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(54) Ink-jet printer nozzle defect detection method and device

Verfahren und Vorrichtung zum Nachweis von Tintenstrahldruckerdüsenfehlern

Méthode et dispositif pour la détection de défauts dans les buses d'imprimantes par jet d'encre

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(73) Proprietor: **SEIREN CO., LTD.
Fukui-shi, Fukui-ken 918-8560 (JP)**

(72) Inventors:
• **Shimada, Ryouichi c/o Seiren Co., Ltd
Fukui-ken (JP)**

• **Fukuoka, Masatoshi c/o Seiren Co., Ltd
Fukui-ken (JP)**
• **Takezawa, Syouji c/o Seiren Co., Ltd
Fukui-ken (JP)**

(74) Representative: **Kinsler, Maureen Catherine et al
Kilburn & Strode,
20 Red Lion Street
London WC1R 4PJ (GB)**

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Description

[0001] This invention mainly relates to a method and device for detecting defects in nozzles of an ink-jet printer for cloth such as blinding of the nozzle, satellite of ink on the cloth and ink drop mislocation.

[0002] Recent ink-jet printers for printing on cloth can express fine and subtle images. For this reason, the diameter of the nozzles which constitute the printing head gets smaller, and accordingly defects in the nozzles such as blinding and satellite of ink and ink drop mislocation happen often. Conventionally, when any of such nozzle defects occur, an operator judges it from the resultant nonconformity in the printed image by visual inspection or such defects are only found out at final inspection of the printed goods. However, experience and hard work are required to detect nonconformity in the image that is being printed. In addition, this may result in a large quantity of defective goods.

[0003] Japanese Publication No. 2708439 proposes a solution to this problem. This describes the following method: a test pattern is printed on a test recording paper located outside of an original recording paper but near the original recording paper and read by a test pattern optical reading device mounted on the printing head (nozzle head). This is then compared with a pre-recorded standard pattern, thereby allowing an output failure of ink to be detected.

[0004] Japanese Patent Publication No. 2712168 shows another technique for solving similar problems; all nozzles are caused to jet their inks at the same time. The jets are then to be photographed to calculate for each ink drop the position of its center gravity. This is then compared with a pre-determined standard centre of gravity and deviations between the two along the X and Y axes are calculated. From the deviations, the flying angle of the ink drop is derived and compared with the standard flying angle to evaluate the quality of the ink-jet.

[0005] Japanese Patent Publication No. 6-198866 discloses a technique that involves photographing an ink-jet test pattern to evaluate its density signal, which density signal is then used to determine ink-jet failure or uneven density.

[0006] Using comparisons of printing patterns such as mentioned in Japanese Patent Publication No. 2708439, it is difficult to judge accurately small deviations for each ink drop because the result of the judgement tends to be significantly affected by the threshold set against the standard pattern. On the other hand, in Japanese Patent Publication No. 2712168, the deviation is judged by comparison of the position of the center of gravity for each ink drop with a standard position of the center of gravity. But such an absolute comparison may result in detection failure caused by mislocation of the recording paper or other similar physical trouble with consequent deterioration of the detecting accuracy. The problem with Japanese Patent Publication No.

6-198866 is that it is difficult to judge uneven coloring especially for pale shades. Further, this technique does not cover detection of positional deviation of the ink drop. Attempts to use this technique for such detection in pale shades may involve further difficulties.

[0007] A prior art document, EP-A-863012 discloses a method for detecting defects in nozzles in a printing head which comprises the steps of making an ink drop test pattern with the ink drops arranged in a column, scanning the pattern in the group to determine an area of each ink drop to calculate an average area and comparing the area of each drop to a criterion representing a given ratio of the average area to judge whether the ink jetting is normal or not. The steps are performed for all the nozzles in the head on a group by group basis.

[0008] Another prior art document, EP-A-500281 discloses an ink jet nozzle defect detecting device having means for driving a test recording medium and sensor means for detecting a test pattern of ink drops printed on the test recording medium. The sensor means includes a light source and light receiving means for converging reflected light from a column of ink drops in the test pattern as one group, receiving the same through a slit and filter means. A scanning means scans the sensor means in a direction perpendicular to the ink drop column in the one group, image processing means processes an output signal from the light receiving means and a comparison means compares with a corresponding criterion to judge failures in the ink jetting.

[0009] An object of the invention is to at least partially mitigate at least some of the problems of the prior art.

[0010] According to the first aspect of the present invention there is provided a method for detecting defects in nozzles in a printing head comprising the steps of:

photographing a plurality of ink drops in a test pattern as one group, the ink drops being preferably arranged in a column;
recognizing the shape of each of the ink drops in said group to determine its edge position along a pre-determined direction; and
comparing the difference between the maximum and minimum values of the ink drop edge positions along the pre-determined direction with a criterion to judge any positional deviation of any ink drop in said group along said pre-determined direction;
said steps being performed for all the nozzles in said printing head on a group by group basis.

[0011] According to a second aspect of the present invention there is provided a method for detecting defects in nozzles in a printing head comprising the steps of:

photographing a plurality of ink drops in a test pattern as one group, the ink drops being preferably arranged in columns;
recognizing the shape of each of the ink drops in

said group and determining its edge positions along a pre-determined direction thereby identifying its center position;
 calculating the center-to-center distance between two neighboring ink drops in said group along said pre-determined direction; and
 comparing the difference between the maximum and minimum values of said center-to-center distances with a criterion to judge any position deviation of any ink drop in said group along the pre-determined direction;
 said steps being performed for all the nozzles in said printing head on a group by group basis.

[0012] According to another aspect of the present invention there is provided an ink-jet nozzle defect detecting device comprising:

means for driving a test recording medium, and sensor means for detecting a test pattern of ink drops printed on said test recording medium and means for judging any failure in an ink jetting about the test pattern;
 said sensor means including a light source and light receiving means for converging the reflected light from a column of ink drops existing in said test pattern as one group and receiving the same through slit means and filter means;
 scanning means for scanning said sensor means in a direction perpendicular to the ink drop column in said one group;
 image processing means for processing an output signal from said light receiving means;
 judging means for using at least one of areas, X direction edge positions and Y direction center-to-center distances of the ink drops in said group, which are determined from the shapes thereof, for comparison with a corresponding criterion to judge any failure in the ink jetting on a group by group basis;
 said filter means and light receiving means including light receiving element arrays receiving an image of the ink drop column at an optimal contrast by switching RGB filters arranged in three rows.

[0013] According to yet another aspect of the present invention there is provided an ink-jet nozzle defect detecting device comprising:

means for driving a test recording medium, and sensor means for detecting a test pattern of ink drops printed on said test recording medium and means for judging any failure in an ink jetting about the test pattern;
 said sensor means including a light source, and light receiving means for converging the reflected light from a column of ink drops existing in said test pattern as one group and receiving the same

through slit means and filter means;
 scanning means for scanning said sensor means in a direction perpendicular to the ink drop column in said one group;
 image processing means for processing an output signal from said light receiving means; and
 judging means for comparing the difference between the maximum and minimum values of pre-determined direction edge positions obtained from the shape of each of the ink drops in said group with a criterion to judge any position deviation of any ink drop along the pre-determined direction on a group by a group basis.

[0014] According to a still further aspect of the present invention there is provided an ink-jet nozzle defect detecting device comprising:

means for driving a test recording medium and sensor means for detecting a test pattern of ink drops printed on said test recording medium, and means for judging any failure in an ink jetting about the test pattern;
 said sensor means including a light source and light receiving means for converging the reflected light from a column of ink drops existing in said test pattern as one group and receiving the same through slit means and filter means;
 scanning means for scanning said sensor means in a direction perpendicular to the ink drop column in said one group;
 image processing means for processing an output signal from said light receiving means; and
 judging means for comparing the differences between the maximum and minimum values of pre-determined direction center-to-center distances obtained from the shape of each of the ink drops in said group with a criterion to judge any position deviation of any ink drop along the pre-determined direction on a group by a group basis;

wherein said filter means and said light receiving means include light receiving element arrays (24) receiving an image of the ink drop column at an optimal contrast by switching RGB filters (23R, 23G, 23B) arranged in three rows.

[0015] An apparatus and various methods in which the invention is embodied will now be described by way of example only, and with reference to the following drawings, of which:

Fig. 1 is a schematic diagram that shows an ink-jet nozzle defect detection device of this invention.
 Fig. 2 is an enlarged model diagram that shows one example of a test pattern printed by ink-jet nozzles.
 Fig. 3 is a perspective drawing that shows a sensor means of this invention's device.
 Fig. 4 is a perspective drawing that shows a light

receiving means of the said sensor means.

Fig. 5 is a side view of the sensor means that shows the detecting principle of this invention.

Fig. 6 is a front view of the sensor means shown in Fig. 5.

Fig. 7 is a drawing that shows the ink drop shape detecting method.

Fig. 8 is a drawing that shows the method of sampling ink drop in detecting its shape.

Fig. 9 is a drawing that shows the method of calculating the area of ink drop.

Fig. 10 is a drawing that shows the method of judging a positional deviation of ink drop along X direction.

Fig. 11 is a drawing that shows the method of judging a positional deviation of ink drop along Y direction.

Fig. 12 is a block diagram of this invention's control device.

Fig. 13 is a drawing that shows the effects of RGB filters.

[0016] Fig. 1 shows a sensor means 1, the details of which will be explained later and a means 2 for driving a test recording medium 3. A test pattern is printed on the test recording medium 3 with a printing head 4. For the test recording medium 3, we use a special recording paper to enhance its detecting accuracy. The cloth to be actually used for production can be used but a recording paper that is less subject to ink bleeding or other similar trouble is more appropriate.

[0017] The recording medium 3 is wound round rubber rolls 7,8 and several guide rolls 9 provided between a feeding roll 5 and a winding roll 6 to control the amount of recording paper to be fed and prevent it slipping. These rolls serve to maintain the tension of the recording paper. Blocks 12 and 13 are placed at a test pattern printing position 10 and a printed test pattern detecting position 11, respectively, to keep the recording medium 3 perpendicular to the printing head 4 and the center shaft of sensor means 1. Numeral 14 is a sensor for detecting the existence of recording medium 3. After the printing of a test pattern is completed, the pattern on the recording medium 3 is moved from the printing position 10 to the printed pattern detecting position 11 just under the sensor means 1 for its positioning. After its mechanical zero setting, the sensor 1 scans along the X direction to capture an image of ink drops in column form in the test pattern on a group-by-group basis. There is no illustrative description given of the scanning method of sensor means 1, which is a driving device composed of a commonly available pulse motor and ball screws. In the Figure, Y indicates the direction in which the recording medium 3 moves at the detecting position 11.

[0018] Fig. 2 shows an example of a test pattern, which is made up of many ink drops 16 printed on the test recording medium 3 in given rows with the printing head 4. In the example, the printing head 4 has 32 noz-

zle heads (area 17 enclosed by outer dotted line represents one nozzle head.), each being composed of 8 x 2 rows = 16 nozzles (not shown). So, this printing head 4 has a total of 512 nozzles. Each nozzle head prints in its own hue. In this invention, each nozzle head is subjected to photographing of one row made up of eight ink drops 16 (area enclosed by inner dotted line) as one group 18 to check the nozzle head for any nozzle defect such as blinding. Range L1 for one group 18 is about 9 mm and range L2 for photographing is about 13 mm.

[0019] The sensor means 1 of the device scans along X direction as indicated in the Figure. The test recording medium 3 moves along Y direction. Therefore, the first row is scanned along X direction on a group 18 basis and checked for any nozzle defect, and then the test recording medium 3 is moved along Y direction. Thereafter, the second row is scanned along X direction and checked in the same way as in the first row. A similar operation is repeated on the third and fourth rows. In this way, all the nozzles in the printing head 4 can be checked for any nozzle defect such as blinding with the sensor means 1 according to the method described below:

[0020] The sensor means 1 is configured as shown in Fig. 3, consisting of a light source 19 made up of a U-shaped fluorescent lamp, a light converging lens 21 and a slit 22 provided in a box 20, and a light receiving element group 24 with filters 23 attached to the top of the box 20 so that all these components can move along X direction together.

[0021] The light receiving element group 24 is composed of light receiving element arrays 24a, 24b and 24c arranged parallel in three rows as shown in Fig.4, each having a CCD made up of 2,592 photo-diodes per line with a RGB filter mounted on it (which consists of a red filter 23R, green-filter 23G or blue-filter 23B). In the Figure, 25 is a plate for mounting the light receiving element group 24.

[0022] Fig. 5 is a side view of the sensor means and Fig. 6 is its front view, showing the detecting principle of this invention.

[0023] The light from the fluorescent lamp of light source 19 impinges and reflects from the recording medium 3 at the ink drops 16, where ink is applied, and white portions 3a where no ink is applied. Each of reflected light 26a and 26b is converged by the converging lens 21, passing through the slit 22, and then the filter 23, which cuts the light 26a reflected at the ink drop 16 or passes it only in a tiny amount. The light 26b reflected at the white portion 3a passes through the filter 23, reaching the CCD 27, the output voltage of which becomes high at the white portion 3a. For this reason, the output voltage of CCD 27 changes at the boundary point of the shape of ink drop 16 as shown in Fig.7 or 13.

(1) The First Method

[0024] The first method of this invention is performed

as follows.

$$SA = \text{Save} \times \alpha / 100$$

① Recognition of ink shape

[0025] The shape of each ink drop 16 in a group 18 is recognized by binarization of its photographed image. There is no illustrative description given of the image processing method, which is a publicly known device connected to the sensor means 1 by a cable for image processing according to the output signal from the light receiving means 24.

[0026] As mentioned above, the output voltage of CCD 27 changes at the boundary point of the shape of ink drop 16. The output voltage of CCD27 having such a characteristic curve as shown in Fig.7 is set with a threshold value c to determine points a and b as the boundary between bright and dark areas of the image by the scanning sensor means 1 along X direction at intervals of $\delta\mu\text{m}$. This allows us to recognize the shape of each ink drop 16.

② Calculation of area of each of ink drops and their average area

[0027] After recognizing the shape of ink drop 16, we calculate the area of each of the ink drops S_i ($i=1, 2, \dots, n$) and their average area Save . The area S_i of ink drop 16 is calculated as follows:

[0028] Ink drop 16 ranges in size from 80 to 100 μm . Area S_i is calculated by sampling the ink drops at intervals of δ and adding their dot widths $W_0, W_1, W_2, \dots, W_n$ as shown in Fig. 9. This can be expressed as the following formula:

$$S_i = W_0 + W_1 + W_2 + \dots + W_n$$

[0029] The sampling interval δ is 5 μm , which is so small that the above formula can represent an integration. The dot area drops in intensity and its width thus represents the CCD output below the threshold in pixels. Next, the average area of ink drop 16 Save is calculated by dividing total sum of said S_i by the quantity of ink drop 16 existing in one group 18 as expressed by the following formula:

$$\text{Save} = \sum S_i / N$$

where N is the quantity of ink drop 16, which is 8 in this case.

③ Setting of the criterion for judgment

[0030] To set tolerances for the judgment, we specify $\alpha\%$ of the average area Save determined in ② as a criterion SA, which can be defined as the following formula:

where α is approximately 80 %.

④ Judgment

[0031] Criterion SA is compared with the area S_i of ink drop 16 determined as directed above. If the result of the comparison shows that the number of ink drops larger in area than the criterion are the same as specified in the group, the ink jetting can be judged as OK. If the result of the comparison shows the presence of any ink drop smaller in area than the criterion in the group, the ink jetting is to be judged as NG. This, in turn, allows us to detect failure in jetting of ink drops 16 present within the group 18, which means ink-jet nozzle blinding, enabling the operator to specify the nozzle that has undergone such failure.

(2) The Second Method

[0032] The second method of this invention is illustrated by reference to Fig.10.

① Ink drop edge position

[0033] The shape of ink drop 16 determined as described above allows one edge position of the ink drop (or its starting position) such as 16a, 16b, and so on to be identified. More specifically, if the above-described recognition of the shape of ink drop 16 is performed with the position of the first dot $\lambda\mu\text{m}$ or above in width stored in the memory, the starting edge position of the ink drop 16 can be identified. Each of the other ink drops in the group is processed in the same way to determine its starting edge position. The edge positions of the ink drops in the group thus determined are then processed to determine the difference between their maximum and minimum values as ΔX .

② Setting of the criterion for judgment

[0034] The criterion for the judgment of the result is specified as $\beta\mu\text{m}$.

③ Judgment

[0035] The said difference between the maximum and minimum values of the ink drop edge positions determined as ΔX is compared with the criterion $\beta\mu\text{m}$. If the comparison shows that ΔX is less than β , the ink jetting can be regarded as OK in terms of ink drop location. If the comparison shows that ΔX is equal or larger than β , the ink jetting is to be regarded as NG in terms of ink drop location. This allows us to detect any positional deviation of ink drop 16 in group 18 along X direction.

(3) The Third Method

[0036] The third method of this invention is illustrated by reference to Fig. 11.

① Ink drop center-to-center distance

[0037] The shape of ink drop 16 determined as described above allows the edge positions of the ink drop along Y direction such as 16f, 16g, and so on to be identified. More specifically, if the above-described recognition of the shape of ink drop 16 is performed with the position of the first dot $\lambda\mu\text{m}$ or above in width stored in the memory, the top and bottom positions of the ink drop 16 can be identified. Each of the other ink drops in the group is processed in the same way to determine its top and bottom positions. The edge positions of each ink drop in the group thus determined are then processed as Y coordinates to determine the half of their sum, thereby calculating its center of gravity (center) position. This allows us to determine the center-to-center distance between two neighboring ink drops (d). The center-to-center distances between every two neighboring ink drops in the group thus determined are then processed to calculate the difference between their maximum value (dmax) and minimum value (dmin) as ΔY .

② Setting of the criterion for judgment

[0038] The criterion for the judgment of the result is specified as $\gamma\mu\text{m}$.

③ Judgment

[0039] The said difference between the maximum and minimum values of the ink drop center-to-center distances determined as ΔY is compared with the criterion $\gamma\mu\text{m}$. If the comparison shows that ΔY is less than γ , the ink jetting can be regarded as OK in terms of ink drop location. If the comparison shows that ΔX is equal or larger than γ , the ink jetting is to be regarded as NG in terms of ink drop location. This allows us to detect any positional deviation of ink drop 16 in group 18 along Y direction or the center-to-center distance is too wide or narrow.

[0040] The arithmetic operations in the first to third methods mentioned above, the comparison of the result of the operations with the criterion and the judgment of the result of the comparison are performed in the CPU 28 shown in Fig. 12.

(4) Effect of RGB filter

[0041] Each nozzle head in the printing head 4 prints in its own color. As shown in Fig.12, therefore, the present invention selects a proper RGB filter according to a digital signal SG4 from the CPU 28 to load the image data. More specifically, the system selects the red filter

23R for blue ink, the green filter 23G for yellow ink and the blue filter 23B for red ink to achieve a stable output voltage. The system has ink colors stored in the memory. In addition, the system deals with pale shade ink color, which develops with poor contrast, by multiple printing to enhance its absolute intensity, thereby increasing its sensitivity. In this way, the system selects the proper RGB filter according to the color of the ink to load its image data under the optimal contrast condition, which is converted by sensor means 1 into an analogue signal SG5 before being transmitted through the cable to the CPU28 where the signal is processed as mentioned above to judge the nozzle head for nozzle blinding, satellite of ink or ink drop mislocation. If the result of the judgment shows any defect in the nozzle head such as nozzle blinding, a digital signal SG1 is transmitted to an ink-jet printer 29 to indicate the occurrence of the defect, specifying the nozzle involved, which the operator can thus take remedial action on.

[0042] Fig.13 (a) shows the effect of the filter on yellow ink, while Fig.13 (b) shows the effect of the filter on blue ink. Both Figures indicate that the variation in the output voltage with the filter is marked compared to that in the case without the filter, showing that the use of the filter is highly effective in enhancing the accuracy of the nozzle defect detection.

Claims

1. A method for detecting defects in nozzles in a printing head comprising the steps of:

photographing a plurality of ink drops in a test pattern as one group, the ink drops being preferably arranged in a column;
recognizing the shape of each of the ink drops in said group to determine its edge position along a pre-determined direction; and
comparing the difference between the maximum and minimum values of the ink drop edge positions along the pre-determined direction with a criterion to judge any positional deviation of any ink drop in said group along said pre-determined direction;
said steps being performed for all the nozzles in said printing head on a group by group basis.

2. A method as claimed in claim 1, wherein the pre-determined direction is a scanning direction of the printing head.

3. A method for detecting defects in nozzles in a printing head comprising the steps of:

photographing a plurality of ink drops in a test pattern as one group, the ink drops being preferably arranged in columns;

recognizing the shape of each of the ink drops in said group and determining its edge positions along a pre-determined direction thereby identifying its center position;
 calculating the center-to-center distance between two neighboring ink drops in said group along said pre-determined direction; and
 comparing the difference between the maximum and minimum values of said center-to-center distances with a criterion to judge any position deviation of any ink drop in said group along the pre-determined direction;
 said steps being performed for all the nozzles in said printing head on a group by group basis.

4. A method as claimed in claim 3, wherein the pre-determined direction is a direction perpendicular to a scanning direction of the printing head.

5. A method according to any one of claims 1 to 4, wherein in loading the image of ink drops in said group, RGB filters in a light receiving unit are selectively used according to the ink color of said group to achieve said loading with the optimum contrast in said image.

6. An ink-jet nozzle defect detecting device comprising:

means (2) for driving a test recording medium (3), and sensor means (1) for detecting a test pattern (15) of ink drops (16) printed on said test recording medium (3) and means (28) for judging any failure in an ink jetting about the test pattern (15);

said sensor means (1) including a light source (19) and light receiving means (24) for converging the reflected light from a column of ink drops (16) existing in said test pattern as one group (18) and receiving the same through slit means (22) and filter means (23);

scanning means for scanning said sensor means (1) in a direction perpendicular to the ink drop column in said one group (18);

image processing means for processing an output signal from said light receiving means (24);

judging means (28) for using at least one of areas, X direction edge positions and Y direction center-to-center distances of the ink drops (16) in said group (18), which are determined from the shapes thereof, for comparison with a corresponding criterion to judge any failure in the ink jetting on a group by group basis;

said filter means and light receiving means including light receiving element arrays (24) receiving an image of the ink drop column at an optimal contrast by switching RGB filters (23R, 23G, 23B) arranged in three rows.

7. An ink-jet nozzle defect detecting device comprising:

means (2) for driving a test recording medium (3), and sensor means (1) for detecting a test pattern (15) of ink drops (16) printed on said test recording medium (3) and means (28) for judging any failure in an ink jetting about the test pattern (15);

said sensor means (1) including a light source (19), and light receiving means (24) for converging the reflected light from a column of ink drops (16) existing in said test pattern as one group (18) and receiving the same through slit means (22) and filter means (23);

scanning means for scanning said sensor means (1) in a direction perpendicular to the ink drop column in said one group (18);

image processing means for processing an output signal from said light receiving means (24); and

judging means (28) for comparing the difference between the maximum and minimum values of pre-determined direction edge positions obtained from the shape of each of the ink drops (16) in said group (18) with a criterion to judge any position deviation of any ink drop along the pre-determined direction on a group by a group basis.

8. An ink jet nozzle defect detecting device according to claim 7, wherein the pre-determined direction is a X direction.

9. An ink-jet nozzle defect detecting device comprising:

means (2) for driving a test recording medium (3) and sensor means (1) for detecting a test pattern (15) of ink drops (16) printed on said test recording medium (13), and means (28) for judging any failure in an ink jetting about the test pattern (15);

said sensor means (1) including a light source (19) and light receiving means (24) for converging the reflected light from a column of ink drops (16) existing in said test pattern as one group (18) and receiving the same through slit means (22) and filter means (23);

scanning means for scanning said sensor means (1) in a direction perpendicular to the ink drop column in said one group (18);

image processing means for processing an output signal from said light receiving means (24); and

judging means (28) for comparing the differences between the maximum and minimum values of pre-determined direction center-to-center

distances obtained from the shape of each of the ink drops (16) in said group (18) with a criterion to judge any position deviation of any ink drop along the pre-determined direction on a group by a group basis;

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wherein said filter means and said light receiving means include light receiving element arrays (24) receiving an image of the ink drop column at an optimal contrast by switching RGB filters (23R, 23G, 23B) arranged in three rows.

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10. An ink jet nozzle defect detecting device according to claim 9, wherein the pre-determined direction is a Y direction.

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11. An ink jet nozzle defect detecting device according to claims 7 or 8, wherein said filter means and said light receiving means include light receiving element arrays (24) receiving an image of the ink drop column at an optimal contrast by switching RGB filters (23R, 23G, 23B) arranged in three rows.

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Patentansprüche

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1. Verfahren zur Detektion von Fehlern an Düsen in einem Druckkopf, welches folgende Schritte aufweist:

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Fotoaufnahme einer Vielzahl von Tintentropfen in einem Testmuster als eine Gruppe, wobei die Tintentropfen vorzugsweise in einer Spalte angeordnet sind;

Erkennung der Form eines jeden der Tintentropfen in der Gruppe zur Bestimmung seiner Randposition entlang einer vorbestimmten Richtung; und

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Vergleich der Differenz zwischen den Maximal- und Minimalwerten der Randpositionen der Tintentropfen entlang der vorbestimmten Richtung mit einem Kriterium zur Beurteilung irgendeiner Positionsabweichung irgendeines Tintentropfens in der Gruppe entlang der vorbestimmten Richtung;

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wobei diese Schritte für sämtliche Düsen in dem Druckkopf auf einer Gruppenvergleichsbasis ausgeführt werden.

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2. Verfahren nach Anspruch 1, worin die vorbestimmte Richtung eine Scanrichtung des Druckkopfes ist.

3. Verfahren zur Detektion von Fehlern an Düsen in einem Druckkopf, welches folgende Schritte aufweist:

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Fotoaufnahme einer Vielzahl von Tintentropfen

in einem Testmuster als eine Gruppe, wobei die Tintentropfen vorzugsweise in Spalten angeordnet sind;

Erkennen der Form eines jeden Tintentropfen in der Gruppe und Bestimmung seiner Randpositionen entlang einer vorbestimmten Richtung, womit dessen Zentralposition identifiziert wird;

Berechnung der Abstände zwischen Zentren von zwei benachbarten Tintentropfen in der Gruppe entlang der vorbestimmten Richtung; und

Vergleich der Differenz zwischen den Maximal- und Minimalwerten der Zentrumsabstände mit einem Kriterium zur Beurteilung einer jeden Positionsabweichung irgendeines Tintentropfens in der Gruppe entlang der vorbestimmten Richtung;

wobei diese Schritte für jede der Düsen in dem Druckkopf auf einer Gruppenvergleichsbasis ausgeführt werden.

4. Verfahren nach Anspruch 3, worin die vorbestimmte Richtung senkrecht zu einer Scanrichtung des Druckkopfes ausgerichtet ist.

5. Verfahren nach einem der Ansprüche 1-4, worin beim Laden des Bildes der Tintentropfen in der Gruppe RGB-Filter in einer Lichtempfangseinheit entsprechend der Tintenfarbe der Gruppe selektiv verwendet werden um das Laden mit dem optimalen Kontrast in dem Bild auszuführen.

6. Vorrichtung zur Detektion von Fehlern an Tintenstrahldüsen, welches umfaßt:

Mittel (2) zum Antrieb eines Testaufzeichnungsmediums (3) und Sensormittel (1) zur Detektion eines Testmusters (15) von Tintentropfen (16), die auf dem Testaufzeichnungsmedium (3) gedruckt sind und Mittel (28) zur Beurteilung irgendeines Fehlers in einem Tintenstrahl in Zusammenhang mit den Testmustern (15);

wobei das Sensormittel (1) eine Lichtquelle (19) und Lichtempfangsmittel (24) beinhaltet zur Umwandlung des reflektierten Lichtes von einer Spalte von Tintentropfen (16), der in dem Testmuster als eine Gruppe (18) existiert, und Empfang desselben durch Spaltemittel (22) und Filtermittel (23);

Scanmittel zum Scannen des Sensormittels (1) in einer Richtung, die senkrecht zu der Tintentropfenspalte in der einen Gruppe (18) liegt;

Bildverarbeitungsmittel zur Verarbeitung eines Ausgangssignales von dem Lichtempfangsmittel

tel.(24);

Beurteilungsmittel (28) zur Verwendung von zumindest einem der Bereiche, entweder der Randpositionen in X-Richtung und der Zentrumsbeabstandungen in Y-Richtung der Tintentropfen (16) in der Gruppe (18), welche bestimmt werden durch die Formen derselben zum Vergleich mit einem korrespondierenden Kriterium zur Beurteilung irgendeines Fehlers beim Tintenstrahlvorgang mit einer Gruppenvergleichsbasis;

wobei das Filtermittel und Lichtempfangsmittel Anordnungen (24) von Lichtempfangselementen umfassen, welche ein Bild der Tintentropfenspalte mit einem optimalen Kontrast empfangen, durch Schalten der RGB-Filter (23R, 23G, 23B), die in drei Reihen angeordnet sind.

7. Vorrichtung zur Detektion von Fehlern an Tintenstrahldüsen, die folgendes umfaßt:

Mittel (2) zum Antrieb eines Testaufzeichnungsmediums (3) und Sensormittel (1) zur Detektion eines Testmusters (15) von Tintentropfen (16), die auf dem Testaufzeichnungsmedium (3) gedruckt sind und Mittel (28) zur Beurteilung irgendeines Fehlers in einem Tintenstrahl in Zusammenhang mit den Testmustern (15);

wobei das Sensormittel (1) eine Lichtquelle (19) und Lichtempfangsmittel (24) beinhaltet zur Umwandlung des reflektierten Lichtes von einer Spalte von Tintentropfen (16), der in dem Testmuster als eine Gruppe (18) existiert, und Empfang desselben durch Spaltmittel (22) und Filtermittel (23);

Scanmittel zum Scannen des Sensormittels (1) in einer Richtung, die senkrecht zu der Tintentropfenspalte in der einen Gruppe (18) liegt;

Bildverarbeitungsmittel zur Verarbeitung eines Ausgangssignales von dem Lichtempfangsmittel (24); und

Beurteilungsmittel (28) zum Vergleich der Differenz zwischen den Maximal- und Minimalwerten von Randpositionen in vorbestimmter Richtung, die erhalten werden aus der Form eines jeden Tintentropfens (16) in der Gruppe (18) mit einem Kriterium zur Beurteilung irgendeiner Positionsabweichung irgendeines Tintentropfens entlang der vorbestimmten Richtung mit einer Gruppenvergleichsbasis.

8. Vorrichtung zur Detektion von Fehlern an einer Tintenstrahldüse nach Anspruch 7, worin die vorbestimmte Richtung eine X-Richtung ist.

9. Vorrichtung zur Detektion von Fehlern an Tintenstrahldüsen, welches umfaßt:

Mittel (2) zum Antrieb eines Testaufzeichnungsmediums (3) und Sensormittel (1) zur Detektion eines Testmusters (15) von Tintentropfen (16), die auf dem Testaufzeichnungsmedium (3) gedruckt sind und Mittel (28) zur Beurteilung irgendeines Fehlers in einem Tintenstrahl in Zusammenhang mit den Testmustern (15);

wobei das Sensormittel (1) eine Lichtquelle (19) und Lichtempfangsmittel (24) beinhaltet zur Umwandlung des reflektierten Lichtes von einer Spalte von Tintentropfen (16), der in dem Testmuster als eine Gruppe (18) existiert und Empfang desselben durch Spaltmittel (22) und Filtermittel (23);

Scanmittel zum Scannen des Sensormittels (1) in einer Richtung, die senkrecht zu der Tintentropfenspalte in der einen Gruppe (18) liegt;

Bildverarbeitungsmittel zur Verarbeitung eines Ausgangssignales von dem Lichtempfangsmittel (24); und

Beurteilungsmittel (28) zum Vergleich der Differenzen zwischen den Maximal- und Minimalwerten der Zentralabstände in vorbestimmter Richtung, die erhalten werden von der Form eines jeden Tintentropfens (16) in der Gruppe (18) mit einem Kriterium zur Beurteilung irgendeiner Positionsabweichung irgendeines Tintentropfens entlang der vorbestimmten Richtung mit einer Gruppenvergleichsbasis;

wobei das Filtermittel und Lichtempfangsmittel Anordnungen (24) von Lichtempfangselementen umfassen, welche ein Bild der Tintentropfenspalte mit einem optimalen Kontrast empfangen, durch Schalten der RGB-Filter (23R, 23G, 23B), die in drei Reihen angeordnet sind.

10. Vorrichtung zur Detektion von Fehlern an einer Tintenstrahldüse nach Anspruch 9, worin die vorbestimmte Richtung eine Y-Richtung ist.

11. Vorrichtung zur Detektion von Fehlern an einer Tintenstrahldüse nach Anspruch 7 oder 8, worin das Filtermittel und das Lichtempfangsmittel Anordnungen (24) von Lichtempfangselementen aufweisen, welche ein Bild der Tintentropfenspalte mit einem optimalen Kontrast empfangen durch die Schaltung von RGB-Filtern (23R, 23G, 23B), die in drei Reihen angeordnet sind.

Revendications

1. Procédé pour la détection de défauts dans des buses d'une tête d'impression, comprenant les étapes :

- de photographie d'une pluralité de gouttes d'encre dans un motif de test sous la forme d'un groupe, les gouttes d'encre étant de préférence agencées dans une colonne ;
de reconnaissance de la forme de chacune des gouttes d'encre dans ledit groupe pour déterminer la position de son bord dans une direction prédéterminée ; et
de comparaison de la différence entre les valeurs maximales et minimales des positions des bords des gouttes d'encre dans la direction prédéterminée avec un critère pour évaluer tout écart de position d'une goutte d'encre quelconque dans ledit groupe dans ladite direction prédéterminée ;
lesdites étapes étant effectuées groupe par groupe pour toutes les buses de ladite tête d'impression.
2. Procédé selon la revendication 1, dans lequel la direction prédéterminée est une direction de balayage de la tête d'impression.
3. Procédé pour la détection de défauts dans des buses d'une tête d'impression, comprenant les étapes :
- de photographie d'une pluralité de gouttes d'encre dans un motif de test sous la forme d'un groupe, les gouttes d'encre étant de préférence agencées dans des colonnes ;
de reconnaissance de la forme de chacune des gouttes d'encre dans ledit groupe et de détermination des positions de son bord dans une direction prédéterminée en identifiant ainsi la position de son centre ;
de calcul de la distance de centre à centre entre deux gouttes d'encre voisines dans ledit groupe dans ladite direction prédéterminée ; et
de comparaison de la différence entre les valeurs maximales et minimales desdites distances de centre à centre avec un critère pour évaluer tout écart de position d'une goutte d'encre quelconque dans ledit groupe dans ladite direction prédéterminée ;
lesdites étapes étant effectuées groupe par groupe pour toutes les buses de ladite tête d'impression.
4. Procédé selon la revendication 3, dans lequel la direction prédéterminée est une direction perpendiculaire à une direction de balayage de la tête d'impression.
5. Procédé selon l'une quelconque des revendications 1 à 4, dans lequel, lors du chargement de l'image des gouttes d'encre dans ledit groupe, des filtres RGB d'une unité réceptrice de lumière sont sélec-
- tivement utilisés en fonction de la couleur de l'encre dudit groupe pour assurer ledit chargement avec le contraste optimal dans ladite image.
6. Dispositif de détection de défauts de buses à jet d'encre, comprenant :
- un moyen (2) pour entraîner un support d'enregistrement de test (3), un moyen détecteur (1) pour détecter un motif de test (15) de gouttes d'encre (16) imprimées sur ledit support d'enregistrement de test (3) et un moyen (28) pour évaluer tout défaut se produisant lors d'une éjection d'encre au voisinage du motif de test (15) ;
ledit moyen détecteur (1) comportant une source de lumière (19) et un moyen récepteur de lumière (24) pour faire converger la lumière réfléchiée par une colonne de gouttes d'encre (16) se trouvant dans ledit motif de test sous la forme d'un groupe (18) et la recevoir à travers un moyen à fentes (22) et un moyen à filtres (23) ;
un moyen de balayage pour animer d'un mouvement de balayage ledit moyen détecteur (1) dans une direction perpendiculaire à la colonne de gouttes d'encre dans ledit un groupe (18) ;
un moyen de traitement d'image pour traiter un signal de sortie dudit moyen récepteur de lumière (24) ;
un moyen d'évaluation (28) pour utiliser au moins l'une de zones, de positions de bords dans la direction X et de distances de centre à centre dans la direction Y des gouttes d'encre (16) dans ledit groupe (18), qui sont déterminées à partir des formes de celles-ci, pour effectuer une comparaison avec un critère correspondant afin d'évaluer, groupe par groupe, tout défaut se produisant lors de l'éjection d'encre ;
ledit moyen à filtres et ledit moyen récepteur de lumière comportant des groupements d'éléments récepteurs de lumière (24) recevant une image de la colonne de gouttes d'encre avec un contraste optimal par commutation de filtres RGB (23R, 23G, 23B) agencés selon trois lignes.
7. Dispositif de détection de défauts de buses à jet d'encre, comprenant :
- un moyen (2) pour entraîner un support d'enregistrement de test (3) et un moyen détecteur (1) pour détecter un motif de test (15) de gouttes d'encre (16) imprimées sur ledit support d'enregistrement de test (3) et un moyen (28) pour évaluer tout défaut lors d'une éjection d'encre à proximité du motif de test (15) ;
ledit moyen détecteur (1) comportant une sour-

ce de lumière (19), et un moyen récepteur de lumière (24) pour faire converger la lumière réfléchiée par une colonne de gouttes d'encre (16) se trouvant dans ledit motif de test sous la forme d'un groupe (18) et la recevoir à travers un moyen à fentes (22) et un moyen à filtres (23) ; un moyen de balayage pour animer d'un mouvement de balayage ledit moyen détecteur (1) dans une direction perpendiculaire à la colonne de gouttes d'encre dans ledit un groupe (18) ; un moyen de traitement d'image pour traiter un signal de sortie dudit moyen récepteur de lumière (24) ; et un moyen d'évaluation (28) pour comparer la différence entre les valeurs maximales et minimales de positions de bords dans une direction prédéterminée, obtenues à partir de la forme de chacune des gouttes d'encre (16) dans ledit groupe (18), avec un critère, afin d'évaluer, groupe par groupe, tout écart de position d'une goutte d'encre quelconque dans la direction prédéterminée.

8. Dispositif de détection de défauts de buses à jet d'encre selon la revendication 7, dans lequel la direction prédéterminée est une direction X.

9. Dispositif de détection de défauts de buses à jet d'encre, comprenant :

un moyen (2) pour entraîner un support d'enregistrement de test (3) et un moyen détecteur (1) pour détecter un motif de test (15) de gouttes d'encre (16) imprimées sur ledit support d'enregistrement de test (13), et un moyen (28) pour évaluer tout défaut lors d'une éjection d'encre à proximité du motif de test (15) ; ledit moyen détecteur (1) comportant une source de lumière (19) et un moyen récepteur de lumière (24) pour faire converger la lumière réfléchiée par une colonne de gouttes d'encre (16) se trouvant dans ledit motif de test sous la forme d'un groupe (18) et la recevoir à travers un moyen à fentes (22) et un moyen à filtres (23) ; un moyen de balayage pour animer d'un mouvement de balayage ledit moyen détecteur (1) dans une direction perpendiculaire à la colonne de gouttes d'encre dans ledit un groupe (18) ; un moyen de traitement d'image pour traiter un signal de sortie dudit moyen récepteur de lumière (24) ; et un moyen d'évaluation (28) pour comparer les différences entre les valeurs maximales et minimales de distance de centre à centre dans une direction prédéterminée, obtenues à partir de la forme de chacune des gouttes d'encre (16) dans ledit groupe (18), avec un critère, afin d'évaluer, groupe par groupe, tout écart de po-

sition d'une goutte d'encre quelconque dans la direction prédéterminée ;

dans lequel ledit moyen à filtres et ledit moyen récepteur de lumière comportent des groupements d'éléments récepteurs de lumière (24) recevant une image de la colonne de gouttes d'encre avec un contraste optimal par commutation de filtres RGB (23R, 23G, 23B) agencés selon trois lignes.

10. Dispositif de détection de défauts de buses à jet d'encre selon la revendication 9, dans lequel la direction prédéterminée est une direction Y.

11. Dispositif de détection de défauts de buses à jet d'encre selon les revendications 7 ou 8, dans lequel ledit moyen à filtres et ledit moyen récepteur de lumière comprennent des groupements d'éléments récepteurs de lumière (24) recevant une image de la colonne de gouttes d'encre avec un contraste optimal par commutation de filtres RGB (23R, 23G, 23B) agencés selon trois lignes.

FIG. 1

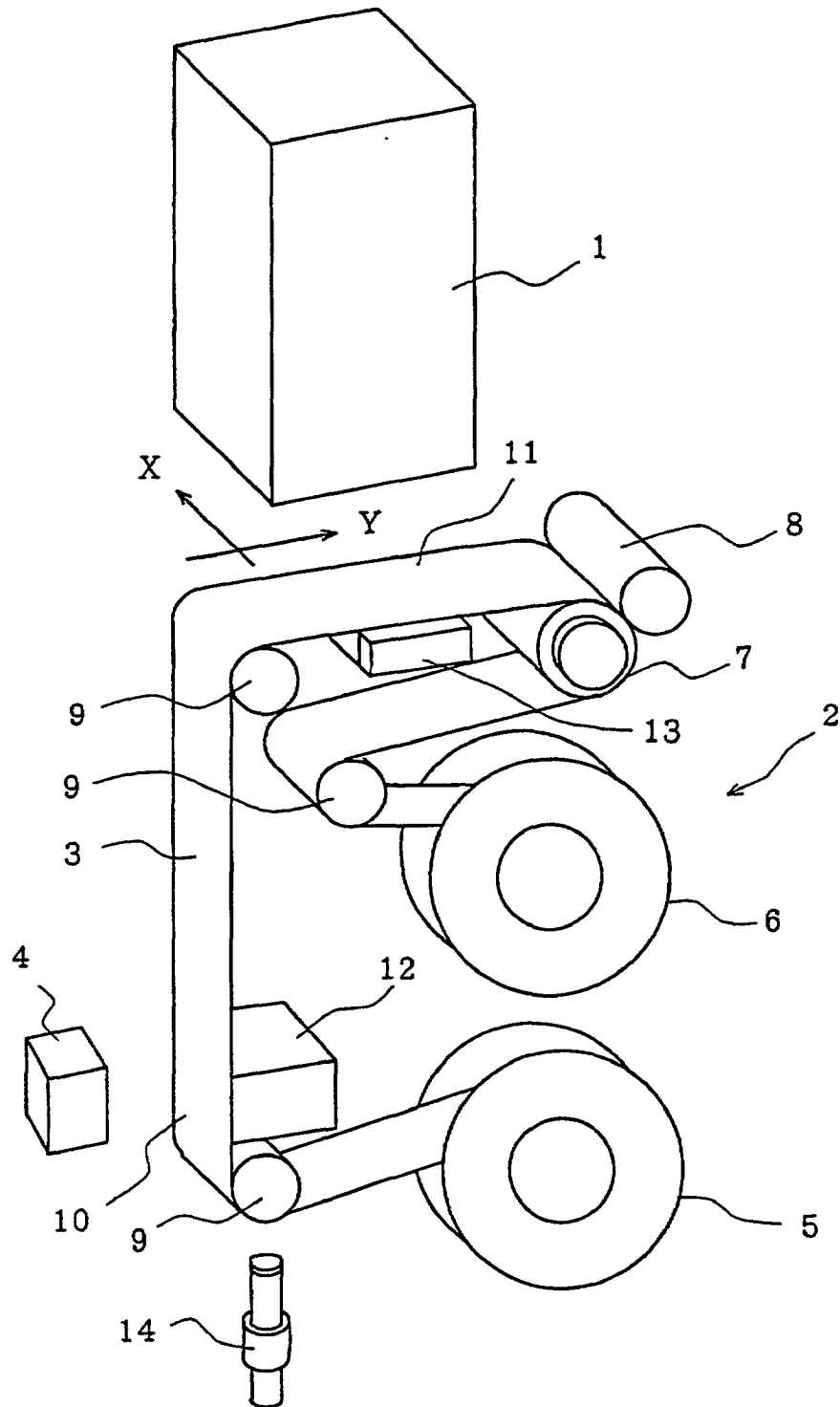


FIG. 2

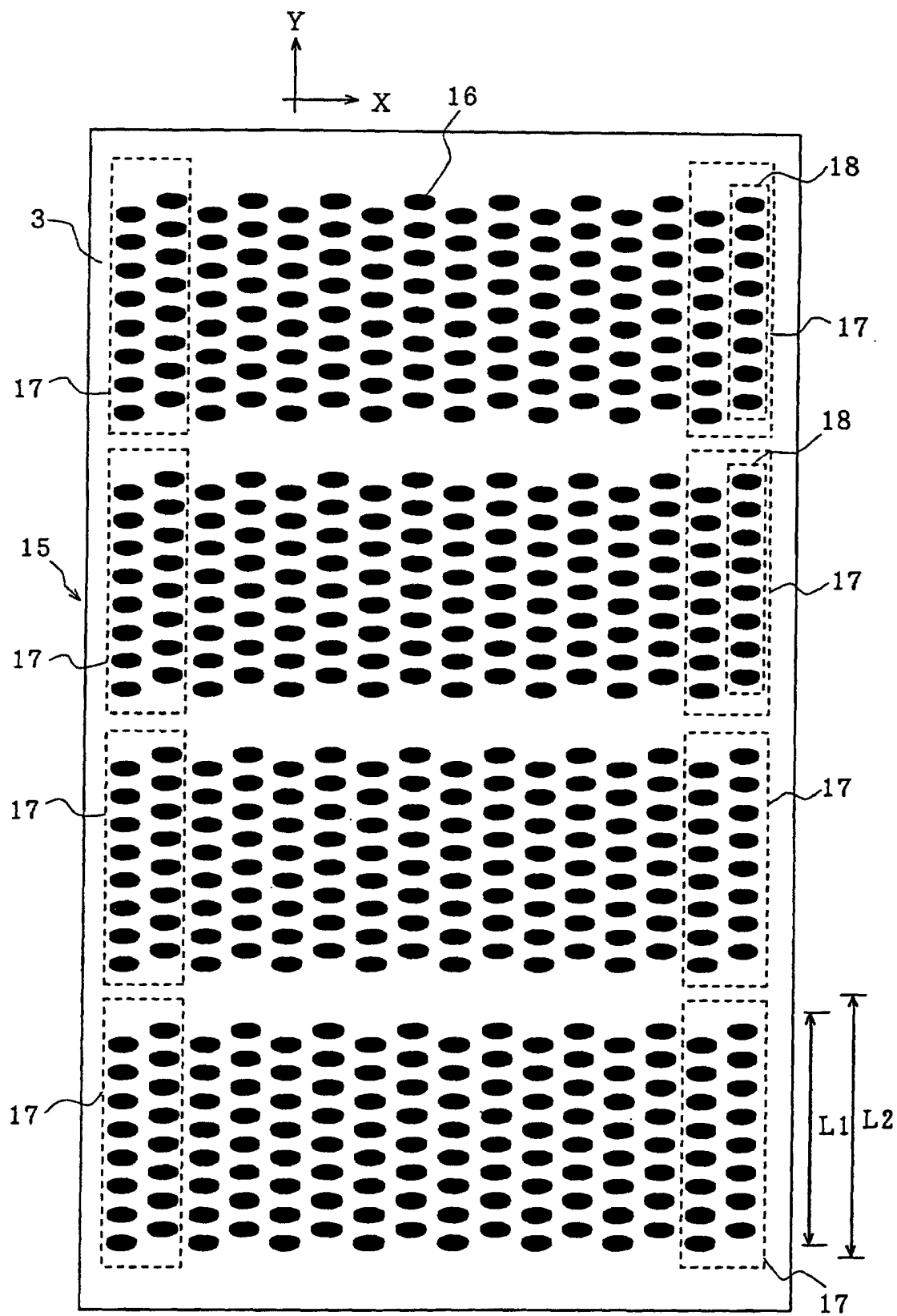


FIG. 3

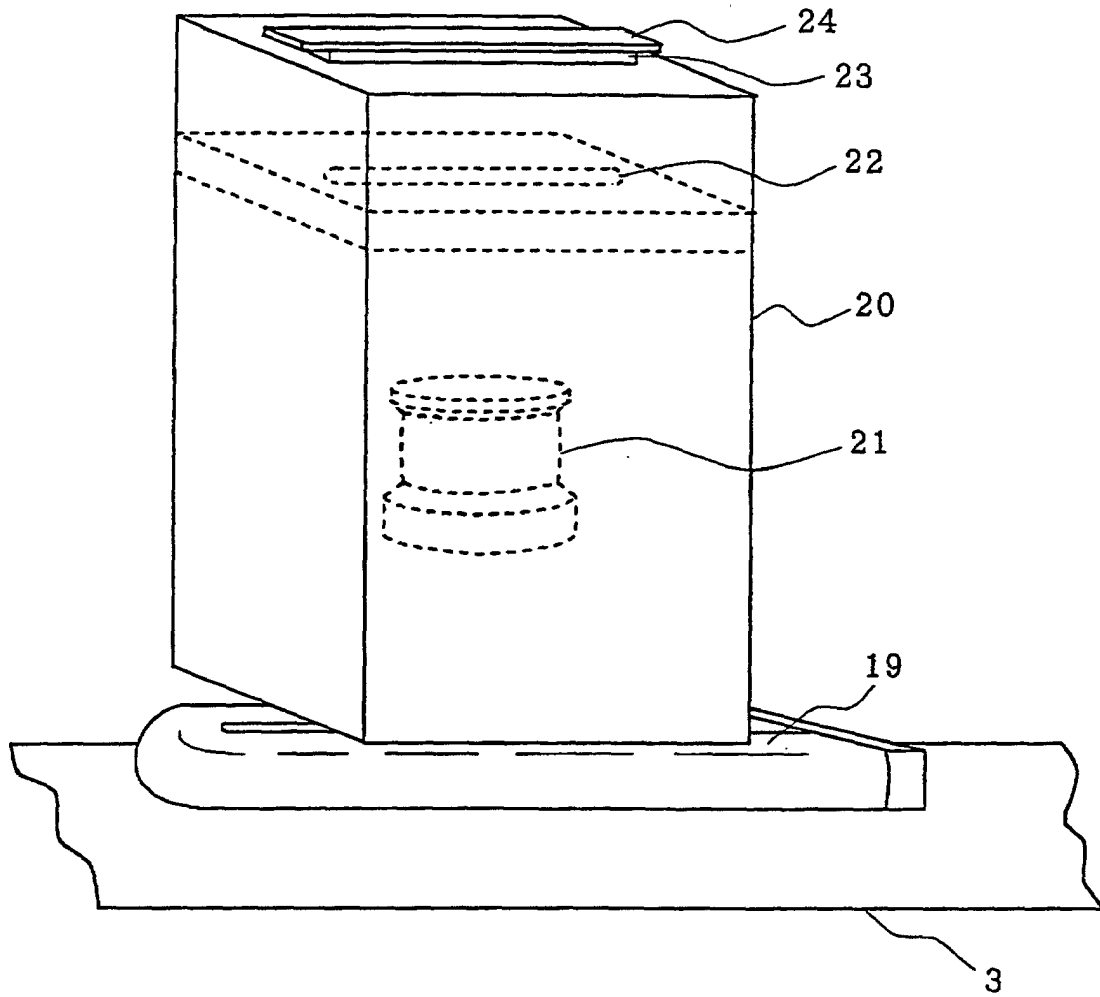


FIG. 4

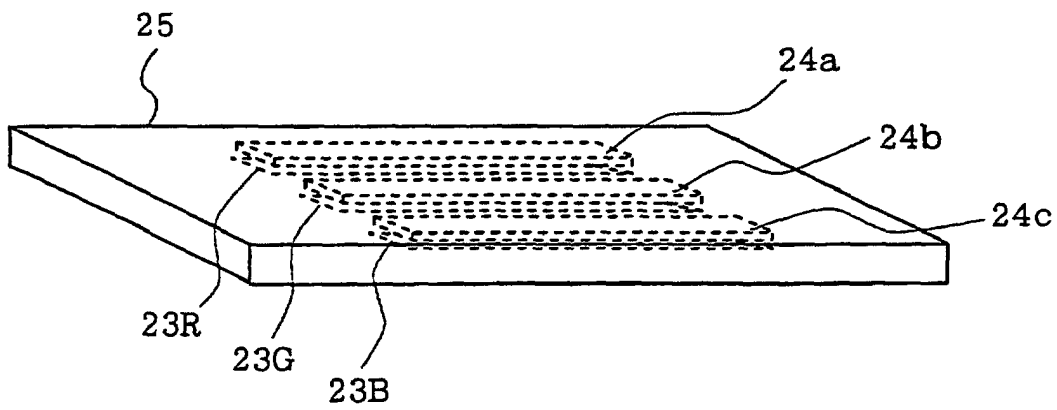


FIG. 5

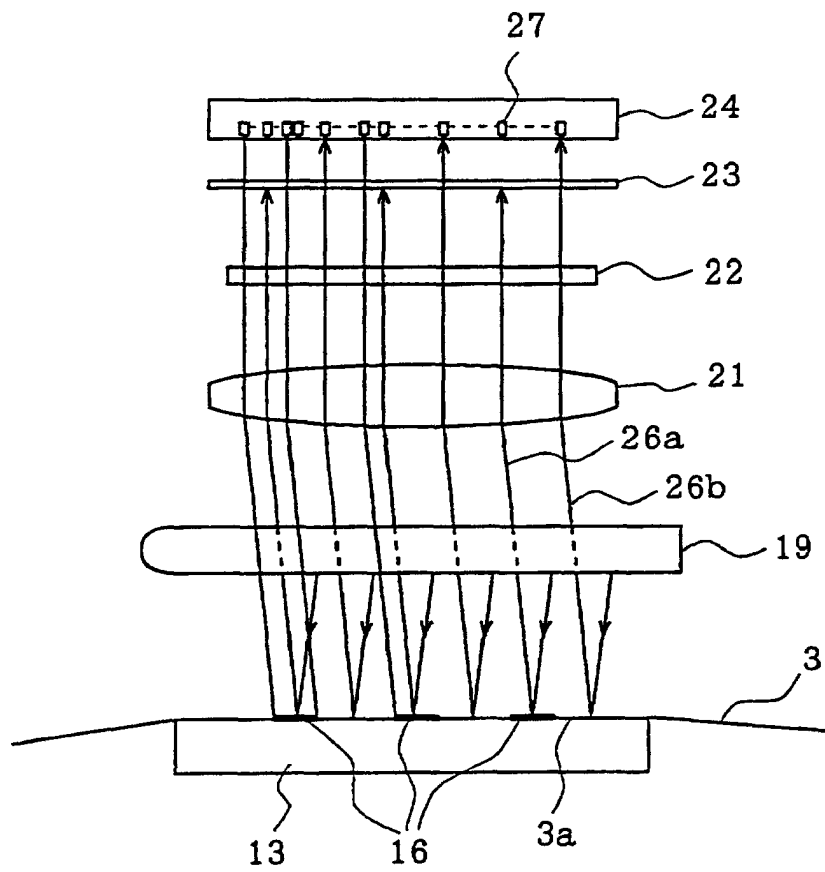


FIG. 6

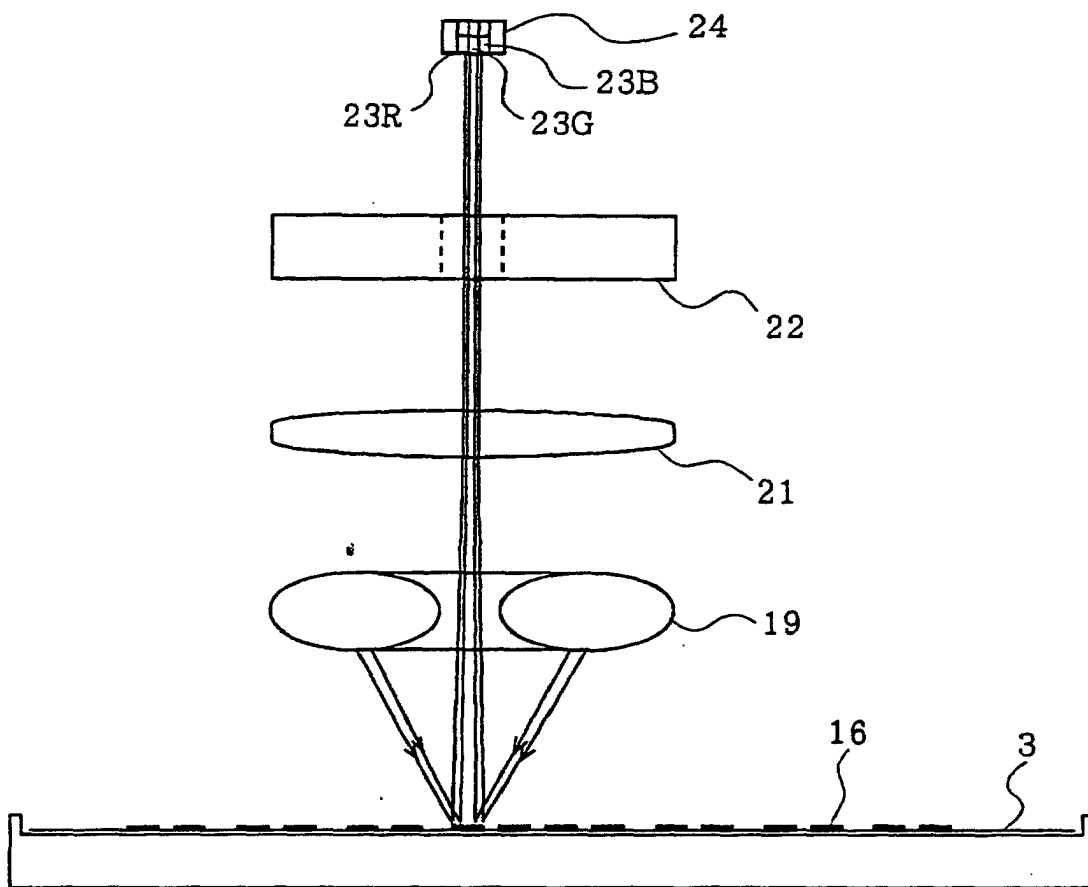


FIG. 7

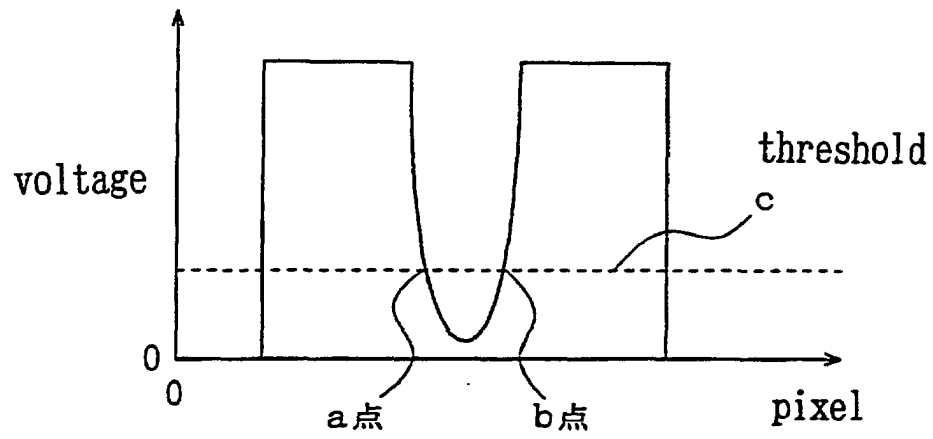


FIG. 8

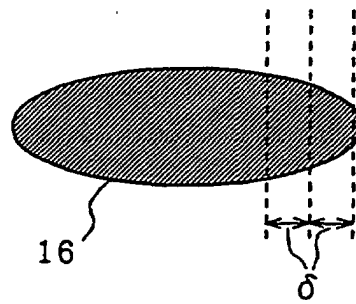


FIG. 9

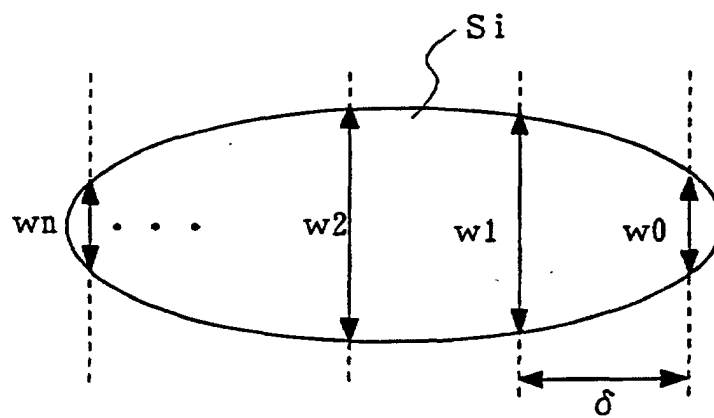


FIG. 10

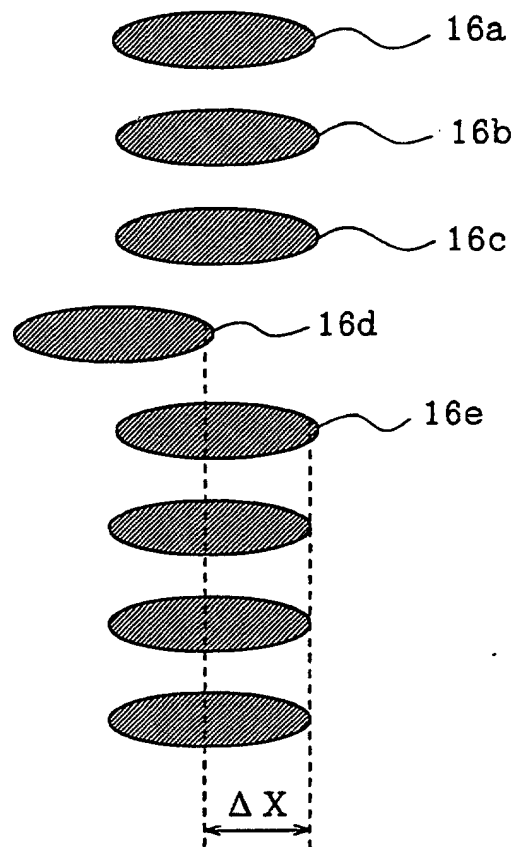


FIG. 11

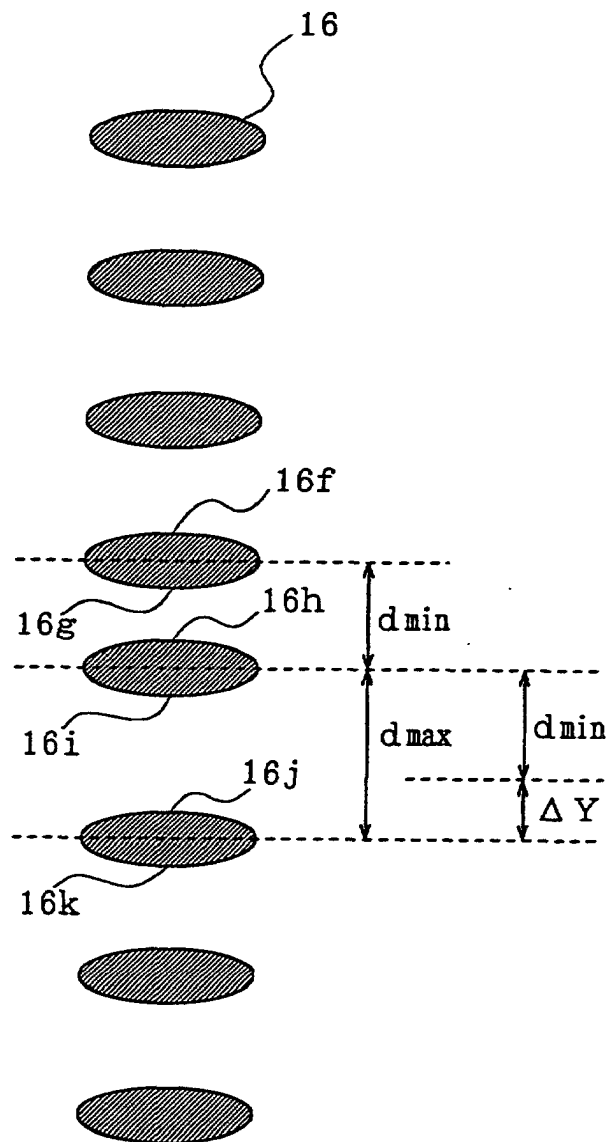
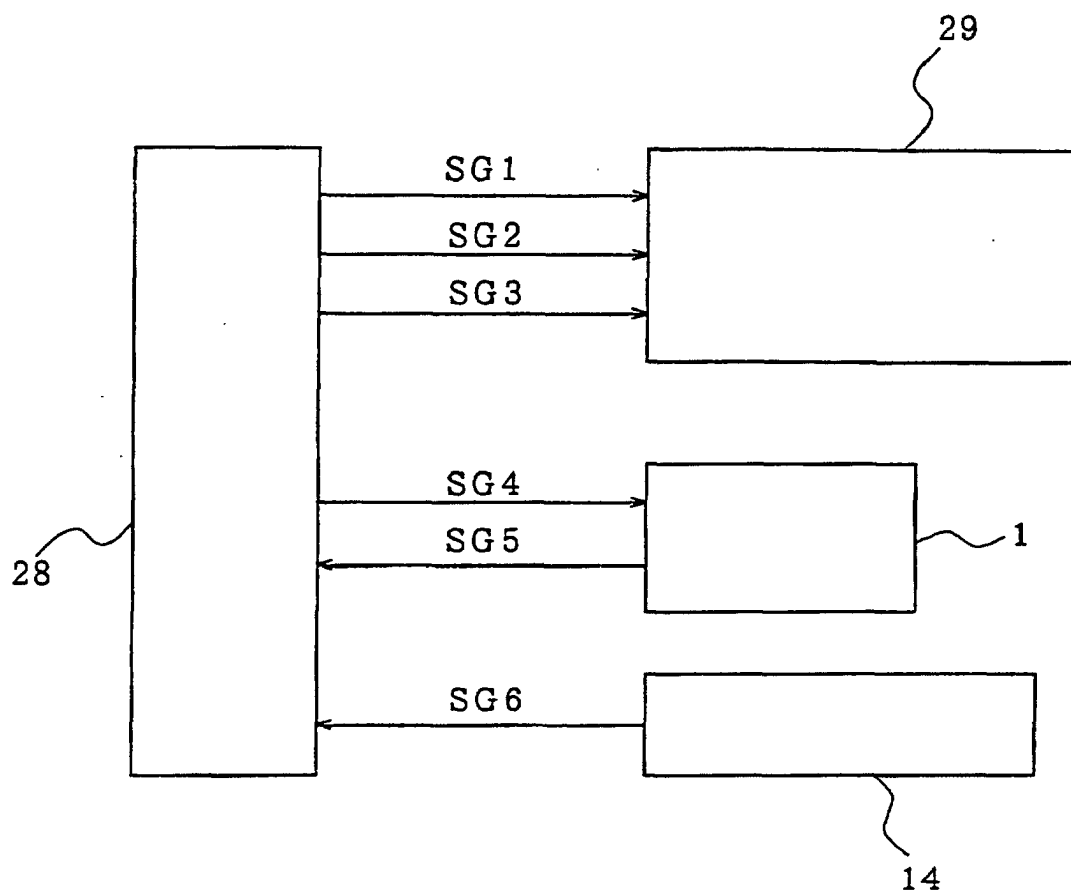


FIG. 12



F I G . 1 3

