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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. EV 348947454 US

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Additional inventors are being named on the <u>1</u> separately numbered sheets attached hereto					
TITLE OF THE INVENTION (500 characters max)					
Solid State Camera					
Direct all correspondence to: CORRESPONDENCE ADDRESS					
☒ Customer Number: <u>34284</u>					
OR					
☐ Firm or Individual Name					
Address					
Address					
City		State		Zip	
Country		Telephone		Fax	
ENCLOSED APPLICATION PARTS (check all that apply)					
☒ Specification Number of Pages <u>16</u>		☐ CD(s), Number _____			
☒ Drawing(s) Number of Sheets <u>7</u>		☒ Other (specify) <u>See Provisional</u>			
☐ Application Data Sheet. See 37 CFR 1.76					
METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT					
☐ Applicant claims small entity status. See 37 CFR 1.27.				FILING FEE Amount (\$) <u>160.00</u>	
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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.					
☒ No.					
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Respectfully submitted,

[Page 1 of 2]

SIGNATURE

TYPED or PRINTED NAME Robert D. FishTELEPHONE 714-641-5100

Date

REGISTRATION NO. 33,880

(If appropriate)

Docket Number: 023758.0002PRO**USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT**

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Additional Page

PTO/SB/16 (04-04)

Approved for use through 07/31/2006. OMB 0651-0032

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Docket Number 023758.0002PRO

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[Page 2 of 2]

Number 1 of 1

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Addendum

Provisional Application for Patent Cover Sheet (PTO/SB/16): Additional Application Parts
Assignment & Assignment Cover Sheet (18 pages)

PROVISIONAL PATENT APPLICATION

SOLID STATE CAMERA

5 Field of the Invention

The field of the invention is digital imaging.

Background of the Invention

The recent technology transition from film to “electronic media” has spurred the rapid growth of the imaging industry with applications including still and video cameras, cell phones,
10 other personal communications devices, surveillance equipment, automotive applications, computers, manufacturing and inspection devices, toys, plus a wide range of other and continuously expanding applications. The lower cost and size of digital cameras (whether as stand-alone products or imbedded in other appliances) is a primary driver for this growth and market expansion.

15 Although traditional component manufacturers continue to shrink the components to take advantage of the electronic media, it is difficult to achieve the ever tightening demand of digital camera producers for smaller sizes, lower costs and higher performance. Several important issues remain, including: 1) the smaller the size of a digital camera (e.g., in cell phones), the poorer the image quality; 2) complex “lenses”, shutter and flash are still required for medium to
20 higher quality imaging, thus negating much of the size advantage afforded by the electronic media; and 3) the cost advantage afforded by the electronic media is somewhat negated by the traditional complex and costly lens systems and other peripheral components.

Summary of the Invention

In this invention an image sensor comprises separate first and second arrays of photo
25 detectors and a signal processing circuitry that combines signals from the arrays to produce a composite image.

Preferred embodiments include three or more arrays of photo detectors, wherein the signal processing circuitry processes the signals from each array and then combines the signals from all

of the arrays to produce a composite image. Such use of multiple arrays allows each of the arrays to be optimized in some respect, such as for receipt of particular colors. Thus, for example, the arrays can be optimized to detect light of different colors, or other wavelengths. The "colors" can be narrow bands, or broad bands such as red, green, or blue. The bands can
5 even be overlapping.

Optimization can be accomplished in any desired manner, including for example having different average pixel depths, column logic, analog signal logic, black level logic, exposure control, image processing techniques, and lens design and coloration.

A sensor having two or more different arrays could advantageously have a different lens
10 over each of the different arrays. Preferred lenses can employ a die coating, defused dye in the optical medium, a substantially uniform color filter or any other filtering technique through which light passes to the underlying array.

The processing circuitry can comprise any suitable mechanism and/or logic. Of particular interest are circuitries that produce multiple separate images from the different arrays,
15 and then combines the multiple separate images to form a single image. During the process the signal processing circuitry can advantageously execute image enhancement functions, such as address saturation, sharpness, intensity, hue, artifact removal, and defective pixel correction.

As far as integration, it is desirable for the various arrays to be physically located on the same chip. In addition, it is desirable to couple a frame to the chip, and to couple at least one of
20 the lenses to the frame. The lenses can be independently positionable during manufacture, and then sealed to the frame using a sealant or other bonding technique. The integration of these elements is called the "Digital Camera Subsystem" (DCS).

Preferred image sensors contain at least several hundred thousand of the photo detectors, and have a total thickness of no more than 10, 15, or 20 mm, including the lens and frame. Such
25 small DCS devices may be incorporated into a semiconductor "package" or directly attached to a circuit board ("packageless"), using wave soldering, die on board, or other techniques. The DCS and/or board can then be incorporated into cameras or other devices having user interface elements, memory that stores images derived from the arrays, and at least one power supply that

provides power to the system. The DCS, cameras and other devices of the invention can be used for any suitable purpose, including especially still and video imaging, calculating a distance, and creating a 3D effect.

Various objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the invention, along with the accompanying drawings in which like numerals represent like components.

Brief description of Drawings

Figure 1 illustrates a prior art digital camera, and its primary components.

Figure 2 illustrates a digital camera, and its primary components, including the DCS.

Figure 3 is a schematic of a DCS.

Figure 4 is a schematic of prior art image capturing elements of a digital camera.

Figure 5 is a schematic of image capture using the DCS of Figures 1 & 2.

Figure 6 is a flow chart for an alternative DCS having four arrays.

Figure 7 is a schematic of a four-lens system used in the DCS of Figure 4.

Detailed Description

In Figure 1, a digital camera 1 generally includes the primary image capturing elements of an image sensor 150, a color filter sheet 160 and a series of lenses 170. Additional electronic components typically include a circuit board 110, peripheral user interface electronics 120, (here represented as the shutter button, but could also include display, setting controls, etc), power supply 130, and electronic image storage media 140.

Figure 2 illustrates a digital camera 2 including a Digital Camera Subsystem (DCS) 200. The additional electronic components generally still include a circuit board 110, peripheral user interface electronics 120, (here represented as the shutter button, but could also include display, setting controls, etc), power supply 130, and electronic image storage media 140.

5

Although Figure 2 reflects a digital still camera, the camera is intended to be emblematic of a generic appliance containing the DCS. Thus, Figure 2 should be interpreted as being emblematic of still and video cameras, cell phones, other personal communications devices, surveillance equipment, automotive applications, computers, manufacturing and inspection devices, toys, plus a wide range of other and continuously expanding applications. Of course these alternative interpretations of the Figure may or may not include the specific components as depicted in Figure 2. For example, the circuit board may not be unique to the camera function but rather the DCS may be an add-on to an existing circuit board, such as in a cell phone.

10
15 Although the DCS 200 in Figure 2 is depicted in a three array/lens configuration, those skilled in the art will appreciate that the DCS can be in a configuration having any multiple numbers and shapes of arrays/lenses.

Image sensor 210 (Figure 3) generally includes a semiconductor chip having several higher order features including multiple arrays (210A – 210 D), and signal processing circuitries 212 and 214, in which each array and the related signal processing circuitry is preferably tailored to address a specific band of visible spectrum. As noted above, the image sensor portion can be configured using any multiple numbers and shapes of arrays. Sensor 210 can be constructed using any suitable technology, including especially silicon and germanium technologies. The pixels can be

formed in any suitable manner, can be sized and dimensioned as desired, and can be distributed in any desired pattern. Pixels that are distributed without any regular pattern could even be used.

Each of lenses 230A-D is advantageously tailored for the respective wavelength of the respective array. Lenses will generally be about the same size as the underlying array, and will therefore

5 differ from one another in size and shape depending upon the dimensions of the underlying array. Of course, there is no requirement that a given lens cover all, or only, the underlying array. In alternative embodiments a lens could cover only a portion of an array, and could extend beyond the array. Lenses can comprise any suitable material or materials, including for example, glass and plastic. Lenses can be doped in any suitable manner, such as to impart a
10 color filtering, polarization, or other property. Lenses can be rigid or flexible.

Frame 220 is used to mount the lenses to the image sensor 210. In this particular example, each lens, array, and signal processing circuitry constitutes an image generating subsystem for a band of visible spectrum (e.g., red, blue, green, etc). These individual images are then combined with additional signal processing circuitry within the semiconductor chip to form a full image for
15 output.

Definitions

As used herein, the following terms are interpreted as described below, unless the context requires a different interpretation.

20 “Array” means a group of photo detectors, also known as pixels, which operate in concert to create one image. The array captures the photons and converts the data to an electronic signal. The array outputs this raw data to signal processing circuitry that generates the image sensor image output.

“Digital Camera” means a single assembly that receives photons, converts them to electrical signals on a semiconductor device (“image sensor”), and processes those signals into an output that yields a photographic image. The digital camera would included any necessary lenses, image sensor, shutter, flash, signal processing circuitry, memory device, user interface
5 features, power supply and any mechanical structure (e.g. circuit board, housing, etc) to house these components. A digital camera may be a stand-alone product or may be imbedded in other appliances, such as cell phones, computers or the myriad of other imaging platforms now available or may be created in the future, such as those that become feasible as a result of this invention.

10 “Digital Camera Subsystem” (DCS) means a single assembly that receives photons, converts them to electrical signals on a semiconductor device (“image sensor”) and processes those signals into an output that yields a photographic image. At a minimum, the Digital Camera Subsystem would include any necessary lenses, image sensor, signal processing circuitry, shutter, flash and any frame to hold the components,as may be required. The power supply,
15 memory devices and any mechanical structure are not necessarily included.

“Electronic media” means that images are captured, processed and stored electronically as opposed to the use of film.

“Frame” or “thin plate” means the component of the DCS that is used to hold the lenses and mount to the image sensor.

20 “Image sensor” means the semiconductor device that includes the photon detectors (“pixels”), processing circuitry and output channels. The inputs are the photons and the output is the image data.

“Lens” means a single lens or series of stacked lenses (a column one above the other) that shape light rays above an individual array. When multiple stacks of lenses are employed over
25 different arrays, they are called “lenses.”

“Package” means a case or frame that an image sensor (or any semiconductor chip) is mounted in or on, which protects the imager and provides a hermetic seal. “Packageless” refers

to those semiconductor chips that can be mounted directly to a circuit board without need of a package.

The terms "Photo detector" and "pixels" mean an electronic device that senses and captures photons and converts them to electronic signals. These extremely small devices are used in large quantities (hundreds of thousands to millions) in a matrix to capture an image much like film.

"Semiconductor Chip" means a discrete electronic device fabricated on a silicon or similar substrate, which is commonly used in virtually all electronic equipment.

"Signal Processing Circuitry" means the hardware and software within the image sensor that translates the photon input information into electronic signals and ultimately into an image output signal.

Imager Sensor Chip

As previously stated, the Image sensor 210 (Figure 3) generally includes a semiconductor chip having several higher order features including multiple arrays (210A – 210 D), and signal processing circuitry 212, in which each array and the related signal processing circuitry is preferably tailored to address a specific band of visible spectrum. As noted above, the image sensor portion can be configured using any multiple numbers and shapes of arrays. Sensor 210 can be constructed using any suitable technology, including especially silicon and germanium technologies. The pixels can be formed in any suitable manner, can be sized and dimensioned as desired, and can be distributed in any desired pattern. Pixels could even be used that are distributed without any regular pattern.

The image sensor chip 210 comprises arrays (designated 210A-D). Note the configuration in Figure 2 illustrates a 4 array/lens structure although as previously stated, any multiple number of arrays/lenses as well as various combinations thereof is possible. Any range of visible spectrum can be applied to each array depending on the specific interest of the

customer. Further, an infrared array could also be employed as one of the array/lens combinations giving low light capabilities to the sensor.

Signal processing circuitry 212 processes signals for each of the individual arrays. Signal processing circuitry 214 combines the output from signal processing 212 into output data (usually in the form of a recombined full color image). Further, although signal processing circuitries 212 and 214 in figure 3 point to specific areas of the image sensor, the signal processing circuitries can be placed anywhere on the chip and subdivided in any fashion. The signal processing circuitries in fact will likely be placed in multiple locations.

As previously described, the arrays 210A-D may be of any size or shape. Figure 3 shows the arrays as individual, discrete sections of the image sensor. These arrays may also be touching. There may also be one large Array configured such that the array is subdivided into sections whereby each section is focused upon one band of spectrum, creating the same effect as separate arrays on the same chip.

In **Figure 4**, the traditional (prior art) photon capture process is illustrated. Each traditional image sensor semiconductor chip 910 contains an array of identical photo detectors (pixels) laid out in a matrix, usually numbering from hundreds of thousands to millions of pixels. To create a color image, each pixel has a separate color filter above it so that each pixel receives a specific band of visible spectrum. These color filters are laid over the pixels in the form of a sheet 920. Historically, the pattern of these color filters, known as the "Bayer Pattern" uses filters of red, green, blue and typically a second green (patterns may vary depending on the need of the customer). This pattern is repeated over the entire array as illustrated. The full spectrum of visible light 999 strikes the set of lenses, which essentially passes along the full spectrum. The full spectrum then strikes the color filters where each of the individual color filters passes its specific band of spectrum on to its specific pixel. This process is repeated for every pixel. Note that this technique (e.g., a filter per pixel), limits the minimal size of a pixel due to the minimal size to which these individual color filters can be made. The signal processing circuitry receives these alternating color signals, processes them in a uniform fashion and ultimately outputs a color image.

In **Figure 5**, the process of stepping across the array (a pixel at a time), integrating each set of four pixels (red/green/blue/green or variation thereof) into a full single color pixel, is supplanted by the DCS. Rather than this Bayer pattern (or variations thereof) alternating approach of collecting the specific colors that form an image, the DCS employs separate arrays (210A-D) on one image sensor. Each array focuses on a specific band of visible spectrum. As such, each array may be tuned so that it is more efficient in capturing and processing the image in that particular color. Individual lenses (230A-D) can be tailored for the array's band of spectrum. Again, this figure depicts a four array/lens arrangement, but the technique can be employed for any multiple number or shape of arrays/lenses. As such, each lens only needs to pass that color (999A-D) on to the image sensor. The traditional color filter sheet is eliminated. Signal processing circuitry for each of these arrays is also tailored for each of the bands of visible spectrum. In effect, individual images are created for each of these arrays. Following this process, the individual images are combined to form one full color or black/white image. By tailoring each array and the associated signal processing circuitry, a higher quality image can be generated than the image resulting from traditional image sensors of like pixel count.

Figure 6 depicts some of the many processing steps that can be advantageously used to tailor the image sensor.

Although the well depth of the photo detectors across each individual array (designated 210A-D) will likely be the same, the well depth of any given array can readily be manufactured to be different from that of other arrays on the image sensor. Selection of an appropriate well depth could depend on many factors, including most likely the targeted band of visible spectrum. Since each entire array is likely to be targeted at one band of visible spectrum (e.g., red) the well depth can be designed to capture that wavelength and ignore others (e.g., blue, green).

Doping of the semiconductor material in the color specific arrays can further be used to enhance the selectivity of the photon absorption for color specific wavelengths.

The array then outputs the signals to the signal processing circuitry 212. Within the signal processing circuitry, each array can be processed separately to tailor the processing to the respective bands of spectrum. Several functions occur:

The column logic (212.1A-D) is the portion of the signal processing circuitry that reads the signals from the pixels. Since the array is targeting a specific wavelength, the column logic may have different integration times for each array enhancing both dynamic range as well as color specificity. Signal processing circuitry complexity for each array can be substantially
5 reduced since logic does not have to switch between extreme color shifts.

The Analog Signal Logic (ASL) (212.2A-D) for each array can now be color specific. The ASL processes a single color and therefore can be optimized for gain, noise, dynamic range, linearity, etc. Due to color signal separation, dramatic shifts in the logic and settling time are not required as the amplifiers and logic do not change on a pixel by pixel (color to color) basis as in
10 traditional Bayer patterned designs.

The black level logic (212.3A-D) assesses the level of noise within the signal, and filters it out. With each array focused upon a narrower band of visible spectrum than traditional image sensors, the black level logic can be more finely tuned to eliminate noise.

The exposure control (212.4A-D) measures the overall volume of light being captured by
15 the array and will adjust the capture time for image quality. Traditional cameras must make this determination on a global basis (for all colors). Our invention allows for exposure control to occur for each array and targeted band of wavelengths differently.

These processed images are then passed to the second group of signal processing circuitry 214. First, the image processing logic 214.1 integrates the multiple color planes into a
20 single color image. The image is adjusted for saturation, sharpness, intensity, hue, artifact removal, and defective pixel correction. The IPL also provides the algorithmic auto focus, zoom, windowing, pixel binning and camera functions.

The final two steps are to encode the signal into standard protocols 214.2 such as MPEG, JPEG, etc. before passing to a standard output interface 214.3, such as USB.

Lens

In Figure 1, a traditional digital camera 1, employing one large array on the image sensor
150, also employs one set of lenses 170 that generally spans the entire array. That creates two

physical size related issues: 1) a lens that spans a large array (e.g. 3 Meg pixels) will be physically larger than a lens that spans a smaller array (e.g., 1 Meg pixels) in both diameter and thickness; and 2) a larger lens/array combination will likely have a longer focal length which will increase the height of the image sensor.

5 Also, since the traditional lens must handle the entire spectrum of visible light wavelengths, they are complex, usually with 3 – 8 separate elements. This also adds height and cost.

 Further, since the traditional lens must pass all bandwidths of color, it must be a clear lens (no individual color filtering). The needed color filtering previously described is
10 accomplished by laying a sheet of tiny color filters 160 beneath the lens and above the image sensor. For example, an image sensor with one million pixels will require a sheet of one million individual color filters. This technique is costly (parts and assembly), presents a limiting factor in shrinking the size of the pixels, plus attenuates the photon stream passing through it (i.e., reduces light sensitivity or dynamic range).

15 As shown in **Figure 7**, the DCS can have multiple separate arrays on a single image sensor, each with its own lens (represented by 230A & C). The simple geometry of smaller, multiple arrays allows for a smaller lens (diameter, thickness and focal length), which allows for reduced stack height in the digital camera.

 Each array can advantageously be focused on one band of visible spectrum. Among
20 other things, each lens may be tuned for passage of that one specific band of wavelength. Since each lens would therefore not need to pass the entire light spectrum, the number of elements will be reduced, likely to one or two.

 Further, due to the focused bandwidth for each lens, each of the lenses may be dyed during the manufacturing process for its respective bandwidth (e.g., red for the array targeting
25 the red band of visible spectrum). Alternatively, a single color filter may be applied across each lens. This process eliminates the traditional color filters (the sheet of individual pixel filters) thereby reducing cost, improving signal strength and eliminating the pixel reduction barrier.

Elimination of the color filter sheet allows for reductions in the physical size of the pixel for further size reductions of the overall DCS assembly.

Although the DCS lenses depicted in the various figures show individual lenses per array, assembled into a frame, the lenses could be manufactured such that the lenses per image sensor come as one mold or component. Further, this one-body construction could also act as the frame for mounting to the image sensor.

The lens and frame concept can be applied to traditional image sensors (without the traditional color filter sheet) to gain physical size, cost and performance advantages.

10 **Frame**

In Figure 7 the frame 220 is a thin plate bored to carry the individual lenses (represented by 230A & C) over each array. Lenses may be fixed to the frame in a wide range of manners: adhesive, press fit, electronic bonding, etc. The mounting holes may have a small “seat” at the base to control the depth of the lens position. The depth may be different for each lens and is a result of the specific focal length for the particular lens tailored for each array.

As shown, the frames are solid devices that offer a wide range of options for manufacturing, material, mounting, size, and shape. Of course, other suitable frames can be readily designed, all of which fall within the inventive scope.

System

20 The above-described devices can include any suitable number of combinations, from as few as 2 arrays/lenses or in a broader array. Examples include:

- 3 arrays/lenses: red, green, blue
- 4 arrays/lenses: red, blue, green, emerald (for color enhancement)
- 4 arrays/lenses: red, blue, green, infrared (for low light conditions)

- 8 arrays/lenses: double the above configurations for additional pixel count and image quality

The inventive subject matter can provide numerous benefits in specific applications. For example, traditional color filters are limited in their temperature range, which limits end user manufacturing flexibility. Wave soldering processes, low cost, mass production soldering
5 processes, cannot be used due to the color filters' temperature limitations. The inventive subject matter does not have that limitation.

In addition, once the imager sensor, frame, and lenses are assembled, the assembly can be a hermetically sealed device. The device does not need a "package" and as such, if desired, can be mounted directly to a circuit board which saves parts and manufacturing costs.

10 Because multiple images are created from separate locations (albeit a small distance between the arrays on the same image sensor), parallax is created, which can be eliminated in the signal processing circuitry or utilized/enhanced for numerous purposes: including for example: to measure distance to the object, and to provide a 3-D effect.

It should be apparent, however, to those skilled in the art that many more modifications
15 besides those already described are possible without departing from the inventive concepts herein. Moreover, in interpreting the disclosure, all terms should be interpreted in the broadest possible manner consistent with the context. In particular, the terms "comprises" and "comprising" should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps could be present,
20 or utilized, or combined with other elements, components, or steps that are not expressly referenced.

CLAIMS

What is claimed is:

1. An image sensor comprising physically separate first and second arrays of photo detectors and a signal processing circuitry that combines signals from the arrays to produce a composite image.
2. The image sensor of claim 1 further comprising a third array of photo detectors, wherein the signal processing circuitry combines signals from the first, second, and third arrays to produce a composite image.
3. The image sensor of claim 1 further comprising a mechanism that renders the first and second arrays to detect light of two distinct colors, respectively.
4. The image sensor of claim 3 wherein at least one of the colors is red.
5. The image sensor of claim 1 further comprising a third array of photo detectors, and a mechanism that renders the first, second and third arrays to detect light of three distinct colors, respectively.
6. The image sensor of claim 5 wherein the colors are red, green and blue.
7. The image sensor of claim 5 wherein at least one of the colors is infrared.
8. The image sensor of claim 1, wherein the first and second arrays have different average pixel depths.
9. The image sensor of claim 1, wherein the first and second arrays are read using different column logics.
10. The image sensor of claim 1, wherein the first and second arrays have different analog signal logic.
11. The image sensor of claim 1, wherein the first and second arrays have different black level logic.

12. The image sensor of claim 1, wherein the first and second arrays have different exposure control.
13. The image sensor of claim 1, wherein the first and second arrays have different image processing.
14. The image sensor of claim 1, further comprising a first colored lens through which light passes to the first array.
15. The image sensor of claim 1, further comprising a substantially uniform color filter sheet through which light passes to the first array.
16. The image sensor of claim 1, further comprising a different lens for each of the first and second arrays.
17. The image sensor of claim 1, wherein the processing circuitry produces multiple separate images, and then combines the multiple separate images.
18. The image sensor of claim 1, wherein the processing circuitry comprises a separate processor for processing output of the first and second arrays.
19. The image sensor of claim 1, wherein the signal processing circuitry executes an image enhancement function which includes, but is not limited to, saturation, sharpness, intensity, hue, artifact removal, and defective pixel correction.
20. The image sensor of claim 1, wherein the first and second arrays are physically located on the same chip.
21. The image sensor of claim 1, wherein at least one of the first and second arrays, and at least part of the processing circuitry is disposed on a chip.
22. The image sensor of claim 1, wherein at least one of the first and second arrays is disposed on a chip, and further comprising a frame coupled to the chip, and at least one lens coupled to the frame.

23. The image sensor of claim 22, further comprising a sealant that seals the frame to at least one of the lens and the chip.
24. The image sensor of claim 1, wherein at least one of the first and second arrays is disposed on a chip, and further comprising a frame coupled to the chip, and a plurality of lenses coupled to the frame, the lenses being independently positionable during manufacture.
25. The image sensor of claim 1, wherein at least one of the first and second arrays contains at least 1 million of the photo detectors.
26. The image sensor of claim 25, having a total thickness of no more than 15 mm.
27. The image sensor of claim 25, having a total thickness of no more than 10 mm.
28. A camera comprising an image sensor according to claim 1, further comprising a memory that stores an image derived from at least one of the arrays, and at least one power supply that provides power to the signal processing circuitry.
29. A camera comprising a circuit board, upon which is mounted an image sensor according to claim 1 without the image sensor being placed within a package.
30. The camera of claim 29, wherein the image sensor is mounted on the circuit board using a wave soldering technique.
31. The image sensor of claim 1, wherein the processing circuitry uses data from the arrays to accomplish at least one of the following: calculate a distance and create a 3D effect.

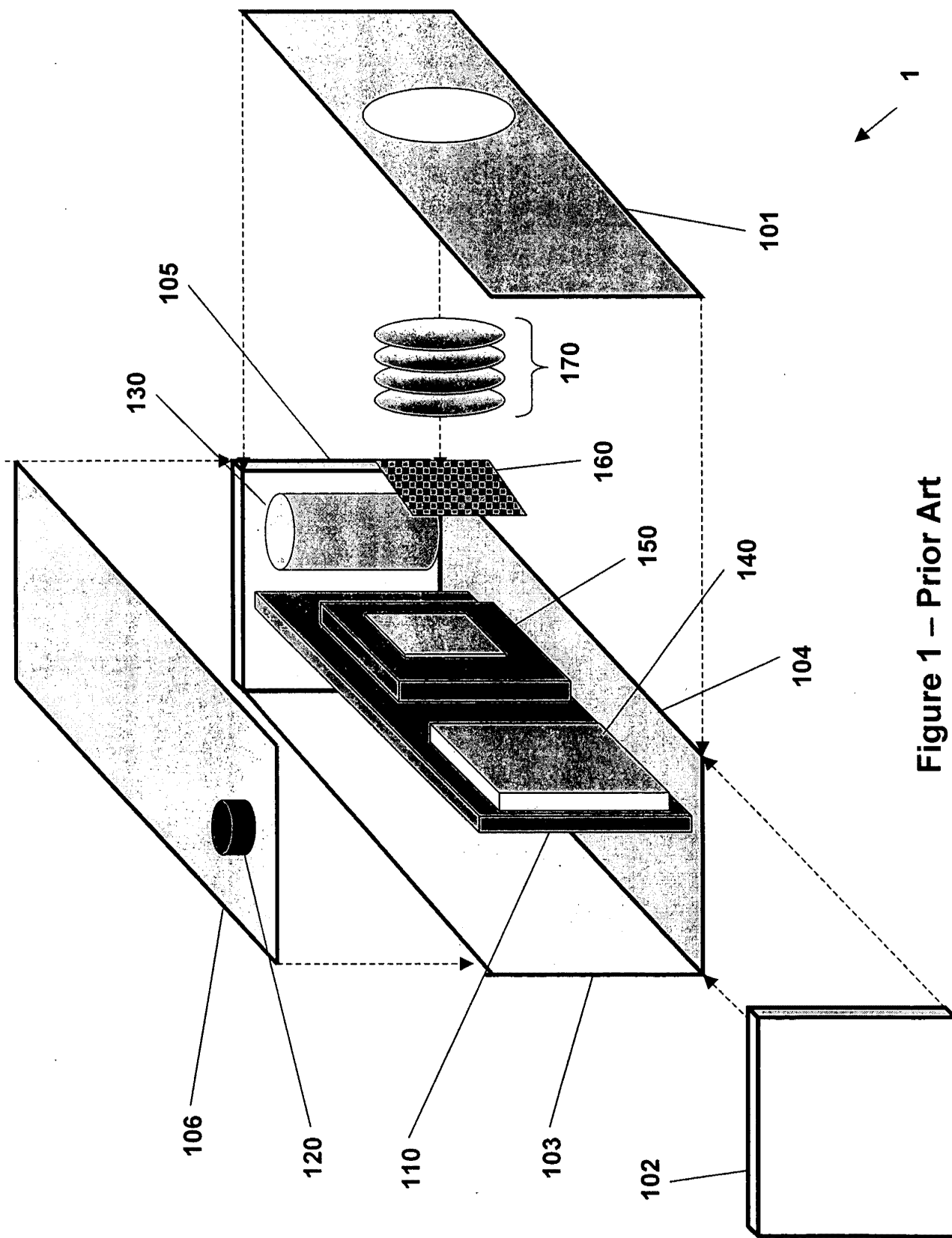


Figure 1 – Prior Art

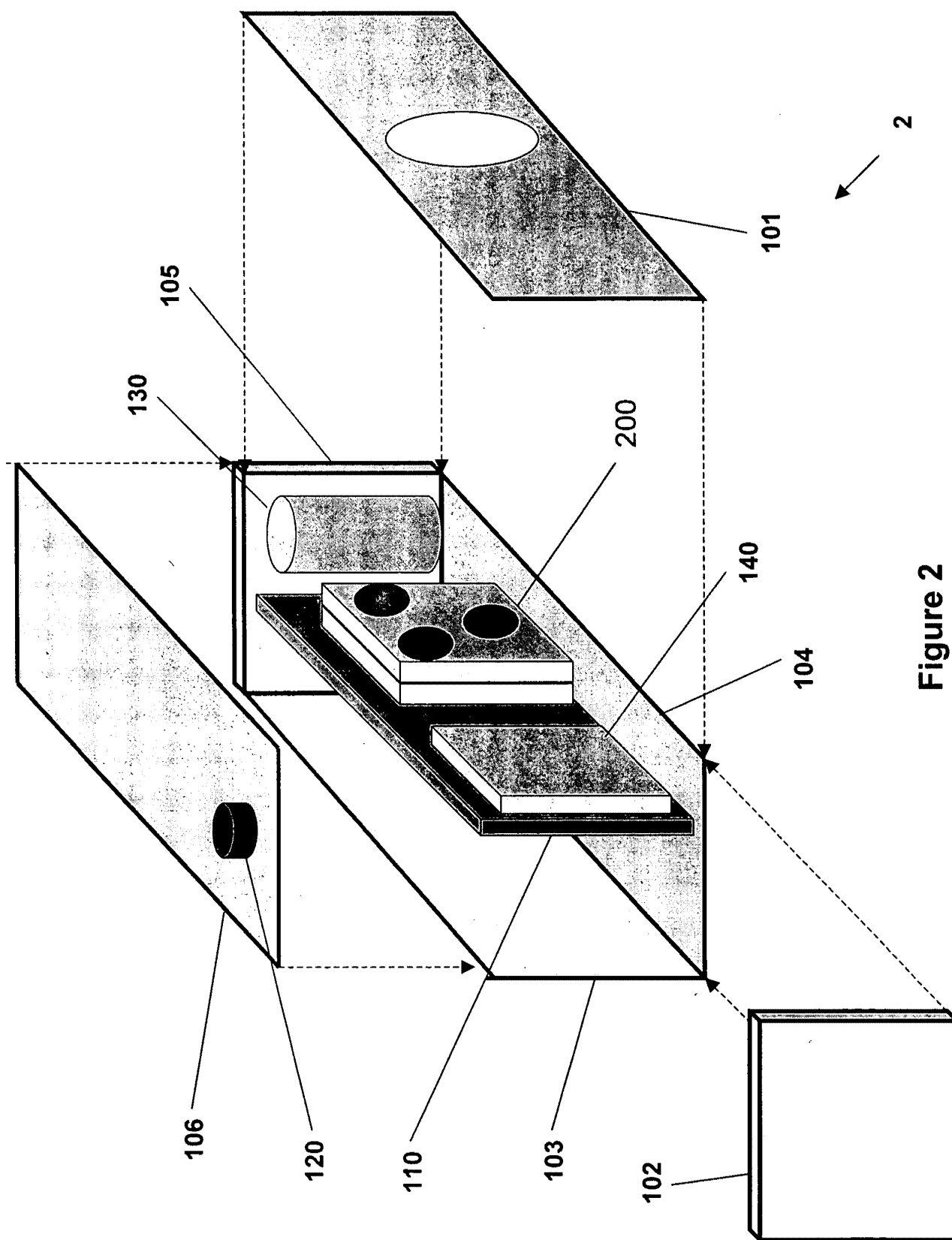


Figure 2

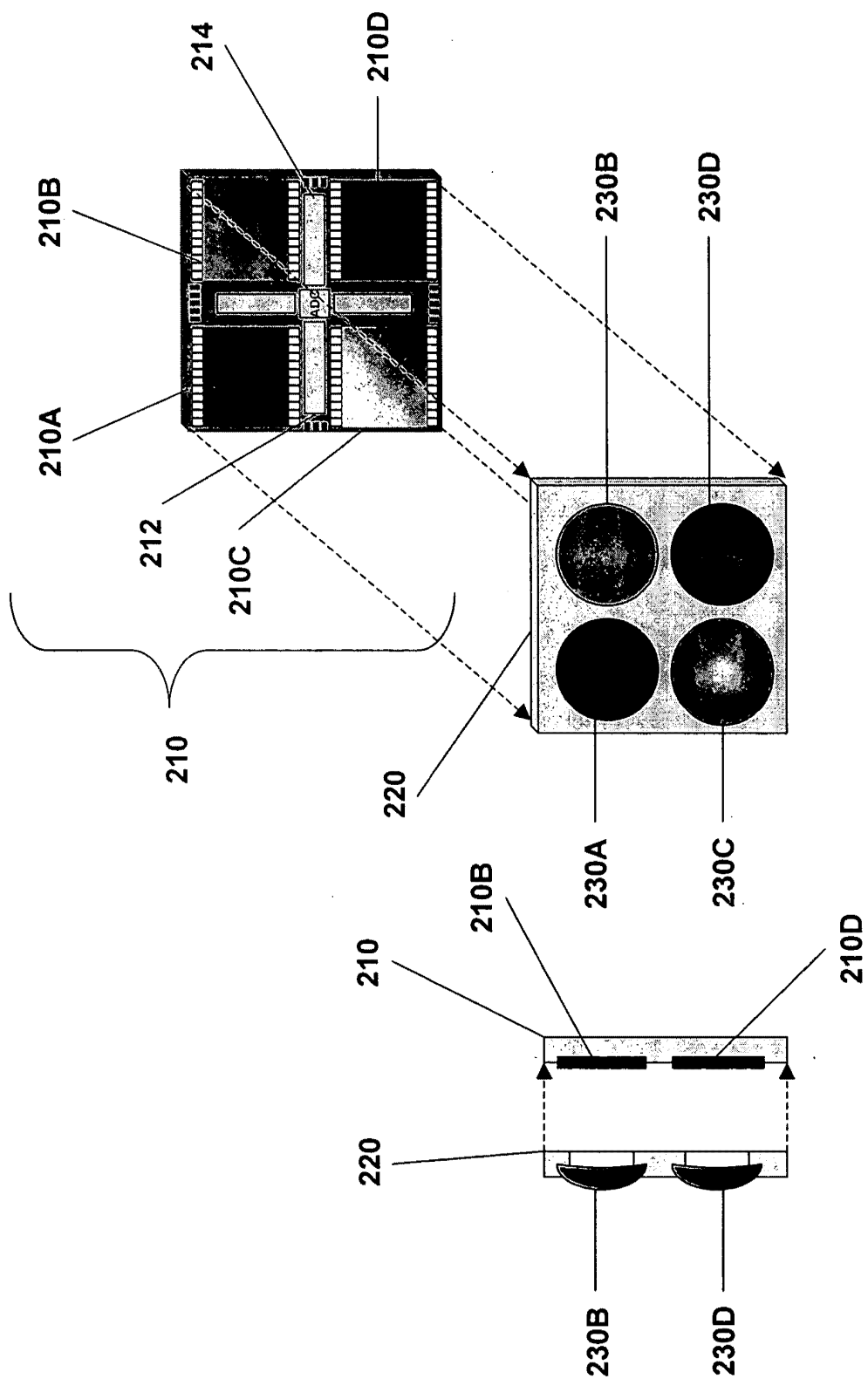


Figure 3

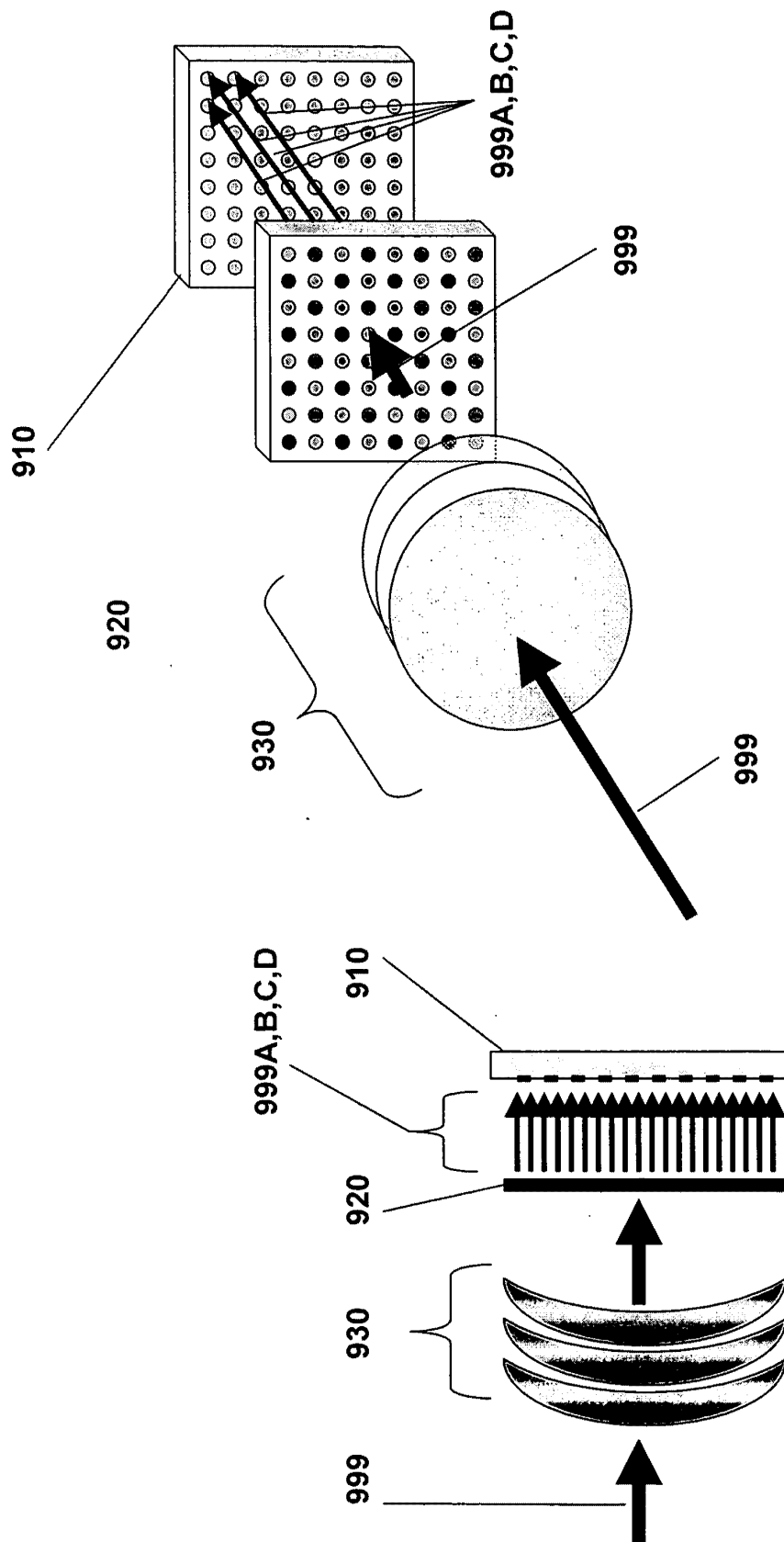


Figure 4 – Prior Art

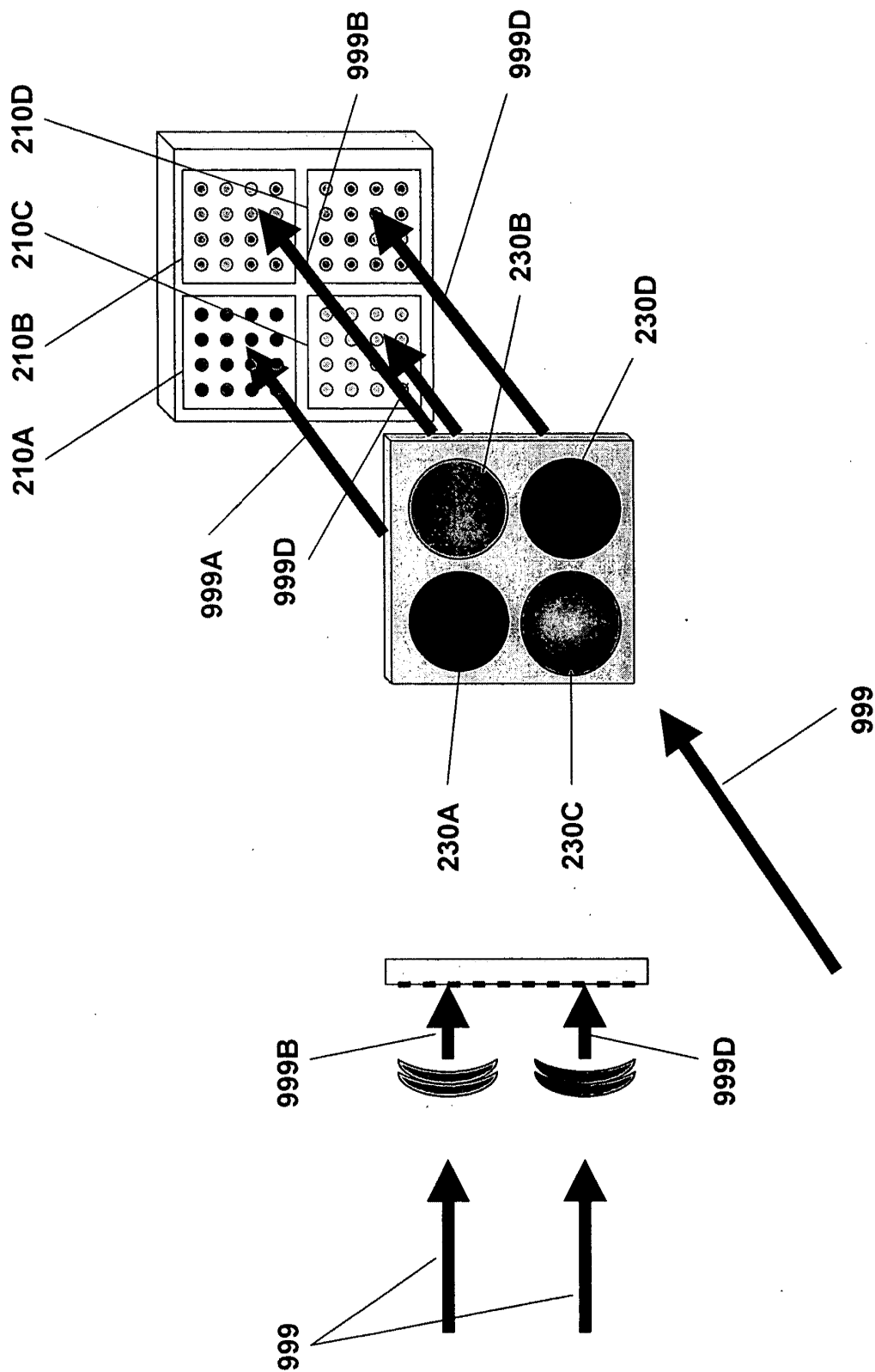


Figure 5

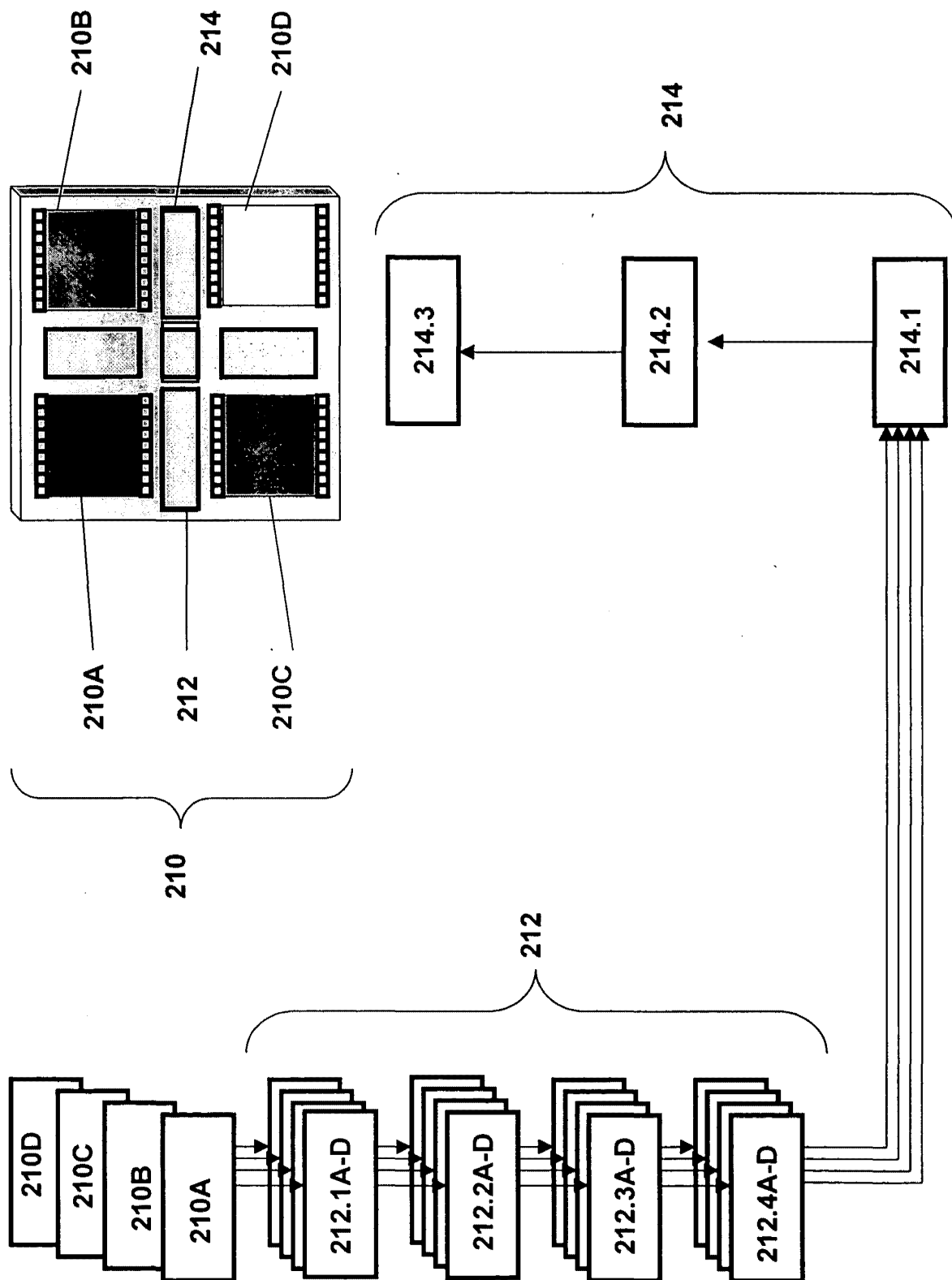


Figure 6

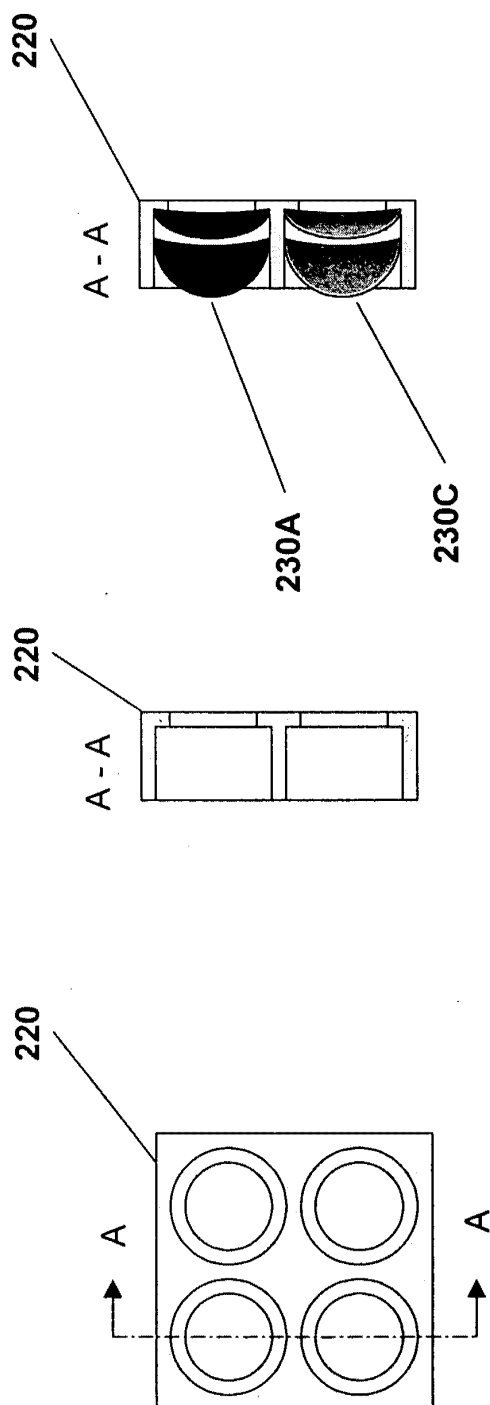


Figure 7