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Araghi et al.

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[54] **REPLACEABLE IMAGE SENSOR ARRAY**

[75] Inventors: **Mehdi N. Araghi**, Webster; **Jagdish C. Tandon**, Fairport, both of N.Y.

[73] Assignee: **Xerox Corporation**, Stamford, Conn.

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[51] **Int. Cl.**[4] **H01L 21/306**; B44C 1/22

[52] **U.S. Cl.** **156/647**; 156/633; 156/659.1; 156/662; 357/32; 357/55; 357/60

[58] **Field of Search** 156/629, 630, 633, 647, 156/659.1, 662; 357/32, 55, 60, 75

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Primary Examiner—Peter Hruskoci

Attorney, Agent, or Firm—Frederick E. McMullen

[57] **ABSTRACT**

An image sensor array and method of fabrication which facilitates replacement of a defective one in a series of arrays butted together to form a longer scanning array in which a (110) silicon wafer having a row of photosites has separation lines etched thereon by orientation dependent etching along the (111) planes, with the separation lines for the opposite ends of the array each consisting of first and second partial boundary lines longitudinally offset from one another connected by a third boundary line so that the ends of the array have a has a generally L-shaped offset permitting bi-directional separating and aligned inserting movement when replacing a defective array.

In a second embodiment, the arrays are formed on (100) silicon with alternating 'nail' head and 'mesa' head shapes to facilitate removal and replacement of a defective array.

4 Claims, 3 Drawing Figures

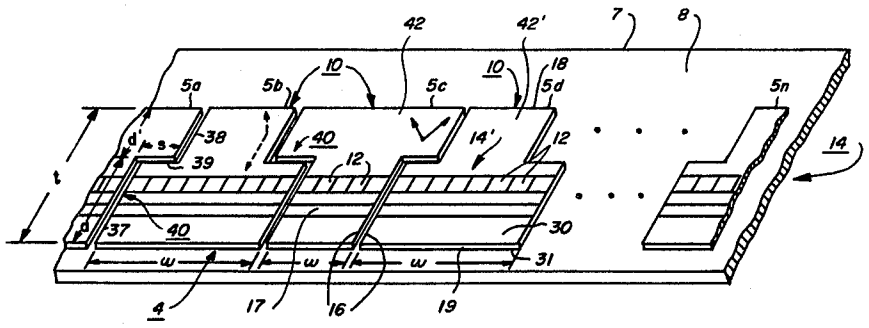

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FIG. 1

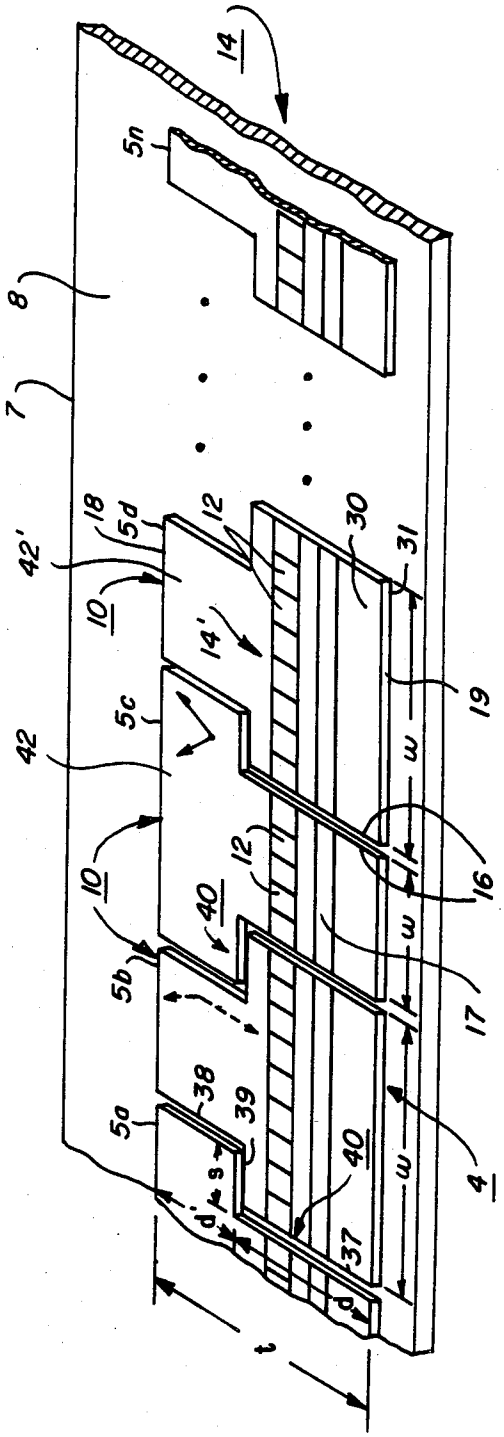

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FIG. 2

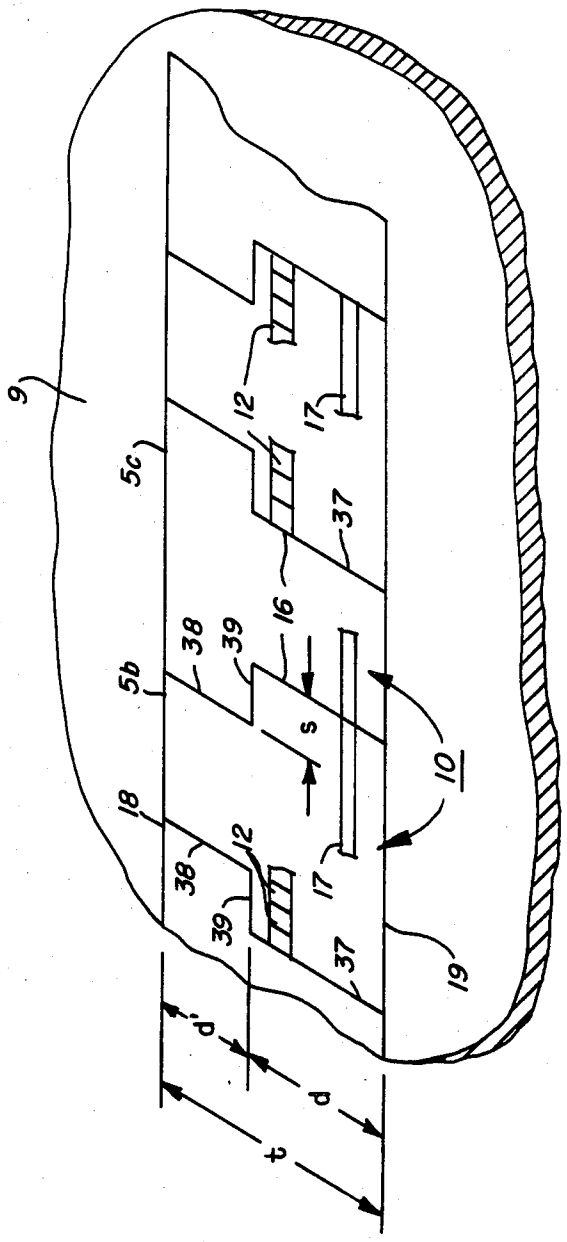

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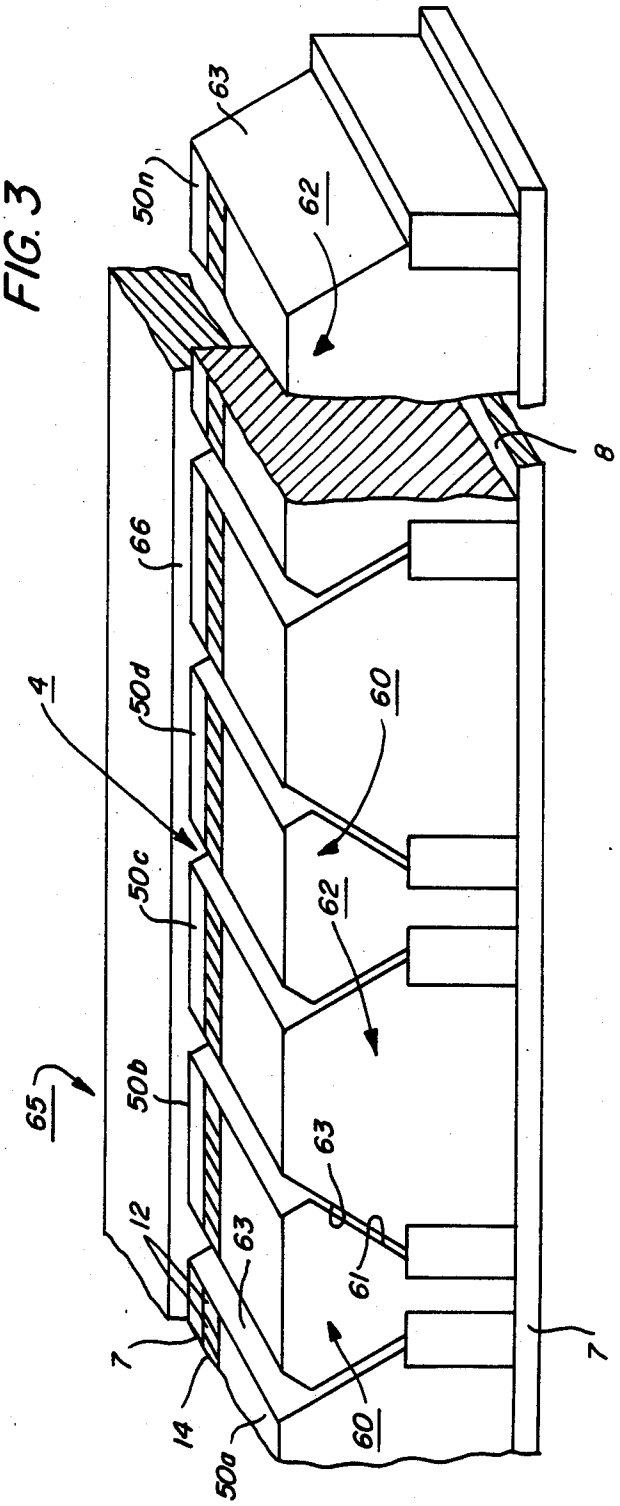
FIG. 3



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REPLACEABLE IMAGE SENSOR ARRAY

The invention relates to image sensor arrays and method of fabrication and more particularly, to an image sensor array fabricated to permit the array to be abutted with other like arrays to form a longer scanning array such that each of the smaller arrays has two degrees of freedom of movement to facilitate removal and aligned replacement of a smaller array without damage to neighboring arrays or distortion or loss of image at the array junctions.

Image sensor arrays for scanning document images, such as Charge Coupled Devices (CCD's), typically have a row or linear array of photosites together with suitable supporting circuitry integrated onto a substrate or chip. Usually, an array of this type scans an image line by line across the document width while the document is moved in synchronism therewith in a direction paralleling the document length.

The image resolution of an array of this type is proportional to the ratio of the length of scan and the number of array photosites. Because of the difficulty in economically designing and fabricating arrays with a large number of photosites on one chip, image resolution for the typical commercial array available today is relatively low. And while resolution may be improved electronically by interpolating extra image signals or pixels, or by using several sensor arrays and electrically interlacing the arrays with one another so as to switch in succession from one array to the next as scanning across the line progresses, electronic manipulations of this type is costly. Further, single or multiple array combinations of the type described usually require a more complex and expensive optical system to assure that the array or arrays accurately scan the image line without loss or distortion.

A single array equal in size to the width of the document to be scanned yet with a very large packing of photosites to assure the high resolution, often referred to as a full width or contact type array, is needed, but not available currently in the art. One concept that has been suggested is to form a longer array by butting several small arrays together. Since photosites can be closely packed on smaller arrays without substantial and costly reduction in yield rates, a longer array having the large number of photosites needed to achieve high resolution can be achieved in this fashion. At the same time, optical requirements are greatly simplified. However, the difficulty in later repairing composite arrays of this type and particularly the difficulty in removing and replacing a defective one of the smaller arrays without damaging the array photosites, or misaligning the arrays, or creating distortion and loss of image at the junctions between the arrays has heretofore necessitated in the event of a failure of one array that the entire full length array be replaced at substantial cost.

The present invention seeks to address and rectify the above by providing a sensor array of the type which is assembled with other arrays to form a full width scanning array which can be removed and replaced without damaging neighboring arrays and without affecting image quality, the sensor array comprising a chip fabricated in accordance with the following steps: forming at least one row of photosites on a relatively large (110) silicon wafer; orientation dependent etching edge separation lines in the wafer delineating the top and bottom edges of the chip; orientation dependent etching separation lines along the (111) plane of the wafer to delineate chip ends having a generally L-shaped offset therein; and separating the chip from the wafer along the separation lines to produce a generally rectangular-shaped chip, each end of the chip having a generally L-shaped offset for interlocking abutment and alignment with the complementary offset ends of other like arrays.

The invention further provides a replaceable array for use in combination with other arrays butted together end to end to form a longer scanning array comprising: a generally rectangular chip of (110) silicon having a predetermined width; at least one row of photosites extending longitudinally of the chip from one end of the chip to the other to provide on abutment of the chip with another like chip an uninterrupted row of photosites, each end of the array being defined by first and second end segments extending along the chip (111) plane, the combined length of the first and second end segments being equal to the chip width with the first and second end segments being offset longitudinally from one another, a third end segment extending along the chip (111) plane connecting the first and second end segments together whereby the first, second, and third end segments cooperate to form the array end, the third end segment being abuttable with the third end segment of a neighboring array to align the chip with the chip of a neighboring array when replacing a defective array.

IN THE DRAWINGS

FIG. **1** is an isometric view of a plurality of small sensor arrays fabricated on (110) silicon in accordance with the invention and abutted together to form a full width scanning array, the small arrays having alternating complementary T and inverted T shapes designed to facilitate removal and replacement of a defective one of the small arrays;

FIG. **2** is an isometric view showing forming of the array chips on a larger silicon wafer; and

FIG. **3** is an isometric view of an alternate embodiment in which the small sensor arrays are fabricated on (100) silicon to provide complementary 'nail' head and 'mesa' head shapes facilitating removal and replacement of a defective one of the arrays.

Referring to FIG. **1** of the drawings, there is shown a long scanning array **4** composed of a plurality of small sensor arrays **5***a*, **5***b*, . . . **5***n* butted together end to end on a base or substrate **7**. Substrate **7** which may be silicon, ceramic, or other suitable material, is generally rectangular in shape with a planar surface **8** supporting the arrays **5***a*, **5***b*, **5***c*, . . . **5***n*. A suitable adhesive such as an epoxy or solder is normally used to attach the arrays **5***a*, **5***b*, **5***c*, . . . **5***n* to the surface **8** of substrate **7** in desired position.

The small arrays **5***a*, **5***b*, . . . **5***n*, which may for example comprise Charge Coupled Device or CCD or NMOS type arrays, are fabricated in accordance with the teachings of the invention for easy repairability of the long scanning array **4** as will appear more fully hereinbelow. As will be understood by those skilled in the art, scanning array **4** is typically used to read or scan a document original line by line and convert the document image to electrical signals or pixels. Preferably, scanning array **4** is a full length or contact type array having an overall length equal to or slightly greater than the width of the largest document. Scanning array **4** has a row of **14** photosites **12** extending from one end to the other.

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