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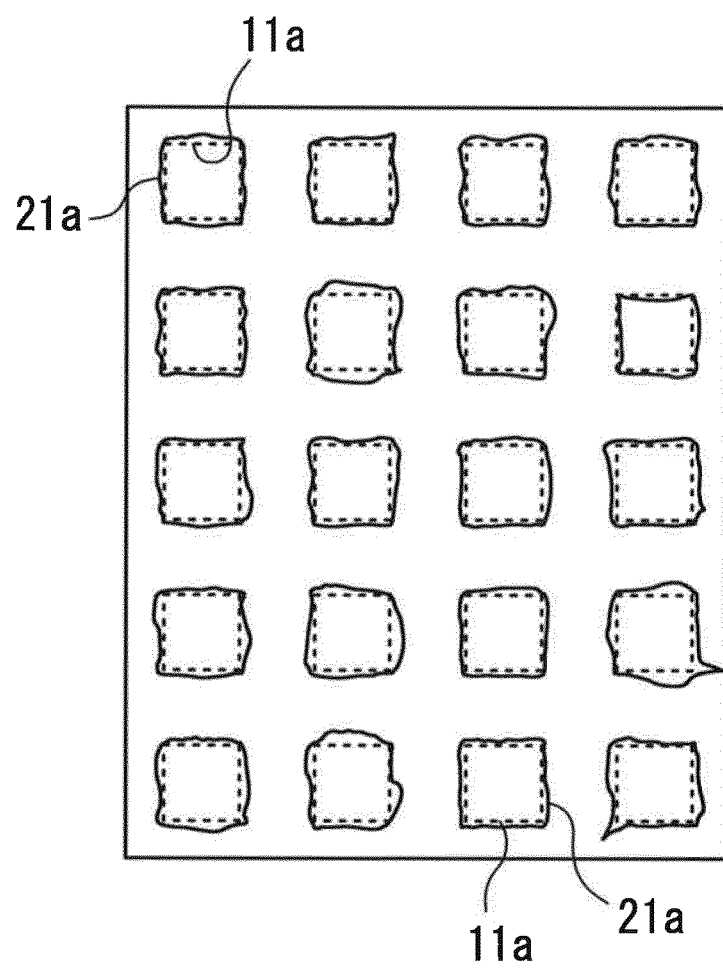
(54) **PRINT QUALITY CONTROL SYSTEM FOR OFFSET PRINTING MACHINE**

(57) Provided is a print quality control device of an offset printing machine in which an operator is notified of a control for suppressing an occurrence of a defective printed matter at an early stage or the control can be automatically executed, when there exists a sign that the defective printed matter will be caused due to deterioration in the print quality. A print quality control system for an offset printing machine is configured to print a pattern and a shape confirmation halftone dot pattern on a paper and comprises an imaging device for capturing the shape

confirmation halftone dot pattern printed on the paper and a determining device which are provided on a paper conveying path, the determining device is configured to confirm a change in a halftone dot shape based on an image of the shape confirmation halftone dot pattern and notify the operator of or execute automatically the control for suppressing the occurrence of the defective printed matter, when the print quality of printed matter would be deteriorated and the defective printed matter would be caused if printing continues as it is.

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FIG. 8



Description

Technical Field

[0001] The present invention relates to a system for controlling print quality of a printed matter printed by an offset printing machine.

Background art

[0002] Regarding offset printing machines, an offset printing machine has been known in which halftone dots according to a pattern to be printed are formed on a plate, ink is applied to the halftone dots, and the ink applied to the halftone dots are transferred to a paper so that the pattern according to the halftone dots is printed on the paper.

[0003] In such offset printing machine, print quality of a printed matter would gradually be deteriorated as proceeding printing, and the printed matter would become defective.

[0004] As one of causes of the deterioration in the print quality of the printed matter, it may be given that a halftone dot shape changes. For example, the halftone dot shape would differ from a predetermined shape due to whether the amount of dampening water supplied together with the ink to the plate is greater than or less than an appropriate value.

[0005] Japanese unexamined patent publication No.2000-158631 discloses that an operator visually inspects the printed matter using a magnifying monitoring device such as a loupe to confirm the halftone dot shape and the like.

Summary of the Invention

Technical Problem

[0006] Determination of the print quality of the printed matter by an operator's visual confirmation of the halftone dot shape, however, may require long work time for determining, take times to discover any sign of defective printed matter due to deterioration in the print quality of the printed matter, which would cause the defective printed matter.

[0007] In addition, for visually grasping the halftone dot shape, it is essential to acquire skills and know-how established by sufficient work experience.

[0008] Furthermore, when a roll paper is used as the paper to be printed, it is necessary to stop temporarily the offset printing machine and visually confirm the printed matter output from the offset printing machine using the magnifying monitoring device in order to confirm the halftone dot shape of the printed matter during printing, which would result in deterioration of the printing work efficiency.

[0009] The present invention has been made to solve the above problems, and its purpose is to provide a print

quality control system for the offset printing machine that enables early detection of the sign of the defective printed matter due to deterioration in the print quality of the printed matter, and allows to control the print quality of the printed matter by confirming the halftone dot shape during printing while maintaining production speed without stopping or decelerating the offset printing machine, even when using the roll paper.

Means to solve the Technical Problem

[0010] The present invention is related to a print quality control system for an offset printing machine which may be configured to form halftone dots for printing a pattern and a shape confirmation halftone dot on a plate cylinder of a printing unit and print a pattern and a shape confirmation halftone dot pattern on a paper, the print quality control system comprising an imaging device for capturing the shape confirmation halftone dot pattern printed on the paper and a determining device which are provided on a paper conveying path, and, wherein the determining device may be configured to confirm a change in the halftone dot shape based on an image of the shape confirmation halftone dot pattern of the imaging device and perform machine learning using the determining device based on a determination result of the change in the halftone dot shape, a printing condition and information of a printing result and notify an operator of or execute automatically a control for suppressing an occurrence of a defective printed matter, when it is at a degree that print quality of a printed matter would be deteriorated and the defective printed matter would be caused if printing continues as it is.

Advantageous Effects of the Invention

[0011] According to the print quality control system for the offset printing machine of the present invention, the sign of defective printed matter due to deterioration in the print quality of printed matter can be detected at an early stage, and the halftone dot shape can be confirmed during printing while maintaining the production speed without stopping or decelerating the offset printing machine and the print quality of the printed matter can be controlled, even when roll paper is used.

Brief Description of the Drawings

[0012]

Fig.1 is an overall front view showing an example of an offset printing machine to which print quality control system of the present invention can be applied. Fig.2 is a perspective view of a plate cylinder, a blanket cylinder and an impression cylinder. Fig.3 is an explanatory view of a pattern part of a paper. Fig.4 is a front view of an imaging device.

Fig.5 is a schematic view of a determining device.

Fig.6 is a schematic view of shape confirmation halftone dots.

Fig.7 is a schematic view of shape confirmation halftone dot patterns.

Fig.8 is a schematic view for comparing shapes of the shape confirmation halftone dots and shapes of the shape confirmation halftone dot patterns.

Description of Preferred Embodiments

[0013] An offset printing machine according to an embodiment of the present invention will be described with reference to Fig.1. Fig.1 is an overall front view which shows an example of an offset printing machine to which a print quality control system of the present invention can be applied.

[0014] The offset printing machine 1 according to an embodiment of the present invention includes a paper feeding part 2 that feeds a paper W, a printing part 3 that performs printing on the paper W conveyed from the paper feeding part 2, and a winding part 4 that winds up the paper printed by the printing part 3.

[0015] The paper feeding part 2 may be constituted to feed the paper W rolled up in rolls, that is, a roll paper, toward the printing part 3.

[0016] The paper feeding part 2 is not limited to this constitution and may have a constitution of a paper feeding part of a known printing machine, such as a constitution for feeding sheet.

[0017] The printing part 3 may be constituted of at least one or more printing units 5. In each printing unit 5, the printing is performed on the paper W using any ink. In the embodiment of Fig. 1, four printing units 5 are provided, and each printing is performed using yellow (Y), cyan (C), magenta (M), and black (K) inks. All printing units 5 have the same constitution.

[0018] The number of printing units 5 used in the printing system of the present invention is not limited to that of the embodiment of Fig. 1, the printing part 3 can be constituted of any number of printing units 5, such as only one printing unit that performs the printing using black (K) ink. Further, available ink is not limited to the above yellow (Y), cyan (C), magenta (M), and black (K), and any color ink such as special color ink can be used.

[0019] The printing unit 5 is provided with a plate cylinder 6, a blanket cylinder 7, and an impression cylinder 8. The plate cylinder 6 is provided with a plate (not shown) halftone dots (not shown) corresponding to a pattern are formed on the plate.

[0020] Rotations of the plate cylinder 6, the blanket cylinder 7 and the impression cylinder 8 are controlled by drive motor(s) not shown. The paper W is conveyed between the blanket cylinder 7 and the impression cylinder 8.

[0021] The printing is performed as in the following way. The ink and dampening water are supplied to the plate cylinder 6, the ink is applied to the halftone dots on

the plate, the ink is transferred from the plate cylinder 6 to the blanket cylinder 7, and the printing is performed by transferring the ink from the blanket cylinder 7 to the paper W.

[0022] The winding part 4 winds the paper W printed by the printing part 3.

[0023] The winding part 4 is not limited to this constitution and may have a constitution of a winding part of a known printing machine, such as a delivery device that delivers the paper W to another processing device or a sheet accumulation device.

[0024] The offset printing machine 1 to which the print quality control system of the present invention can be applied may not be limited to this constitution but also have any constitution, such as one in which a processing part to perform cutting and folding processing of the paper W is provided between the printing part 3 and the paper winding part 4.

[0025] The print quality control system of the present invention can be applied regardless of types of paper W. Therefore, as the paper W, any material used in a known offset printing machine such as paper, film, or label paper can be used. Further, it can be used regardless of forms of continuous paper, sheet, or the like.

[0026] Next, an embodiment of the print quality control system of the present invention will be described.

[0027] As shown in Fig. 2, a shape confirmation halftone dot 11 for confirming the halftone dot shape is formed on a plate 10 of the plate cylinder 6 of each printing unit 5.

[0028] In the present embodiment, the shape confirmation halftone dot 11 is formed at a position away from halftone dots 12 corresponding to the pattern. For example, the halftone dots 12 corresponding to the pattern are formed at an axial middle portion of the plate cylinder 6 on the plate 10, and the shape confirmation halftone dot 11 is formed on the plate 10 at an axial end of the plate cylinder 6.

[0029] Then, when printing, ink is applied to the shape confirmation halftone dot 11 and the halftone dots 12 corresponding to the pattern in the same way.

[0030] In the present embodiment, the shape confirmation halftone dot 11 formed on the plate 10 of each printing unit 5 is formed at a position that is deviated in a rotational direction of each of plate cylinders 6.

[0031] The position of shape confirmation halftone dot 11 is not limited to the position of Fig.2. For example, it may be formed, along the axial direction of the plate cylinder 6 at a position overlapping halftone dots 12 corresponding to the pattern in the axial direction of the plate cylinder 6 and a position different from the halftone dots 12 corresponding to the pattern in the rotational direction of the plate cylinder 6.

[0032] In this case, the shape confirmation halftone dot 11 is printed on the printed paper W between the halftone dots 12 corresponding to the pattern in a paper conveying direction. Then, the shape confirmation halftone dots 11 formed on the plates 10 of each printing unit 5 are formed

at positions deviated in the axial direction of the plate cylinder 6 for each printing unit 5. Further, it may be formed at positions deviated in the rotational direction of the plate cylinder 6.

[0033] When the label paper is used as the paper W, if the shape confirmation halftone dot 11 is printed on a place where stripping is performed by a stripping device provided in the processing part, it can be removed together with residue.

[0034] In the case of form printing that uses paper as the paper W, the same effect can be obtained by forming the shape confirmation halftone dot 11 on a part to be removed by a processing part such as a slit or marginal hole processing device provided on a downstream side of the printing part 3, or between the marginal holes.

[0035] Further, among halftone dots 12 corresponding to the pattern, a halftone dot at any position may be set in advance as the shape confirmation halftone dot 11.

[0036] From this, since the shape confirmation halftone dot 11 is sequentially printed in different color at the end away from the pattern, each time when the pattern is sequentially printed on the paper W in different color at each printing unit 5, a color pattern 20 and a plurality of shape confirmation halftone dot patterns 21 next to the pattern 20 are printed in different colors on the paper W printed as shown in Fig. 3.

[0037] For example, a shape confirmation halftone dot pattern 21-1 printed with yellow (Y) ink, a shape confirmation halftone dot pattern 21-2 printed with cyan (C) ink, a shape confirmation halftone dot pattern 21-3 printed with magenta (M) ink, and a shape confirmation halftone dot pattern 21-4 printed with black (K) ink are arranged at intervals in the paper conveying direction.

[0038] As shown in Fig. 1, the shape confirmation halftone dot pattern 21 printed on the paper W is captured by an imaging device 30 disposed opposite to a paper conveying path 9 in the winding part 4.

[0039] As shown in Fig. 4, the imaging device 30 is disposed opposite to the paper conveying path 9 and includes a camera 31 for capturing the shape confirmation halftone dot patterns 21 printed on the paper W, and lightings 32 that lighten up a portion to be captured by the camera 31.

[0040] The camera 31 has high resolution performance. Specifically, when it has a resolution of 7 μ m/pixel or higher, it can measure the halftone dot shape. In addition, when a target printing speed is set at 60 m/min, a scan rate of about 150 kHz would be required at 7 μ m/pixel, so a selection of a camera and an adaption of an imaging method which satisfy this condition are required.

[0041] The image to be captured by the camera 31 may be a color image or a monochrome image. When it is the color image, the camera 31 can also be used as a density detecting camera.

[0042] When it is the monochrome image, it has smaller data amount than that of the color image, so it is capable of imaging at a high resolution even if the printing speed is high. When it becomes to be necessary to meas-

ure the density of each color in the case of the monochrome image, a density measurement camera may be provided separately from the camera 31 in the paper conveying path 9.

[0043] An imaging direction 31a of the camera 31 is at a right angle to a paper surface of the paper W to be conveyed and is directed to the shape confirmation halftone dot pattern 21 on the paper W.

[0044] Two high-brightness lightings 32 that throw light on the shape confirmation halftone dot pattern 21 of the paper W are arranged close to the paper W, whose irradiation directions 32a are of an inverted V shape to throw light on the same position of the paper W at 45 degrees to the paper surface of the paper W.

[0045] The number of the high brightness lighting 32 is not limited to two, may be one or three or more, and the angle of the irradiation directions 32a to the paper surface of the paper W may not be limited to 45 degrees, it may be enough to throw light on the same position.

[0046] When the target printing speed is 60 m/min, at 7 μ m/pixel, an exposure time of 7 μ sec or less is required, so it is necessary to select the lighting and optical conditions satisfying these conditions.

[0047] According to the imaging device 30 of this constitution, since the camera 31 is of high-resolution performance and the lightings 32 can realize brightness corresponding to a short exposure time due to the high resolution, the resolution of the image capturing the confirmation halftone dot pattern 21 of the paper W conveyed at a fast speed can become excellent.

[0048] Therefore, it can correspond to the offset printing machine 1 that is driven at high speed and has a high paper conveying speed.

[0049] The imaging device 30 is not necessary to capture the corresponding shape confirmation halftone dot 11 each time when the pattern 20 is printed. The capture timing may be set in advance, for example, such as capturing every 10 images, and the image may be captured at a specified timing.

[0050] A mounting position of the imaging device 30 may be movable in a paper width direction (axial direction of the plate cylinder 6). An imaging position can be thereby adjusted according to the paper width of the paper W. Further, when the shape confirmation halftone dot 11 is formed along the axial direction of the plate cylinder 6, the shape confirmation halftone dot 11 can be captured at any position in the paper width direction. Furthermore, the imaging device 30 can be automatically moved in the paper width direction, and the shape confirmation halftone dot patterns 21-1, 21-2, 21-3, and 21-4 of each color printed in the paper width direction may be captured sequentially at each set number of sheets.

[0051] A determining device for determining print quality of a printed matter based on the captured image will be described with reference to Fig 5.

[0052] As shown in Fig. 5, the determining device 100 includes an image processing part 40, a calculation part 50, and a display part 60.

[0053] The image of the shape confirmation halftone dot pattern 21 captured by the imaging device 30 is sent to the image processing part 40 for image processing. An image-processed image is sent to the calculation part 50 to confirm the halftone dot shape of the shape confirmation halftone dot pattern 21.

[0054] Since the ink is applied to the shape confirmation halftone dot pattern 21 and the pattern 20 in the same condition, the halftone dot shapes of both would become the same, therefore, when the shape confirmation halftone dot pattern 21 has changed from a predetermined shape, the halftone dot shape of the pattern 20 would have changed as well.

[0055] When the calculation part 50 determines that the change in the halftone dot shape of the shape confirmation halftone dot pattern 21 is at a degree that the print quality of the printed matter would be deteriorated and a defective printed matter would be caused if the printing continues as it is, the display part 60 shows that the print quality has been deteriorated, as a sign that the defective printed matter will be caused. The display part 60 may be enough to be a display that allows the operator to sense the quality deterioration, such as an audio display or a character display.

[0056] According to this constitution, since the image captured by the imaging device 30 is processed by the image processing part 40 and calculated by the calculation part 50 to confirm a change in a halftone dot shape of the shape confirmation halftone dot pattern 21, the change in the halftone dot shape can be confirmed in a short time, and from the result, since the sign can suggest that the defective printed matter will be caused, the sign of the defective printed matter due to deterioration in the print quality can be detected at an early stage.

[0057] The operator can obtain the sign of occurring of the defective printed matter from the indication of the display part 60.

[0058] Moreover, since the imaging device 30 is provided opposite to the paper conveying path 9 of the offset printing machine 1 and the shape confirmation halftone dot pattern 21 of the conveyed printed matter is captured to confirm the change in the halftone dot shape, the halftone dot shape can be confirmed and the print quality of the printed matter can be determined during printing without stopping or decelerating the offset printing machine 1, even when roll paper is used.

[0059] The change in the halftone dot shape of each shape confirmation halftone dot pattern 21-1, 21-2, 21-3, or 21-4 of each shape confirmation halftone dot 11 formed on the plate 10 of the plate cylinder 6 of each printing unit 5 is confirmed, and it is thereby determined whether the sign of occurring of the defective printed matter for each printing unit 5 exists, so by displaying the printing unit 5 in which the sign has appeared on the display part 60, the operator can sense in which printing unit 5 the sign has appeared, and can control printing conditions such as the amount of dampening water in that printing unit 5 to achieve normal print quality.

[0060] For example, when it is determined that the change in the halftone dot shape of the shape confirmation halftone dot pattern 21-1 printed with yellow (Y) ink is the sign that the defective printed matter will be caused and it is displayed on the display part 60, the printing conditions of the printing unit 5 printing with yellow (Y) ink is controlled.

[0061] Next, determination of the change in the halftone dot shape of the shape confirmation halftone dot pattern 21 will be described.

[0062] The shape confirmation halftone dot 11 will be described based on Fig. 6. Fig. 6 schematically shows the shape confirmation halftone dot and may differ from the actual situation.

[0063] As shown in Fig. 6, a plurality of shape confirmation halftone dots 11 are formed at intervals within a frame 13. For example, the sum of the areas of all shape confirmation halftone dots 11 is set to be 50% of the area within the frame 13.

[0064] While the shape confirmation halftone dot 11 is a quadrangle, the control of the present invention can be performed with any shape such as a round shape or an oval shape.

[0065] The shape confirmation halftone dot pattern 21 printed on the paper will be described based on Fig. 7. Fig. 7 schematically shows the shape confirmation halftone dot pattern and may differ from the actual situation.

[0066] As shown in Fig. 7, the shape confirmation halftone dot patterns 21 as many as the shape confirmation halftone dots 11 are printed on the paper W.

[0067] Regarding the shape of the shape confirmation halftone dot pattern 21, there are various shapes, such as a shape that is the same as, slightly different from, and greatly different from the shape confirmation halftone dot 11.

[0068] The captured image of the imaging device 30 is the same as that shown in Fig. 7, and the captured image is sent to the image processing part 40 for image processing.

[0069] The image processing part 40 processes the sent image to make the shape confirmation halftone dot pattern 21 constituted of only an outline, and sends an image of only the outline to the calculation part 50.

[0070] Determination carried out in the calculation part 50 will be described based on Fig. 8.

[0071] As shown in Fig. 8, an outline 11a of the shape confirmation halftone dot 11 and an outline 21a of the shape confirmation halftone dot pattern 21 are superimposed and compared, and difference between the halftone dot shape of the shape confirmation halftone dot pattern 21 and the shape of the shape confirmation halftone dot 11, that is, the change in the halftone dot shape of the shape confirmation halftone dot pattern 21 is confirmed.

[0072] When the confirmed change in the halftone dot shape is at a degree that the print quality of the printed matter would be deteriorated and the defective printed matter would be caused if printing continues as it is, it is

determined as the sign that the defective printed matter will be caused. Then, the calculation part 50 indicates that the print quality has been deteriorated on the display part 60. It should be noted that Fig. 8 schematically illustrates each outline 11a and 21a and may differ from the actual one.

[0073] The calculation part 50 performs a control for suppressing an occurrence of the defective printed matter as described later and notifies the operator of or automatically executes control contents.

[0074] The change in the halftone dot shape of the shape confirmation halftone dot pattern 21 is confirmed as follows.

[0075] A shape of the shape confirmation halftone dot 11 and a halftone dot shape of each confirmation halftone dot pattern 21 are compared, and a shape difference corresponding to each halftone dot is summed up, and when the summed shape differences become greater than or equal to a preset setting value, it is confirmed that the change in the halftone dot shape is the degree that the print quality of the printed matter would be deteriorated and the defective printed matter would be caused if printing continues as it is.

[0076] Numerical values obtained by capturing the shape confirmation halftone dot 11 include area, height, width, roundness, outline length, aspect ratio, ellipse approximation (long axis, short axis, angle), number of holes, and the like. One or more of these numerical values is used to confirm the halftone dot shape.

[0077] For example, when the halftone dot becomes to have a shape being extended in the paper conveying direction and shorten in the paper width direction, the roundness and aspect ratio becomes different, even if the area of the halftone dot is the same. Even in this case, the print quality may sometimes be deteriorated and the defective printed matter may be caused. Therefore, the occurrence of the defective printed matter can be predicted more accurately by measuring the shape other than the area of the halftone dot.

[0078] The set value may be set by experiment or experience so far, or the like.

[0079] More specifically, the area on which the shape confirmation halftone dot patterns 21 are printed is captured by the imaging device 30.

[0080] In the example of Fig. 3, while a region on which the shape confirmation halftone dot pattern 21 is printed is set as being at the width direction end of the paper W, it can be provided in any position. Further, it may be any region within the pattern 20.

[0081] The image processing part 40 receives the captured image from the imaging device 30, and extracts the shape confirmation halftone dot pattern 21 for confirming the halftone dot shape from the captured image.

[0082] Regarding the shape confirmation halftone dot pattern 21 to be extracted, the shape, size, density, and the like of the halftone dot to be extracted can be arbitrarily determined based on the performance of the imaging device 30, printing conditions such as printing

speed, and measurement data to be used for machine learning described later. By detecting more shape confirmation halftone dot patterns 21 and confirming changes in the halftone dot, the accuracy of the machine learning described later can be improved and the print quality of the printed matter can be determined more accurately.

[0083] Hereinafter, a determination method related to the outline of the captured shape confirmation halftone dot patterns 21 will be described.

[0084] The image processing part 40 determines the outline 21a of the shape confirmation halftone dot pattern 21 by binarizing the captured image. By binarization, the region on which the shape confirmation halftone dot patterns 21 are printed and a nonprinted region (the color region of the paper W, that is the background color) can be distinguished in the captured image.

[0085] Therefore, by binarization, the outline 21a of each shape confirmation halftone dot pattern 21 in the captured image can be calculated. Information of the outline 21a is used as detection data for the machine learning described later and for determining the print quality of the printed matter.

[0086] In binarizing, for distinguishing the color of any ink to be extracted from the color of the paper W that is the background color, setting values for binarization are set with respect to the RGB values or grayscale value of the extracted image, and those RGB values or grayscale value are compared with the setting values for binarization.

[0087] The setting values for binarization can be arbitrarily set according to printing conditions such as the color of any ink to be extracted and the color of paper W that is the background color.

[0088] In this embodiment, the image processing part 40 and the calculation part 50 are shown as being independent, but both processes may be performed with one device.

[0089] The resolution of the image captured by the imaging device 30 may be any resolution enabling to determine the outline 21a of the shape confirmation halftone dot pattern 21 calculated by binarizing.

[0090] The calculation part 50 determines the change in the shape of an arbitrary number of shape confirmation halftone dot pattern 21 in the image extracted by binarizing. The larger the number of the shape confirmation halftone dot pattern 21 to be determined becomes, the higher accuracy of the machine learning described later becomes, and the print quality of the printed matter can be determined with the more accuracy. In the present embodiment, the outline 21a is determined for all the shape confirmation halftone dot patterns 21 within the extracted image.

[0091] The calculation part 50 determines each halftone dot shape as follows.

[0092] The calculation part 50 stores the halftone dot shape on the plate 10 (the shape of the shape confirmation halftone dot 11) as an ideal halftone dot shape of the printed halftone dot. The calculation part 50 compares

the shape of each shape confirmation halftone dot pattern 21 determined by binarizing with the halftone dot shape on the plate 10.

[0093] Measurement data to be used for comparison may be used as follows based on the halftone dot shape to be used as the shape confirmation halftone dot pattern 21.

[0094] When the halftone dot to be used is a square, as the measurement data, the area, the length (height, width) of each side, the ratio of each side, the deviation of each side to the halftone dot shape on the plate 10, etc. are used as a feature amount of the outline 21a, based on the outline calculated from the captured image.

[0095] When the halftone dot to be used is circular, the area, roundness, ellipse approximation (long axis, short axis, angle), aspect ratio, outline length, etc. are used as the feature amount of the outline, based on the outline calculated from the captured image.

<Embodiment when using deviations of each side as measurement data>

[0096] For the above measurement data, for example, when the halftone dot is a regular square and the deviation of each side to the halftone dot shape on the plate 10 is calculated as measurement data, four sides of the outline 21a calculated from the captured image are subdivided at any intervals, and the deviation from the halftone dot shape on the plate 10 to the outline 11a is calculated at each subdivided point. The calculated deviations are used as measurement data for determining the change in the halftone dot shape.

[0097] The determination of the halftone dot shape for the deviations means that, when any deviation exceeds a certain value, a convex change would be caused in the outline 21a and the larger the deviation value becomes, the larger the convex change becomes.

[0098] Also, a standard deviation may be calculated from the calculated deviations and the standard deviation may be compared with a set value of standard deviation. It means that the larger the value of the standard deviation becomes, the more distorted the outline 21a becomes.

<Embodiment of using roundness as measurement data>

[0099] For the above measurement data, for example, when the halftone dot is a perfect circle and the roundness is calculated as measurement data, the difference in outlines between the outline calculated from the captured image and the outline of the halftone dot shape of the plate 10, or the distance between the two concentric geometric circles when the outline calculated from the captured image is put between the above two circles is calculated as roundness.

[0100] Calculated roundness may be used as measurement data for determining the change in the halftone

dot shape. If the roundness is large, it means that the outline is out of the perfect circle and the outline is distorted.

[0101] It means that there is a tendency in which the more change in convex shape occurs and the greater the distortion of the outline 21a becomes, the lower the print quality and the defective printed matter would be resulted.

[0102] The measurement data showing the features of the above outline 21a can be used to determine the halftone dot shape by arbitrarily combining a plurality of different measurement data.

[0103] The calculation part 50 determines the sign of the occurrence of the defective printed matter as follows from the measurement data showing the change in the halftone dot shape calculated from the above outline 21a.

[0104] The calculation part 50 determines the degree of the change in the halftone dot shape using information, such as data concerning the operation status or the like of the offset printing machine 1 described later, information on the printing results input by the operator, and information from the machine learning described later, in addition to the measurement data.

[0105] The calculation part 50 determines the degree of change in the halftone dot shape for all the set shape confirmation halftone dot patterns 21 among the captured images. The calculation part 50 calculates the ratio of halftone dots whose degree of the shape change exceeds a set value for the total number of shape confirmation halftone dot pattern 21 that have been determined, and, when it is more than the set value of ratio, confirms that the halftone dot change has been at the degree that the print quality of the printed matter would be deteriorated and the defective printed matter would be caused, if the printing is continued as it is.

[0106] Each of the above setting values is set by experiment or experience so far, or the like. Alternatively, it can be set by learning by the machine learning described later.

[0107] In the above example, while an example is shown in which captured shape confirmation halftone dot patterns 21 are compared individually with the halftone dot shapes on the plate 10, by taking a position of any one shape confirmation halftone dot pattern 21 included in the captured region as a reference and assuming the outlines of the plurality of shape confirmation halftone dot patterns 21 as one data, it can also be compared with the dotted shape on the plate 10 including a positional relationship between a plurality of halftone dots.

[0108] In this case, not only the individual shapes of the halftone dots but also the data obtained by comparing the relative position between the captured halftone dots and the relative position between the halftone dots on the plate 10 can be measurement data for determining the print quality. The number of the shape confirmation halftone dot patterns 21 that are to be assumed as one data can be set arbitrarily, and all the shape confirmation halftone dot patterns 21 included within the captured re-

gion can be assumed as one data.

[0109] Although the print quality has been conventionally determined by the area ratio of the halftone dot, according to the conventional determination of print quality by the area ratio of the halftone dot, for example, the determination by concentration, even if the outline of the halftone dot is distorted, it cannot be detected that the change has been caused in the halftone dot shape, if it is matched in area with the halftone dot on the plate. Thus, it could not be detected, even if there caused the change in the halftone dot shape that would affect the print quality.

[0110] According to the print quality control system of the offset printing machine 1 of the present invention, since the shape of each halftone dot can be accurately determined, it is possible to detect the changes in the halftone dot shapes and determine the sign of the defective printed matter accurately, that could not have been detected by conventional evaluation of print quality during printing.

[0111] Next, a control related to the machine learning will be described.

[0112] The determining device 100 of the print quality control system of the offset printing machine 1 of the present invention stores, as data for performing the machine learning, the outline of each calculated shape confirmation halftone dot patterns 21, the printed halftone dot shape on the plate 10, the measurement data, that are the area, the length (height, width) of each side, the ratio of each side, the deviation of each side to the halftone dot shape on the plate 10, roundness, ellipse approximation (long axis, short axis, angle), aspect ratio, outline length, number of holes, etc., and the degree of change in each halftone dot shape calculated from the measurement data, the percentage of shape confirmation halftone dot patterns 21 whose change of degree exceeds the set value with respect to the total number, which have been used by the calculation part 50 as above mentioned.

[0113] Data storage may be performed by the determining device 100 or by any storage device provided independently of the determining device 100.

[0114] As the initial stage of the machine learning, the result of the operator's determination of the occurrence of print quality deterioration of the printed matter is stored in association with the above data.

[0115] The determining device 100 performs the machine learning based on determination result data on the print quality input by the operator and the halftone dot shape detection data confirmed by the calculation part 50, and creates and updates a control model that predicts changes in the halftone dot shape detection data and the printing result.

[0116] In other words, the determining device 100 confirms the change in the halftone dot shape by the image of the shape confirmation halftone dot pattern 21 captured by the imaging device 30 using the control model by the machine learning and, when the change in the

halftone dot shape is at the degree that print quality of the printed matter would be deteriorated and the defective printed matter would be caused if printing continues as it is, can inform it the operator.

[0117] Further, the offset printing machine 1 may be configured to be automatically controlled according to the change in the halftone dot shape that would cause the defective printed matter.

[0118] Since the relationship between the change in the halftone dot shape and the printing result may be updated at any time, the sign of print quality deterioration can be detected with high accuracy.

[0119] As machine learning data, in addition to the above data concerning to the halftone dot shape and the print result data, the determining device 100 can further use any data from data or the like such as, paper width, paper type as the paper information, the amount of dampening water supplied at the start of printing, the amount of ink supplied at the start of printing, the information of the pattern to be printed, the printing speed during printing, the amount of dampening water supplied during printing, and the ink supply amount during printing data as an operation status of the offset printing machine 1, halftone dot area ratio, ink concentration data as detection information of the printing result of the offset printing machine 1, the dampening water temperature at the start of printing, the ink temperature at the start of printing, the swinging roller water flow temperature at the start of printing, the plate cylinder water flow temperature at the start of printing, the temperature in the factory at the start of printing, the humidity in the factory at the start of printing, the temperature of the dampening water during printing, the ink temperature during printing, the swinging roller water flow temperature during printing, the plate cylinder water flow temperature during printing, the temperature in the factory during printing, the humidity in the factory during printing as the information on the temperature and humidity of the offset printing machine 1. Using these data on the offset printing machine 1 for the machine learning, influence on print quality that would change due to various environmental factors can be reflected in the control model.

[0120] The data to be used for the above machine learning are stored in associated with elapse time.

[0121] In the above description, while the control by edge AI in which the determining device 100 in the offset printing machine 1 performs the machine learning has been shown by taking as an example, the machine learning is not limited to this example but may use cloud Servers.

[0122] When using the cloud Servers, the determining device 100 transmits the above data to the cloud Servers via Internet.

[0123] The cloud Servers store the received data, perform the machine learning to create and update the control model, and output the result output by the control model to the offset printing machine 1 for the input data.

[0124] The offset printing machine 1 responds to the

sign of the defective printed matter based on the result output from the cloud Servers.

[0125] The cloud Servers can also manage a plurality of offset printing machines 1 with one cloud Server. In this case, the control model can be built using the measurement data of the plurality of offset printing machines 1. 5

[0126] The print quality control system of the present invention can be controlled using the machine learning by the above edge AI or a learnt control model prepared by the machine learning using the cloud Servers. 10

[0127] The determining device 100 does not perform the machine learning but applies data such as the outline 21a calculated by the calculation part 50 and operation status of the offset printing machine 1 to the control model, and responds to the sign of the defective printed matter that will be caused according to the output results. 15

[0128] When using the learnt control model, the determining device 100 is implementable even if its processing capacity is low. 20

Claims

1. A print quality control system for an offset printing machine which is configured to form halftone dots for printing a pattern and a shape confirmation halftone dot on a plate cylinder of a printing unit and print a pattern and a shape confirmation halftone dot pattern on a paper, the print quality control system comprising an imaging device for capturing the shape confirmation halftone dot pattern printed on the paper and a determining device which are provided on a paper conveying path, and wherein the determining device is configured to confirm a change in a halftone dot shape based on an image of the shape confirmation halftone dot pattern of the imaging device and perform the machine learning using the determining device based on a determination result of the change in the halftone dot shape, a printing condition and information of a printing result and notify an operator of or execute automatically a control for suppressing an occurrence of a defective printed matter, when it is at a degree that print quality of a printed matter would be deteriorated and the defective printed matter would be caused if printing continues as it is. 25 30 35 40 45

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FIG. 1

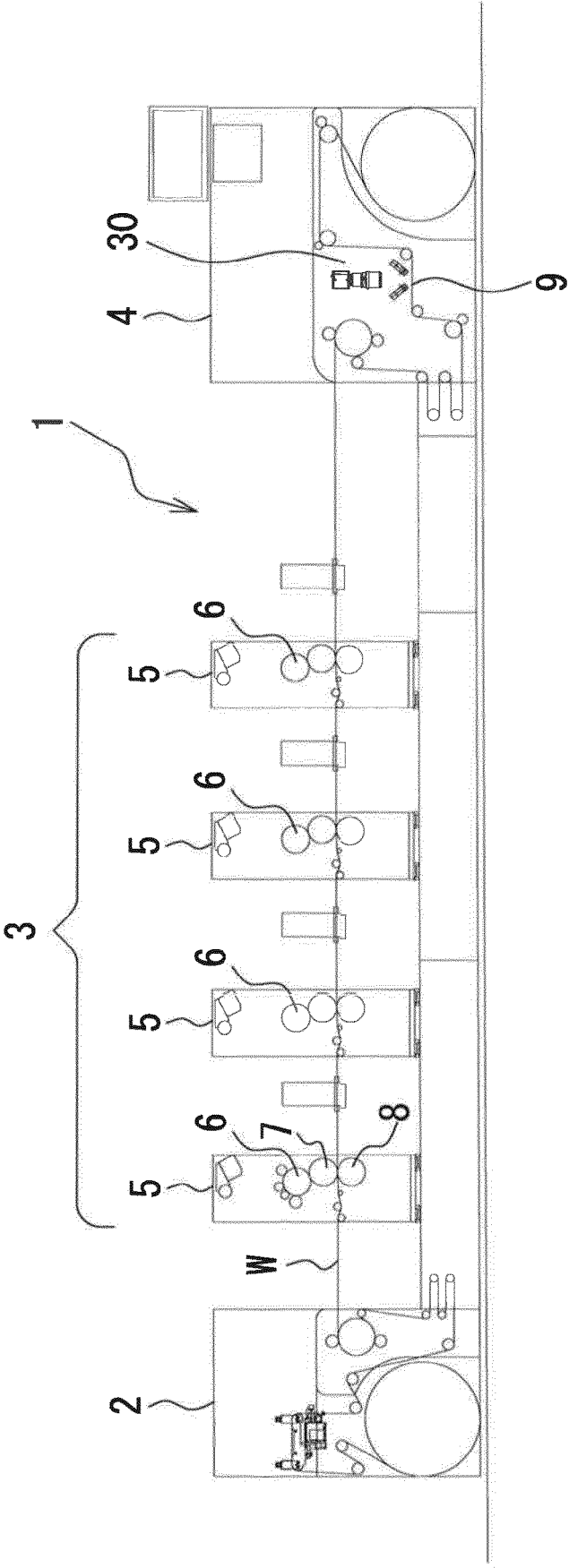


FIG. 2

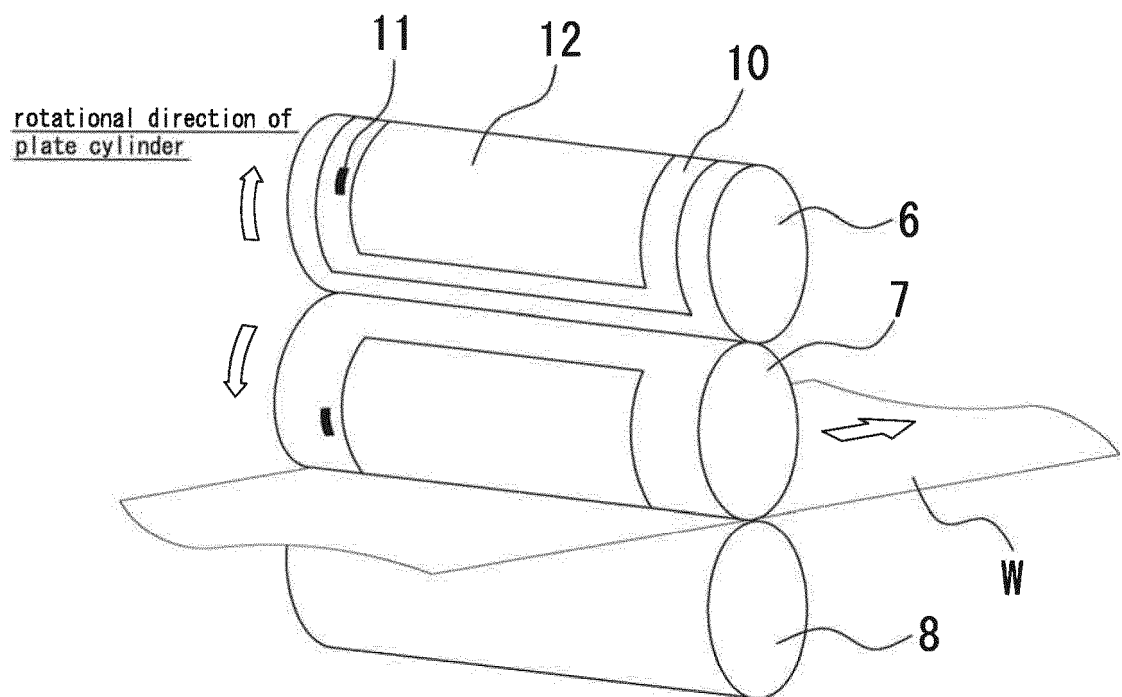


FIG. 3

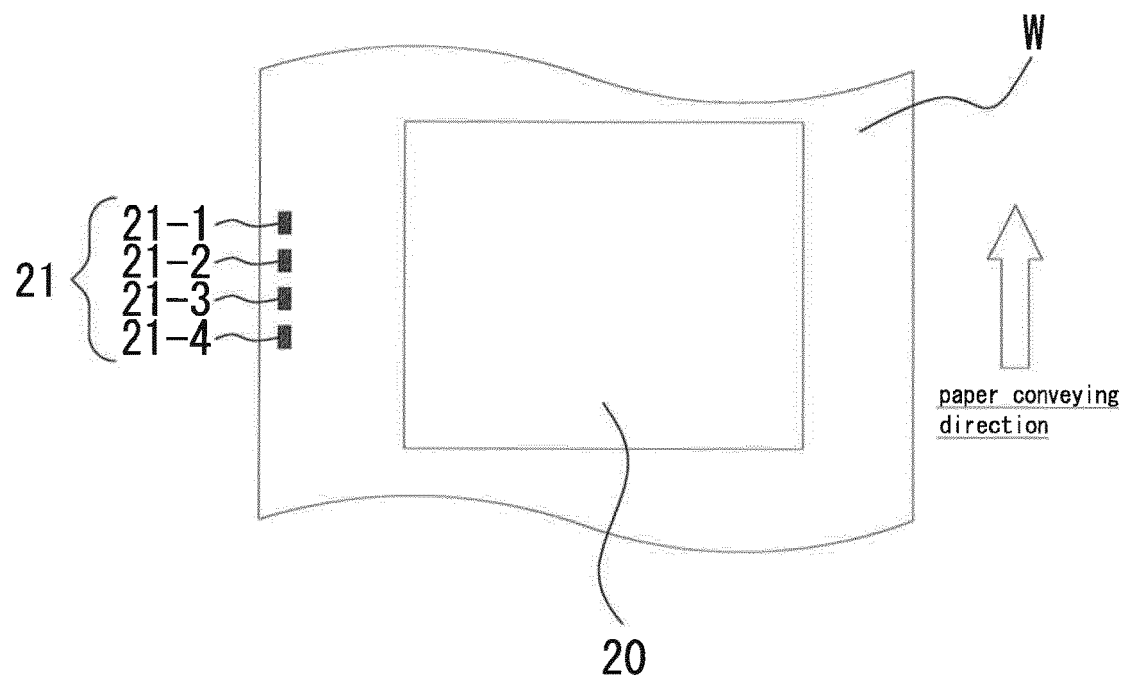


FIG. 4

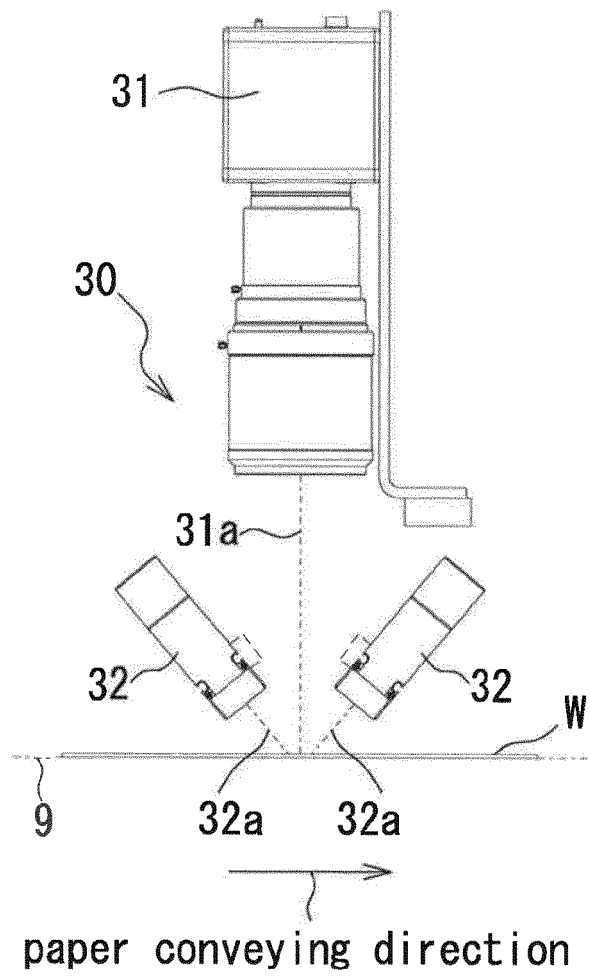


FIG. 5

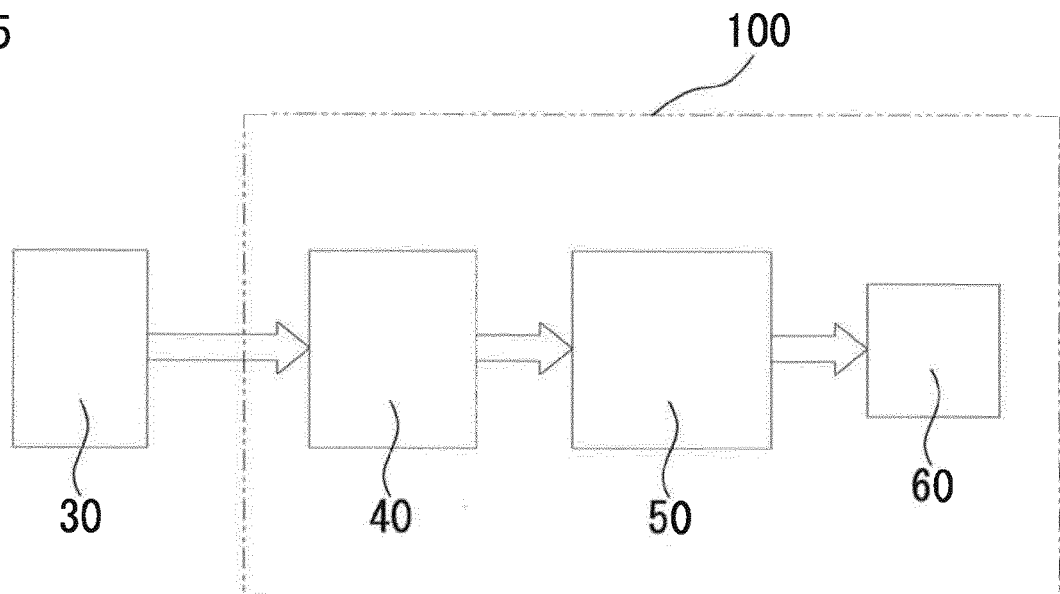


FIG. 6

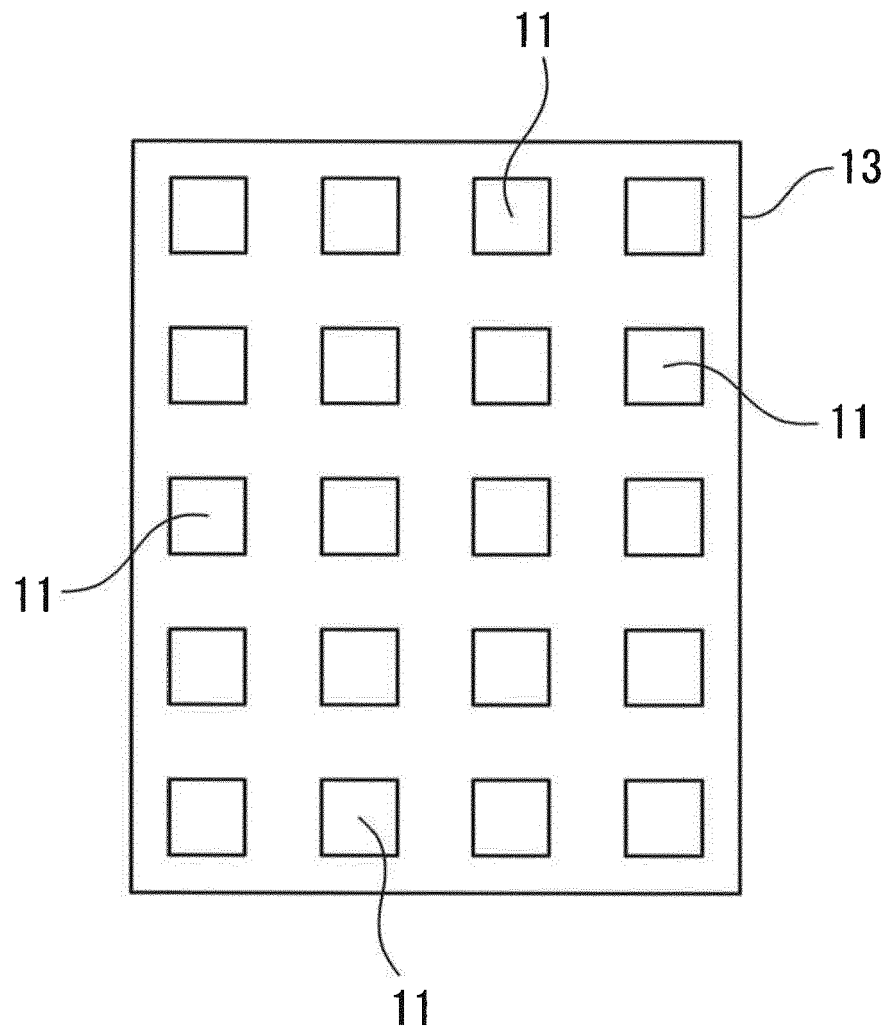


FIG. 7

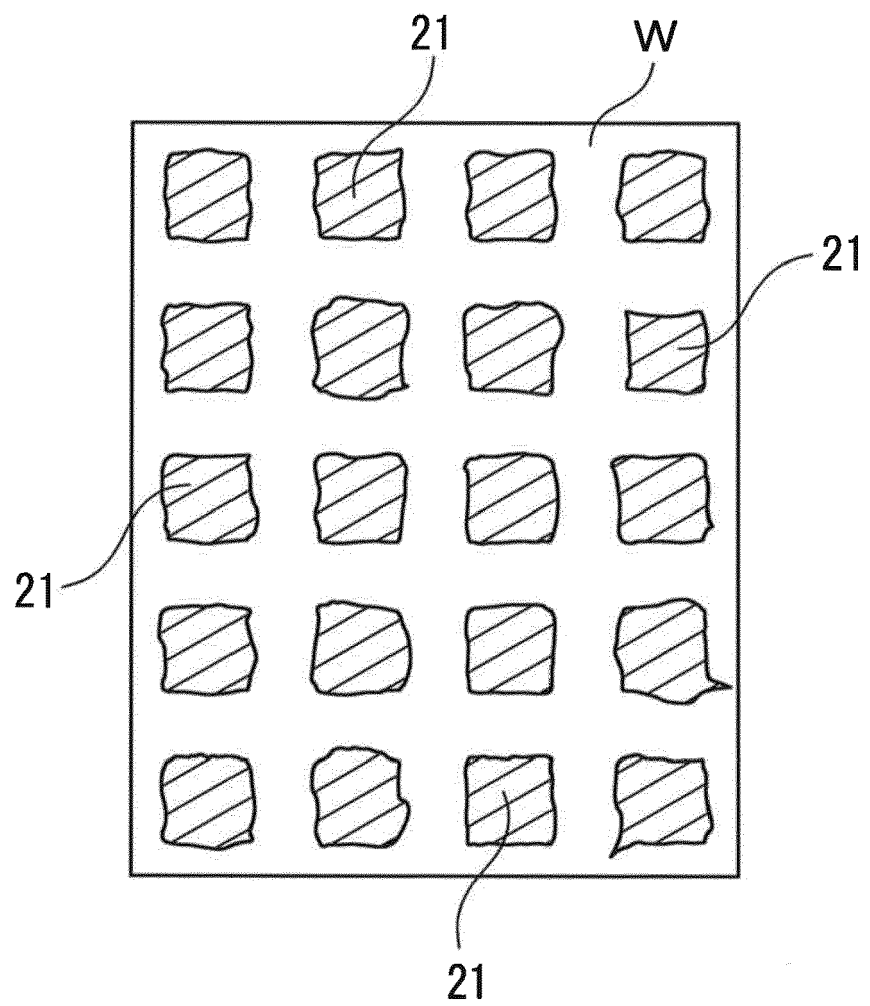
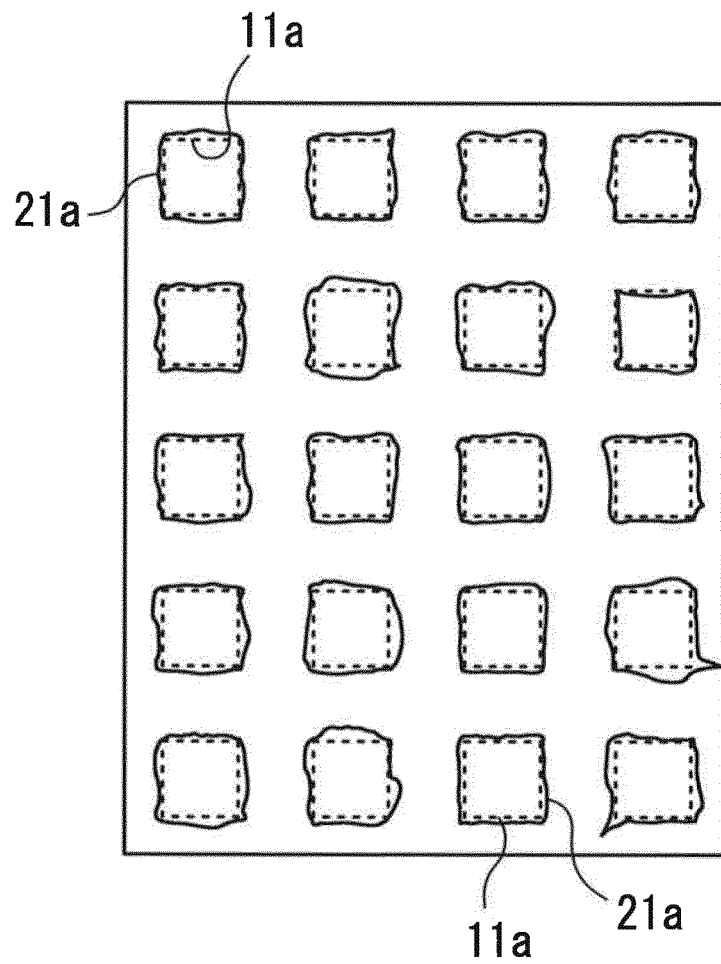


FIG. 8





EUROPEAN SEARCH REPORT

Application Number

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X	US 9 967 428 B2 (FUJIFILM CORP [JP]) 8 May 2018 (2018-05-08) * column 43, line 55 - line 59 * * column 46, line 9 - column 47, line 24 * * column 125, line 3 - column 126, line 59; figures 1-52 *	1	INV. B41F33/00 B41F33/02 G06T1/00
A	JP 2017 022695 A (RICOH CO LTD) 26 January 2017 (2017-01-26) * the whole document *	1	
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			B41F G06T
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 10 October 2023	Examiner Kelliher, Cormac
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ON EUROPEAN PATENT APPLICATION NO.**

EP 23 16 4970

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10-10-2023

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