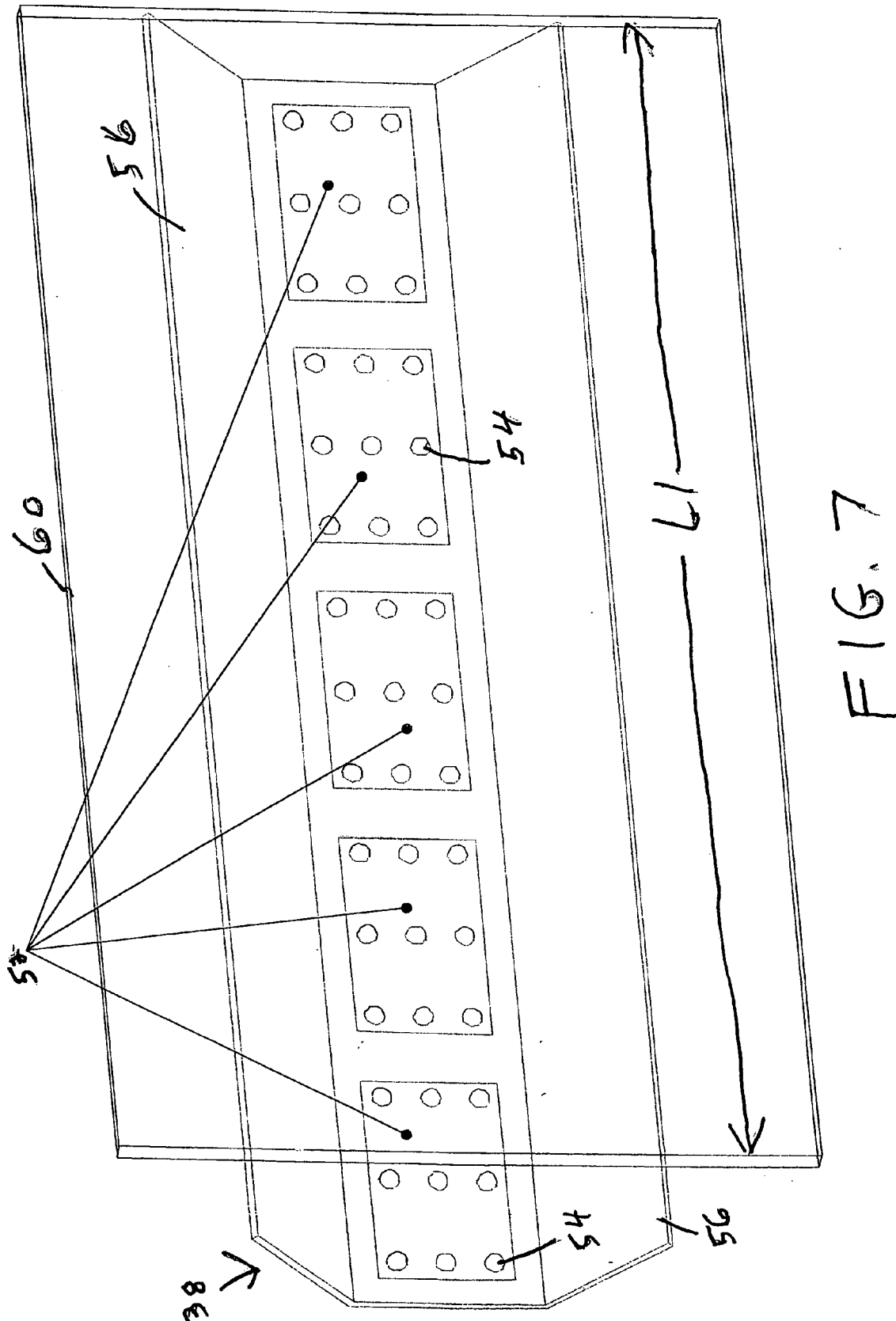


FIG. 2



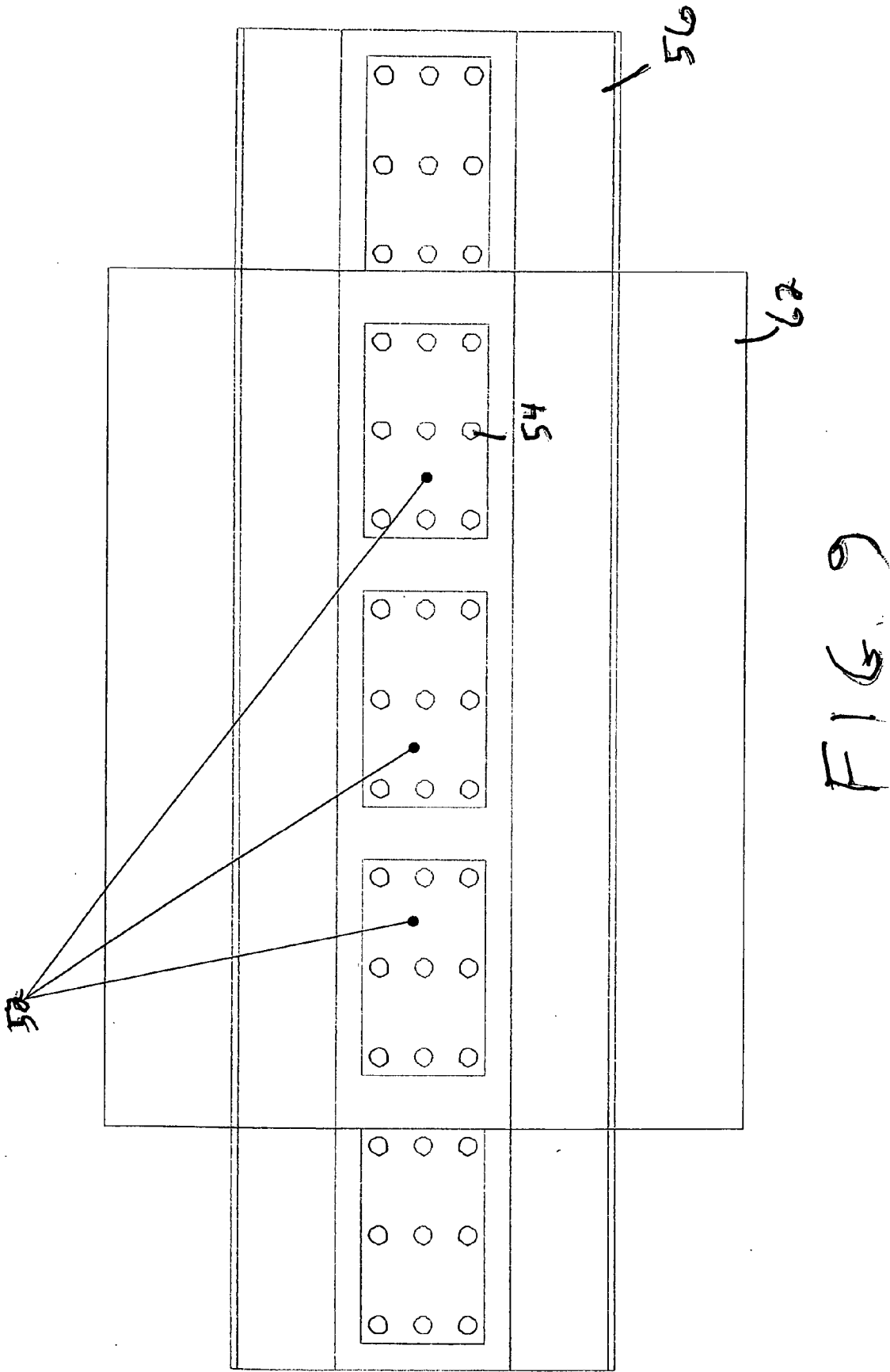












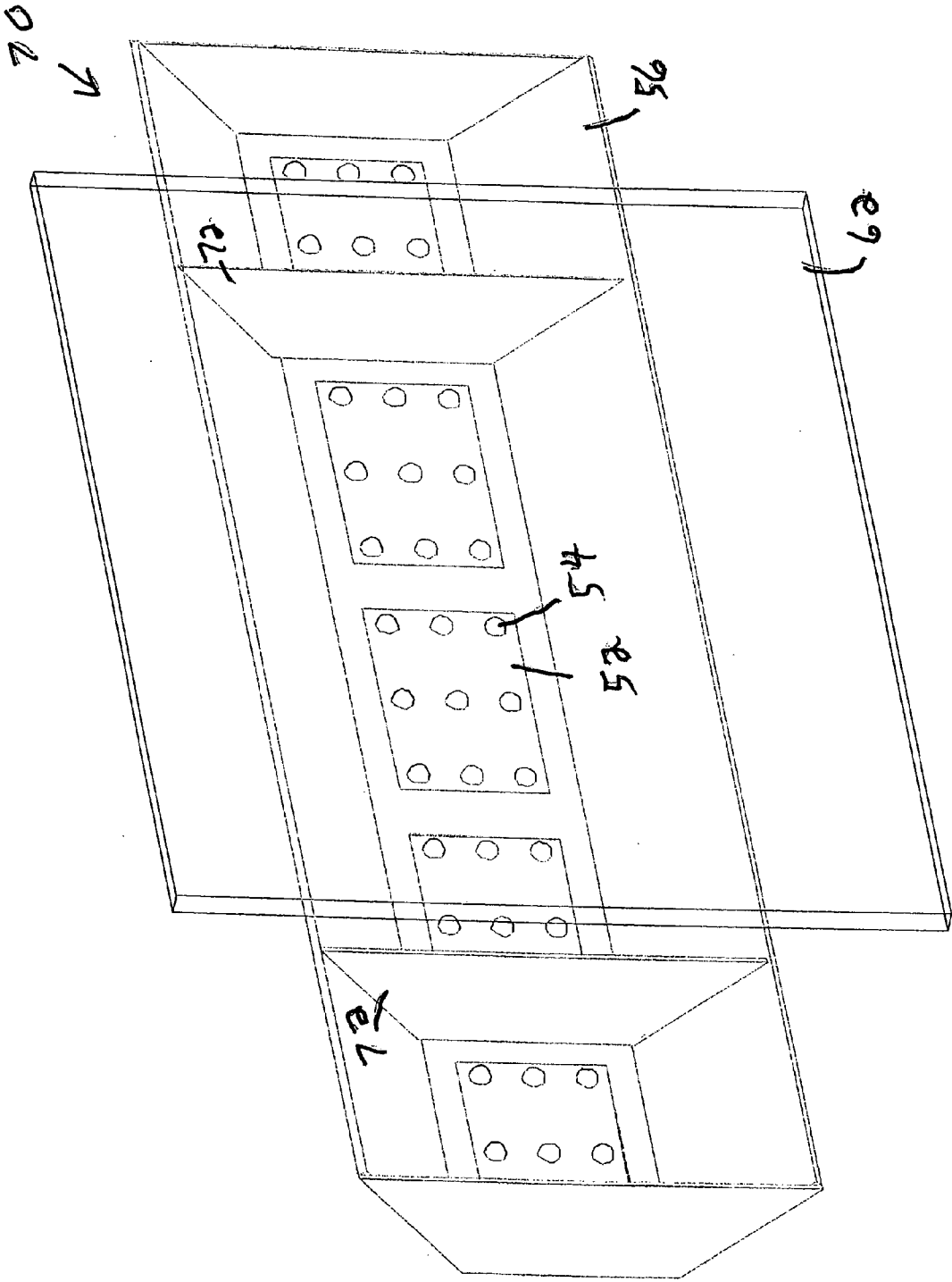


FIG. 10



## STORAGE PHOSPHOR ERASE

### CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part application of U.S. patent application Ser. No. 10/625,923, filed Jul. 24, 2003, inventors Trzcinski et al.

### FIELD OF THE INVENTION

[0002] This invention relates in general to computed radiography systems using storage phosphors to record radiographic images and more particularly to a technique for erasing a storage phosphor so that it can be reused.

### BACKGROUND OF THE INVENTION

[0003] In a storage phosphor computed radiography system, a storage phosphor, also known as a stimulable phosphor, is exposed to an x-ray image of an object, such as a body part of a patient, to record a latent radiographic image in the storage phosphor. The latent radiographic image is read out by stimulating the storage phosphor with stimulating radiation of a first wavelength, such as red or infra-red radiation, produced by a laser. Upon stimulation, the storage phosphor emits stimulated radiation of a second wavelength, such as blue radiation. To produce a signal useful in electronic image processing the storage phosphor is scanned in a raster pattern by a laser beam deflected across one dimension of the storage phosphor by a reciprocating or rotating mirror. The stimulated radiographic image is detected by a photodetector to produce an electronic radiographic image which is digitized and stored, transmitted or output on a display or as a radiographic film.

[0004] The storage phosphor is then erased so that it can be reused. Successful erasure results in removal of any residual image and any background image noise. Many techniques have been used to erase storage phosphors.

[0005] U.S. Pat. No. 6,528,812 B1, issued Mar. 4, 2003, inventors LeBlanc et al., discloses a radiation image readout method and apparatus including an enclosure in which is positioned a photostimulable phosphor screen, a source of stimulating light, an array of transducer elements, and a linear erasing light source, such as an array of 50 to 2000 LEDs. The erasing light source is transported in a sub-scanning direction and illuminates a line of the image after it has been subjected to readout.

[0006] U.S. Pat. No. 4,849,630, issued Jul. 18, 1989, inventors Fukai et al., discloses a cassette and erasure device for a stimulable phosphor sheet. The erasure device can include a matrix of LEDs on substantially the overall surface of the bottom of a casing containing a read-out stimulable phosphor sheet.

[0007] U.S. Pat. No. 4,786,808, issued Nov. 22, 1988, inventor Saito, discloses a residual image erasing apparatus for a stimulable phosphor sheet. The apparatus includes a detector for detecting the distribution of residual radiation in a predetermined direction. An erasing apparatus controlled by the residual radiation detected can include a linear array of point light sources (LEDs), a nonuniform area array of point light emitting elements, or a uniform area array of light emitting elements which are independently controlled by a drive control circuit.

[0008] U.S. Pat. No. 5,051,587, issued Sep. 24, 1991, inventors Hara et al., discloses a radiation image readout method in which the background region is determined and erased before image readout of the image region.

[0009] U.S. Pat. No. 6,140,663, issued Oct. 31, 2000, inventors Neary et al., discloses a technique for erasing a storage phosphor wherein the storage phosphor is first erased using a sodium vapor light source and then using an infrared light source.

[0010] U.S. Pat. No. 4,496,838, issued Jan. 29, 1985, inventors Umemoto et al., discloses an area noise erasing apparatus for a stimulable phosphor sheet including an array of white fluorescent lamps.

[0011] U.S. Pat. No. 5,665,976, issued Sep. 9, 1997, inventor Arakawa, discloses a radiation image readout and erasing method and apparatus. After readout, a stimulable phosphor sheet is passed to a first erasing section wherein the first erasing light contains no light component in a wavelength range that can be detected by the readout photodetector. The sheet is then exposed to a second erasing light having a component in the detectable wavelength range as the sheet is moved back towards the readout section.

[0012] US Patent Application Publication No. 2001/0012386 A1, published Aug. 9, 2001, inventors Struye, et al., discloses a method for readout of a stimulable phosphor screen wherein a pulsed light source is used for stimulation and the stimulating period and readout period do not overlap.

[0013] U.S. Pat. No. 6,773,160 B2, issued Aug. 10, 2004, inventors Evans et al.; U.S. Pat. No. 6,339,225, issued Jan. 15, 2002, inventor Funabashi; US Patent Application Publication No. 2005/0012057 A1, published Jan. 20, 2005, inventors Smith et al.; and U.S. Pat. No. 4,584,482, issued Apr. 22, 1986, inventors Suzuki et al. disclose storage phosphor erase apparatus. US Patent Application Publication No. 2002/0070681 A1, published Jun. 13, 2002, inventors Shimizu et al. discloses an LED lamp.

[0014] None of these references disclose the capability of selectively erasing storage phosphors of different dimensions. There is thus a need for an erasure technique that is low in cost, has long life, compact size, mechanical rigidity, and which can selectively erase storage phosphors of different dimensions.

### SUMMARY OF THE INVENTION

[0015] According to the present invention, there is provided a solution to the problems and a fulfillment of the needs of known erasure techniques.

[0016] According to one aspect of the present invention, there is provided storage phosphor erase apparatus for selectively erasing storage phosphors having different lateral dimensions transported along a first direction, comprising: an array of point sources of erasing radiation spanning at least the greatest lateral dimension of a storage phosphor to be erased; and a control for actuating the array of point sources when a storage phosphor of the greatest lateral dimension is to be erased, and for actuating less than all of said array of point sources when a storage phosphor of a lateral dimension less than said greatest lateral dimension is to be erased.

[0017] The invention is advantageous in that it is low in cost, compact in size, has long life, has mechanical rigidity, and can selectively erase storage phosphors of different dimensions.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The foregoing and other objects, features, and advantages of the invention will be apparent from the following more particular description of the embodiments of the invention, as illustrated in the accompanying drawings. The elements of the drawings are not necessarily to scale relative to each other.

[0019] **FIG. 1** is a block diagram of a computed radiography system incorporating the present invention.

[0020] **FIG. 2** is a diagrammatic view including an embodiment of the present invention.

[0021] **FIGS. 3 and 4** are graphical views useful in explaining the present invention.

[0022] **FIG. 5** is a diagrammatic view of an embodiment of the present invention.

[0023] **FIGS. 6-9** are diagrammatic views useful in explaining the present invention.

[0024] **FIGS. 10-11** are diagrammatic views of another embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE INVENTION

[0025] Referring now to **FIG. 1**, the present invention relates to a computed radiography imaging system **10** in which a storage phosphor is exposed to an x-ray image of an object, such as an individual's body part (box **12**), the stored x-ray image in the storage phosphor is read out in a storage phosphor reader to produce an electronic (digital) radiographic image (box **14**), the electronic image is output on a video display or on a hard copy, such as paper or film (box **16**). The read out storage phosphor containing noise and/or a residual image is then erased by an erasure apparatus (box **18**) and the erased storage phosphor reused (box **20**). The storage phosphor can be a rigid or flexible member, usually contained in a cassette. The storage phosphor read-out and erase procedures are carried out in a storage phosphor reader which extracts an exposed storage phosphor from a cassette, transports the storage phosphor through read-out and erasure assemblies, and then replaces the erased storage phosphor in the cassette.

[0026] According to the present invention, there is provided a storage phosphor erase apparatus and method that can selectively erase storage phosphors of different dimensions. The invention is low in cost, compact in size, has long life and mechanical rigidity. As shown in **FIG. 2**, a storage phosphor **30** is transported in a vertical direction **32** past image readout assembly **34**, baffle **36**, and erase assembly **38**. Image readout assembly **34** typically includes a laser which produces a laser beam of stimulating radiation which is scanned across storage phosphor **30** by a reciprocating or rotating polygon mirror. Stimulated radiation from storage phosphor **30** is detected by a photodetector which converts the stimulated radiation image into an electronic image. Baffle **36** attenuates radiation from erase assembly **38** from passing into image readout assembly **34**. According to one

feature of the present invention, a sensor **44** is provided to sense the lateral dimension of storage phosphor **30**. Control **42** controls the operation of image readout assembly **34**. Control **42** also controls erase assembly **38** as a function of the sensed lateral dimension of storage phosphor **30**.

[0027] Erase assembly **38** produces erase radiation **40** during a period when the image readout laser is off during retrace or the like. This is graphically illustrated in **FIGS. 3 and 4** where, in **FIG. 4**, the erase radiation source is shown on when the read laser is off and, where, in **FIG. 3** the read laser is shown on when the erase radiation source is off.

[0028] **FIG. 5** shows an embodiment of the present invention. As shown, erase apparatus **38** includes several (five) clusters **52** of point sources **54** of erasing radiation, such as Light Emitting Diodes (LEDs) mounted in a high reflectance reflector **56**. Apparatus **38** is dimensioned to at least equal the greatest dimension of a storage phosphor to be erased. Each cluster **52** is shown as including a matrix of three rows and columns of LEDs. It will be understood that any number of clusters can be used to effect proper erasure and that any number of rows and columns of LEDs can constitute each cluster. All of the LEDs **54** in erase apparatus **38** can emit erasing radiation of the same wavelength (such as red or infra-red) or of different wavelengths. For example, in the apparatus of **FIG. 5**, each column of LEDs can include three LEDs, each of which emits erasing radiation of a different wavelength. For example, each column can include an LED **54R** that emits red radiation, an LED **54B** that emits blue radiation, and an LED **54G** that emits green radiation.

[0029] **FIGS. 6 and 7** are plan and perspective diagrammatic views of the embodiment of **FIG. 5** showing erasure of a storage phosphor **60** having a lateral dimension **L1** in which all of the clusters **52** of LEDs are actuated to erase any noise and residual image from storage phosphor **60**. Erase apparatus **38** is controlled by control **42** as a function of the dimension of storage phosphor **60** sensed by sensor **44**. It will be understood that the dimension of storage phosphor **60** can be known from other sources such as information associated with storage phosphor **60** on a cassette containing storage phosphor **60**. Such information can be stored in storage media, such as a bar code, RFID unit, magnetic or optical storage media, or the like. The information can also be entered by an operator of the storage phosphor reader. In the latter cases, sensor **44** would not be needed.

[0030] **FIGS. 8 and 9** are plan and perspective views of the embodiment of **FIG. 5**, showing erasure of a storage phosphor **62** having a lateral dimension of **L2** which is less than the dimension **L1** of storage phosphor **60**. In this case, only the central three clusters **52** of LEDs **54** are actuated to erase any noise or residual image from storage phosphor **62**. It will be understood that should the storage phosphor **62** be transported so that a common edge of different dimensioned storage phosphors coincide, that a different set of clusters **52** would be actuated. It will also be understood that a greater number of different dimensioned storage phosphors can be processed with the necessary number of LED clusters actuated.

[0031] **FIGS. 10 and 11** are perspective views of another embodiment of the present invention. As shown, erase apparatus **70** includes baffles **72** to more efficiently direct the erasing radiation from LED clusters **52** onto a storage phosphor.

[0032] According to the invention, the erase radiation is turned on during retrace of each scanned line or between each scanned line. The radiation can be pulsed to deliver anywhere from 0-300% of allowable electrical energy to the LEDs to erase the storage phosphor during retrace. According to another aspect of the invention, in addition to the erasure method above, if, at the end of image acquisition, a latent image still exists, all LEDs are turned on to continue the erase, preferably as the storage phosphor is reversed in direction.

[0033] The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

#### PARTS LIST

- [0034] 10—computed radiography imaging system
- [0035] 12—storage phosphor exposure
- [0036] 14—storage phosphor image read-out
- [0037] 16—image output
- [0038] 18—storage phosphor erase assembly
- [0039] 20—storage phosphor reused path
- [0040] 30—storage phosphor
- [0041] 32—vertical direction
- [0042] 34—image readout assembly
- [0043] 36—baffle
- [0044] 38—erase assembly
- [0045] 42—control
- [0046] 44—sensor
- [0047] 52—clusters
- [0048] 54—point sources of erasing radiation (LEDs)
- [0049] 54R—red LED
- [0050] 54B—blue LED
- [0051] 54G—green LED
- [0052] 56—high reflectance reflector
- [0053] 60—storage phosphor
- [0054] 62—storage phosphor
- [0055] 70—erase apparatus
- [0056] 72—baffles

1. A storage phosphor erase apparatus for selectively erasing storage phosphors having different lateral dimensions transported along a first direction, comprising:

an array of point sources of erasing radiation spanning at least the greatest lateral dimension of a storage phosphor to be erased; and

a control for actuating all of the array of point sources when a storage phosphor of the greatest lateral dimension is to be erased, and for actuating less than all of the array of point sources when a storage phosphor of a lateral dimension less than the greatest lateral dimension is to be erased.

2. The apparatus of claim 1 wherein the point sources of erasing radiation are Light Emitting Diodes (LEDs).

3. The apparatus of claim 1 wherein all of the array of point sources of erasing radiation emit radiation of the same wavelength.

4. The apparatus of claim 1 wherein the array of point sources of erasing radiation include first and second subsets of point sources that emit radiation of different wavelengths.

5. The apparatus of claim 1 wherein the array of point sources of erasing radiation include clusters of three point sources that emit radiation at multiple different wavelengths.

6. The apparatus of claim 5 wherein the clusters of three point sources respectively emit red, blue, and green radiation.

7. The apparatus of claim 1 wherein the control actuates the array of point sources during the period when a scanning beam of stimulating radiation is off during retrace or between scan lines.

8. The apparatus of claim 1 wherein the control pulses to deliver from 0 to 300% of allowable electrical energy to the point sources.

9. The apparatus of claim 1 wherein the control actuates the point sources of light after image acquisition is ended if a latent image still exists in a storage phosphor.

10. The apparatus of claim 1 including a sensor for determining the lateral dimension of a storage phosphor to be erased; and wherein the control actuates the point sources of erase radiation in response to the sensor determination.

11. The apparatus of claim 1 including a high reflectance reflector associated with the array of point sources of erasing radiation.

12. The apparatus of claim 11 wherein the reflector includes baffles to concentrate the erase radiation on a storage phosphor.

13. The apparatus of claim 1 wherein the array of point sources are arranged in columns across the lateral dimension of the storage phosphor and wherein the control actuates the columns of point sources as a function of the lateral dimension of a storage phosphor to be erased.

14. The apparatus of claim 1 including a source of power for the array of point sources and wherein the power delivered to the point sources from the power source varies from the rated power of the power source.

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