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(54) **Title:** SYSTEM AND METHOD FOR INSPECTING A PRINTED SURFACE EXHIBITING OPTICAL MANIPULATION PROPERTIES

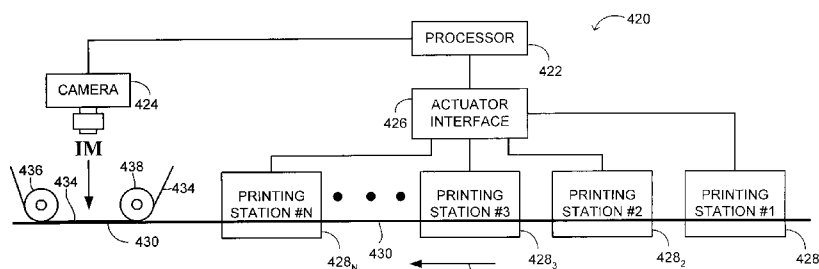


FIG. 8A

(57) **Abstract:** In a print image acquisition and inspection system, an apparatus for enabling acquisition of an image of a section of a printed surface, the printed surface including a carrier surface and an optical manipulating surface, the optical manipulating surface optically manipulating light impinging on the printed surface, the apparatus comprising a diffusing surface, being in temporary contact with the printed surface, the diffusing surface diffusing the light transmitted therethrough, thereby moderating the optical manipulation effects.

SYSTEM AND METHOD FOR INSPECTING A PRINTED SURFACE EXHIBITING OPTICAL MANIPULATING PROPERTIES

FIELD OF THE DISCLOSED TECHNIQUE

5 The disclosed technique relates printing equipment, in general, and to methods and systems for acquiring images and inspecting a printed surface exhibiting optical manipulation properties, in particular.

BACKGROUND OF THE DISCLOSED TECHNIQUE

10 Images can be printed on surfaces using various methods. In particular, color images can be printed on a web substrate (e.g., paper, textiles, plastic films and the like) by employing various printing methods, such as flexography and rotogravure. In each one of these printing methods a plate cylinder is formed with a pattern of an image to be printed
15 on a web substrate. Rollers are used to move the web substrate through a printing press wherein the plate cylinder is used to transfer the image to the web substrate. For printing a color image on a web substrate, a printing press usually includes a respective printing station, located in sequence, for each basic color according to a particular color gamut. For
20 example, a flexographic printing press may have three printing stations, one for producing the image in red, one for producing the image in green, and one for producing the image in blue. The outer surface of each of the rollers is made of a resilient material, such as rubber, so that the pressure between the rollers can be adjusted by varying the distance between
25 them.

 Prior to a print run (i.e., the printing of the images on the web), the printing press has to be set up (i.e., adjusted) in order to print the image on the web substrate at an acceptable quality level. Setting up a printing press includes determining the correct relative pressure between
30 the printing rollers. Furthermore, for the pattern to be printed properly, the

printing stations in the printing press must be registered with each other such that each station prints the respective image objects thereof at the respective relative location of the image object. In other words, registration includes determining the correct relative position between the rollers of the printing stations.

Setting up a printing press includes printing an image object on the web substrate, acquiring an image of the printed object and inspecting the acquired image. Inspecting the image includes monitoring and controlling the quality of the printed object (e.g., determining colors and registration errors). Setup includes adjusting the position of and the pressure between the printing rollers to correct for deviations of the color and registration if such deviations occur. Methods for setting up a printing press are known in the art. In a manual method, an operator runs the printing press, inspects the printed image and adjusts the pressure between the rollers until the printed image is acceptable. In an automatic method, an opto-electronic sensor acquires an image of a printed contact strip on the web substrate. A processor inspects the printed image and adjusts the relative position of and pressure between the rollers, for example, according to the width of the contact determined according to the output of the opto-electronic sensor. In another automatic method, the processor adjusts the relative position of and pressure between the rollers by comparing the contour of the current image with that of a desired image which is stored in a memory. Furthermore, the images of the printed objects may be continuously acquired to adjust and control the relative position of the rollers and the pressure between the rollers.

US Patent No. 6,634,297 to Poetter et al., entitled "Device and Process for Setting the Printed Image in a Flexographic Press," is directed to a system for setting up a printing job. The system includes a printing roller, an engraved roller, a counter-impression roller, an actuating device, a plurality of servo motors, a control and regulating unit, an input device, an input unit and a camera. The control and regulating unit is connected

to the input device, the input unit, the camera and to the actuating device. The actuating device is connected to the servo motors. A first pair of servo motors is connected to each end of the engraved roller. A second pair of servo motors is connected to each end of the printing roller.

5 A paper web runs over the printing roller. The engraved roller is provided with an inking unit. The printing roller is provided with a plurality of blocks to be printed on the paper web. The engraved roller picks up the ink from the inking unit and transfers the ink to the printing roller by means of a contact there between. The printing roller transfers the ink to the
10 paper web by means of contact with the counter-impression roller, and in this manner, a pattern defined by the blocks of the printing roller is printed on the paper web.

The first pair of servo motors provides horizontal movement of each end of the engraved roller. The second pair of servo motors provides
15 horizontal movement of each end of the printing roller. The actuating device directs the servo motors to move each of the engraved roller and the printing roller, either individually or together, towards or away from the counter-impression roller. The desired contour which is to be printed on the paper web is entered into the control and regulating unit by means of
20 the input unit. The diameter of the printing roller and the thickness of the blocks are entered into the control and regulating unit by means of the input device.

The camera scans the printed image and feeds the scanned image to the control and regulating unit. The control and regulating unit
25 compares the scanned image with the desired contour and directs the actuating device to control the servo motors, and to move the engraved roller and the printing roller to a position which produces the qualitatively best printed image. The values respective of this position are stored in a storage of the control and regulating unit so that the optimal setting can be
30 found again.

US Patent No. 6,166,366 to Lewis et al., entitled "System and

Method for Monitoring and Controlling the Deposition of Pattern and Overall Material Coatings," is directed to a system for detecting voids in a cold seal. The system includes a computer processor, a printing cylinder, an anilox roller, an ink tank, a traversing mechanism, an encoder, a display monitor and a touch screen. The traversing mechanism includes a camera and a radiation source. The encoder is connected to the anilox roller. The computer processor is connected to the encoder, the camera, the radiation source, the display monitor and to the touch screen.

The anilox roller picks up the ink from the ink tank and transfers the ink to a printing plate of the printing cylinder in order to form the cold seal on a web substrate. The traversing mechanism moves the camera and the radiation source across the entire width of the web substrate. The encoder provides the signal to the computer processor in order to trigger the radiation source.

To set up the system, an operator positions the camera over the web substrate, at a position of interest where the camera can automatically view the coating on the web substrate, via the touch screen, while viewing an image of the web substrate on the display monitor. When the camera is positioned at the position of interest, the operator stores the position of interest in the computer processor as the coating defect analysis position. The operator enters the maximum allowable coating void warning size, via the touch screen, and enables the automatic void detection. The computer processor determines whether there is a void larger than the maximum allowable coating void warning size by employing a coating defect detection algorithm. In case the computer processor detects such a void, the computer processor produces a warning beacon and directs the display monitor to display the void.

US Patent No. 5,448,949 to Bucher, entitled "Method and Device for Adjusting a Contact Pressure Between Ink-Carrying Cylinders of a Printing Machine," is directed to a system for setting up a printing job. The system includes a plate cylinder, a plurality of form rollers, a

dampening roller, a connecting roller, a plurality of adjusting drives, a plurality of position sensors, an angular position sensor, two opto-electronic sensors and a control or regulating device. Each of the adjusting drives is connected to a respective one of the position sensors.

5 The form rollers and the dampening roller are connected with the respective adjusting drives. The angular position sensor is connected with a rotational axis of the plate cylinder. A flexible printing form is clamped to the plate cylinder. The position sensors, the angular position sensor and the two opto-electronic sensors are connected to the control or
10 regulating device.

 The form rollers and the dampening roller are associated with the plate cylinder. The connecting roller is located between the form roller and the dampening roller. The two opto-electronic sensors are aimed at the surface of the flexible printing form, at the outer periphery of the plate
15 cylinder along a peripheral line. The adjusting drives provide engagement and disengagement of the form rollers and the dampening roller from the plate cylinder.

 When the form rollers and the dampening roller are engaged with the plate cylinder, and when the plate cylinder is stationary, the form
20 rollers and the dampening roller are inked and a contact strip is formed on the surface of the printing form. When the plate cylinder rotates, the two opto-electronic sensors sense the contact strip. The control or regulating device determines the association between an output of the two opto-electronic sensors, the form rollers and the dampening roller. The
25 control or regulating device determines the width of the contact strip, according to outputs of the angular position sensor and the two opto-electronic sensors. The control or regulating device directs the adjusting drives to move the form roller and the dampening roller, according to the width of the contact strip, in order to adjust the contact
30 pressure between each one of the form rollers and the dampening roller on one hand, and the plate cylinder on the other.

US Patent No. 5,812,705 to Wang et al., entitled "Device for Automatically Aligning a Production Copy Image with a Reference Copy Image in a Printing Press Control System," is directed to a system which includes a 4 CCD camera coupled with a computer. The 4 CCD camera is operative to acquire an image of a reference print in red, green, blue and infrared. This reference print serves as a hard proof of the live print. The reference image is converted into a monochrome image. Four object models are identified at each quadrant of the reference image. These object models are features in the image (i.e., transitions from dark to light) within a quadrant.

During registration, the 4 CCD camera acquires a live image of the print. The live image is converted into a monochrome image. The computer looks for a model within the search region of each object model. Each potential find is given a score indicating the likelihood that the model was actually found. When the computer declares that the model was found (i.e., according to the score thereof), the computer defines a transfer function which maps the position of the found model to the position of the model found in the reference image.

US Patent No. 6,129,015 to Dewey, entitled "Method and Apparatus for Registering Color in a Printing Press," is directed to a method including the steps of identifying an area of the desired image that is intended to be printed in black and forming registration images on the plate cylinders of the printing stations. The registration images are positioned on the plate cylinders such that, during subsequent printing operations, they will produce color registration marks that cooperate to print a process black registration mark on the web in the identified area (i.e., when the printing stations are in registration). The patent to Dewey is further directed to a method comprising the steps of passing a web through the plurality of printing stations and printing a process black registration mark on the web. Furthermore, a black ink image on the web, adjacent to the process black registration mark, is printed. Thereafter, the

process black registration mark and the black ink image are examined and an error signal is generated when the process black registration mark is not in the desired registration relative to the black ink image. It is noted that the term 'registration marks' in the patent to Dewey refers to part of the image that is printed in process black and not in black.

German Patent Application No. DE 19855177 to Krümpelmann, entitled "Method for the Automatic Adjustment of Circumference and Side Registers of Press Cylinders," is directed to a method for adjusting individual printing units in a printing press. Each printing unit prints a print image. The printing press prints superimposed print images. The method includes the steps of selecting a print image printed by a printing unit as a reference image, recording with a camera the superimposed print images and comparing the actual position of the print images with respect to each other, and with respect to the desired position of each print image. The method further includes the steps of generating correcting signals for adjusting the press cylinders circumferential or side registers and actuating motors of the press cylinders according to the generated correcting signals. The reference print image may be the first print image or one that exhibits simple composition.

SUMMARY OF THE PRESENT DISCLOSED TECHNIQUE

It is an object of the disclosed technique to provide a novel method and system for inspecting a section of a printed surface, the printed surface including a carrier surface and an optical manipulating surface, the optical manipulating surface optically manipulating light impinging on the printed surface and an apparatus for enabling acquisition of an image of a section of the printed surface.

In accordance with the disclosed technique, there is thus provided, in a print image acquisition and inspection system, an apparatus for enabling acquisition of an image of a section of a printed surface. The printed surface includes a carrier surface and an optical manipulating surface. The optical manipulating surface optically manipulates light impinging on the printed surface. The apparatus includes a diffusing surface, being in temporary contact with the printed surface. The diffusing surface diffuses the light transmitted therethrough, thereby moderates the optical manipulation effects.

In accordance with another aspect of disclosed technique, there is thus provided, a print image acquisition and inspection system for inspecting a section of a printed surface. The printed surface includes a carrier surface and an optical manipulating surface. The optical manipulating surface optically manipulates light impinging on the printed surface. The system includes an apparatus for enabling acquisition of an image of the section of the printed surface and a camera. The apparatus includes a diffusing surface, being in temporary contact with the printed surface. The diffusing surface diffuses the light transmitted therethrough, thereby moderates the optical manipulation effects. The camera acquires an image of the printed surface through the diffusive surface.

In accordance with a further aspect of disclosed technique, there is thus provided, method for inspecting a printed surface. The printed surface includes a carrier surface and an optical manipulating surface. The optical manipulating surface optically manipulates light impinging on

the printed surface. The method includes the procedure of temporarily applying an optically diffusing surface to an inspected section of a printed surface. The diffusing surface diffuses the light transmitted therethrough, thereby moderates the optical manipulation effects. The method further
5 includes the procedure of acquiring an image of an inspected section of the printed surface through the diffusing surface.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosed technique will be understood and appreciated more fully from the following detailed description taken in conjunction with the drawings in which:

5 Figure 1A is an image of a printed surface exhibiting optical manipulation properties;

 Figure 1B is a schematic illustration of the cross-section of a printed surface which exhibits optical manipulating effects;

 Figure 2A is a set of three images of the printed surface of
10 Figure 1A showing the cancellation of optical manipulating effects on the printed surface in accordance with an embodiment of the disclosed technique;

 Figure 2B is a schematic illustration of the cross section of a printed surface with a diffusing surface applied thereon constructed in
15 accordance with an embodiment of the disclosed technique;

 Figures 3A and 3B are schematic illustrations of diffusing surfaces in accordance with another embodiment of the disclosed technique;

 Figure 4 is a schematic illustration of a material roll of a diffusing
20 surface in accordance with a further embodiment of the disclosed technique;

 Figure 5A which is a schematic illustration of a print image acquisition and inspection system constructed and operative in accordance with another embodiment of the disclosed technique;

25 Figure 5B is a schematic illustration of another print image acquisition and inspection system constructed and operative in accordance with a further embodiment of the disclosed technique;

 Figure 6 is a schematic illustration of another print image acquisition and inspection system constructed and operative in
30 accordance with another embodiment of the disclosed technique;

Figure 7 is a schematic illustration of a print image acquisition and inspection system in accordance with a further embodiment of the disclosed technique;

5 Figure 8A, is a schematic illustration of a printing press using the print image acquisition and inspection system of Figures 4A, 4B, 5, 6, and 7 constructed and operative in accordance with another embodiment of the disclosed technique;

Figure 8B is a schematic illustration of an image printed on a surface inspected and verified according to another embodiment of the disclosed technique; and
10

Figure 9 is a schematic illustration of a method for acquiring an inspectable image of a printed surface, operative in accordance with a further embodiment of the disclosed.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The disclosed technique overcomes the disadvantages of the prior art by providing a novel method system for acquiring and inspecting an image of an object, printed on a surface, which includes an optical manipulating surface, and an apparatus which enables acquisition of an image of a section of the printed surface. The apparatus includes a diffusing surface which is temporarily applied onto the printed surface. The term 'inspecting' refers herein to monitoring and controlling the quality of the properties of the printed object (e.g., color, color registration, opacity, optical density, dot gain, content correctness and content position). The term 'printed surface' refers herein to a surface which includes two surfaces, a carrier surface and an optical manipulating surface. The term 'carrier surface' refers herein to the surface onto which the object is printed. The term 'optical manipulating surface' refers herein to a surface which manipulates the frequency, the phase, the intensity or any combination thereof, of light reflected from the printed surface. Such optical manipulation is caused, for example, by dispersion or specular reflection. One example of an optical manipulating surface, which causes the light reflected from the surface to exhibit the effects of dispersion and specular reflection is a micro-prism surface (i.e., a surface made up of micro-prisms).

As mentioned above, the optical manipulating surface manipulates at least one of the frequencies, the phase, the amplitude, the polarization or any combination thereof, of the light reflected off the surface. Thus, when viewing or inspecting such a printed surface, having an object printed thereon, the printed object may exhibit different colors (i.e., parasitic colors) other than those actually printed (i.e., due to the manipulation of the light reflecting off the surface). These effects are due to the dispersion of light which passes through the optical manipulating surface as it reflects off the carrier surface. In addition, when viewing the printed surface from different viewing angles, the surface may appear

bright and glossy at certain regions of the surface. This effect is due to the concentration of dispersed light beams at those regions. Such optical manipulating effects inhibit the image acquisition and inspection of printed objects on the carrier surface.

5 According to the disclosed technique a substantially diffusing surface is used to cover the printed surface. This diffusing surface diffuses the light passing through toward the carrier surface as well as the light reflected from the carrier surface. Consequently, the reflected light will be reflected in a plurality of directions. Thus, when viewing the printed
10 surface from different viewing angles, the surface will appear to have a substantially uniform brightness and without parasitic colors (i.e., without the unwanted colors resulting from the optical manipulation effects). An image of the printed surface can therefore be acquired without interference, thereby rendering the printed surface inspectable (i.e.,
15 enabling the inspection of the objects printed on the printed surface).

Reference is now made to Figure 1A, which is an image of a printed surface exhibiting optical manipulation properties, generally referenced 100. Image 100 is an image of a portion of a cigarette pack 102 which exhibits optical manipulation properties. During the printing of
20 cigarette pack 102, a single color was printed, as is shown in section 104, as the background of cigarette pack 102. However, since cigarette pack 102 is covered with an optical manipulating surface, cigarette pack 102 exhibits optical manipulation properties which cause optical manipulating effects such as specular reflection. Thus, one region in image 100 may
25 appear brighter than another region. For example, a section 106 exhibits a different color than a section 104, even though both sections were printed using the same color. It is noted that the actual color of sections 106 and 104 are substantially similar but appear different in image 100 due to the optical manipulating properties of cigarette pack 102.
30 Furthermore, the brightness of section 106 is greater than the dynamic range of the camera (not shown) since a plurality of beams is reflected

back toward the camera, thereby resulting in saturation of the imaging sensor of the camera. In printing equipment such as printers (e.g., digital printers), printing presses (e.g., flexography, rotogravure), finishers (e.g., rewinders, laminators) images of a printed surface are acquired, inspected and analyzed. The results of this inspection are used to alert that defects are found on cigarette pack 102 and to adjust and set up (i.e., registration and contact pressure adjustments between the rollers of the printing press) the printing equipment. As can be seen from Figure 1A, the optical manipulating effects distort the acquired image. Thus, cigarette pack 102 is un-inspectable and inspecting cigarette pack 102 may lead to erroneous results, since the acquired image exhibits artifacts (e.g., section 106) which are not a part of cigarette pack 102.

Reference is now made to Figure 1B which is a schematic illustration of the cross-section of a printed surface, generally reference 120, which exhibits optical manipulating effects. Printed surface 120 includes a carrier surface 122 and an optical manipulating surface 124. Optical manipulating surface 124 is a micro-prism surface. Light beam 126 is directed toward printed surface 124. Light beam 126 represents a single light beam used to illustrate optical manipulating effects on printed surface 120. It is noted that a plurality of light beams impinge on optical manipulating surface 124, although only light beam 126 is shown for the purposes of clarity. Light beam 126 impinges on optical manipulating surface 124. When light beam 126 impinges on optical manipulating surface 124, a portion of light beam 126 is reflected off of optical manipulating surface 124 as a light beam 128. Since surface 124 is a composed of micro-prisms, surface 124 has a smooth reflecting surface. Therefore, light beams impinging on optical manipulating surface 124 reflect at the same angle, and light beam 128 exhibits specular reflection.

Another portion of light beam 126 enters optical manipulating surface 124 and undergoes dispersion. Dispersion occurs as light is composed of various beams of light having different wavelengths. As the

index of refraction of optical manipulating surface 124 is wavelength dependent, each beam of light having a different wavelength refracts through optical manipulating surface 124 at a different angle. The splitting of light therefore results in a dispersion of light beam 126. Accordingly, the portion of light beam 126 that enters optical manipulating surface 124 is divided into a plurality of light beams each exhibiting a different wavelength. In Figure 1B only two light beams, a light beam 130 and a light beam 132 are shown for clarity. Light beam 130 exhibits a first color designated by a dotted line and light beam 132 exhibits a second color designated by a dashed line. Even though light beams 130 and 132 impinge on optical manipulating surface 124 at the same angle, as they both were part of the composition of light beam 126, they each impinge on carrier surface 122 at a different point with a different angle of incidence. Both of light beams 130 and 132 then reflect off of carrier surface 122 and refract through optical manipulating surface 124 at different points. As light beams 130 and 132 do not mix together once they exit optical manipulating surface 124, carrier surface 122 appears to exhibit colors, such as those defined by the wavelengths of light beams 130 and 132, which were not originally printed on substrate 122. Accordingly, the light reflected off of, as well as refracted through surface 124 exhibits both specular reflection (i.e., light beam 128) and dispersion (i.e., light beams 130 and 132). For example, referring back to Figure 1A, the brightness of region 106 is caused by a plurality of light beams, similar to light beams 130 and 132, originating from light beams similar to light beam 126, all being reflected toward the camera (not shown).

Reference is now made to Figure 2A, which is a set of three images of the printed surface of Figure 1A, generally referenced 148, showing the cancellation of optical manipulating effects on the printed surface in accordance with an embodiment of the disclosed technique. Figure 2A includes three images of the printed surface of Figure 1A, a first image 150₁, a second image 150₂ and a third image 150₃. First image

150₁ is a copy of the image of the printed surface of Figure 1A. As can be seen in first image 150₁, not only do the optical manipulating properties of the printed surface exhibit additional colors not initially printed (i.e., when the light reflecting from the printed surface includes additional wavelengths different than the wavelengths of the colors printed on the printed surface), in addition, they make it difficult to inspect detailed features of the image, such as any writing on the image, as depicted by sections 152 and 154. Whereas section 152, which delineates text on the printed surface, is quite clear in first image 150₁, section 154, which also delineates text on the printed surface, is unclear due to the optical manipulating properties of the printed surface of first image 150₁ which results in specular reflection in that section.

Second image 150₂ shows a diffusing surface 156 being placed over second image 150₂ according to the disclosed technique. Selecting the material of diffusing surface 156 is further discussed below. In second image 150₂, diffusing surface 156 appears to be opaque. This is because diffusing surface 156 is not in contact with the printed surface. Third image 150₃ shows diffusing surface 156 placed on top of the printed surface. In this image, diffusing surface 156 is in contact with the printed surface, and as seen, is at least partially transparent. As seen in Figure 2A, sections 160 and 162, which correspond to sections 152 and 154 respectively in first image 150₁, exhibit substantially the same color and the same clarity. The transparent diffusing surface diffuses the light reflected from the printed surface and moderates the optical manipulating effects of light as it reflects off of the printed surface of third image 150₃. In this respect, additional exhibited colors due to the micro-prism surface are not exhibited in the image of the printed surface when diffusing surface 156 is placed on top of the printed surface. In addition, the specular reflection off of the micro-prisms surface is no longer seen in the image (diffuse reflection is seen instead), thereby increasing the clarity of items printed on the surface (such as text) and rendering third image 150₃

inspectable. Third image 150₃ can now be used for inspecting the printed surface and setting up printing equipment, because the image of the printed surface can now be properly compared to a reference image.

In image 150₂, a gap exists between diffusing surface 156 and the printed surface. As such, the resolution of the section covered by diffusing surface 156 is reduced. In image 150₃, a gap does not exist between diffusing surface 156 and the printed surface, and the resolution (i.e., the smallest possible distance between two discernable objects in an acquire image) of the section covered by diffusing surface 156 is substantially similar to the resolution of the section that is not covered with the diffusing surface. Accordingly, the resolution of the acquired image may be determined and controlled by controlling the distance between the printed surface and the diffusing surface. In other words, the resolution of the acquired image may be determined and controlled according to the size of the gap between the printed surface and the diffusing surface.

Reference is now made to Figure 2B, which is a schematic illustration of the cross section of a printed surface with a diffusing surface applied thereon, generally reference 170, constructed in accordance with an embodiment of the disclosed technique. Printed surface 170 includes a carrier surface 172, an optical manipulating surface 174 and a diffusing surface 176. Printed surface 170 includes printed objects (not shown). For simplicity, it is assumed that the color of the printed objects is composed of two different wavelengths, a first wavelength and a second wavelength. A light beam 178 passes through diffusing surface 176. For simplicity, light beam 178 is a white beam of light. However, light beam 178 may be composed of only a selected portion of the spectrum of interest (e.g., visible, infrared). Diffusing surface 176 diffuses light beam 178 (i.e., light beam 178 is transmitted through diffusing surface 176 in all directions). Diffusion may be regarded as dividing the light beam into a plurality of light beams, each directed toward a different direction. When light beam 178 is diffused into a plurality of light beams, each light beam

remains a white beam of light. For clarity of explanation, only the optical paths of two light beams, light beams 180 and 182, divided from light beam 178 are described herein. A portion of light beams 180 and 182 are reflected off optical manipulating surface 174 as specular reflection in the form of light beams 184 and 186 respectively. Light beams 184 and 186 then pass through diffusing surface 176. Diffusing surface 176 diffuses light beams 184 and 186 (i.e., light beams 184 and 186 are transmitted through diffusing surface 176 in all directions and remain white beams of light).

Another portion of light beams 180 and 182 refracts through optical manipulating surface 174 and undergoes dispersion. Accordingly, the portions of light beams 180 and 182, which are each white beams of light, that enters optical manipulating surface 174, are divided into a plurality of light beams each exhibiting a different wavelength. For clarity, only one light beam, of the diffused light beams, divided into two wavelengths is described herein. Thus, light beam 188 is dispersed from light beam 180 and light beam 190 is also dispersed from light beam 180. Light beam 188 exhibits the first wavelength designated by a dotted line and light beam 190 exhibits the second wavelength designated by a dashed line. Both light beams 188 and 190 are reflected off carrier surface 172 through optical manipulating surface 174 and diffusing surface 176. It is noted that the wavelengths of light beams 182 and 180, which are different from the wavelengths printed on the printed surface (not shown) are absorbed by carrier surface 172. Diffusing surface 176 diffuses light beams 188 and 190 (i.e., light beam 188 and 190 are transmitted through diffusing surface 176 in all directions). Furthermore, a light beam 192, exhibiting the second wavelength and originating from another light beam (not shown) is transmitted through diffusing surface at the same point through which light beam 188 is transmitted. Similarly a light beam 194, exhibiting the first wavelength, and originating from a light beam 196 which exhibits similar wavelengths to light beam 178, is

transmitted through diffusing surface 176 at the same point through which light beam 190 is transmitted. Thus, the resulting light beams exiting diffusing surface 176 in a plurality of directions exhibit the different wavelengths of light beam 178. Therefore, at any point of observation, the diffused light beams recombine to re-create the colors reflected off of carrier surface 172 and all the sections of printed surface 170 appear to exhibit a substantially uniform brightness and intensity, such as sections 160 and 162 (both from Figure 2A).

The diffusing surface may include a single material layer surface or a multi-material layer surface. The multi-material diffusing surface may include separable or un-separable layers. Reference is now made to Figures 3A, 3B which are schematic illustrations of diffusing surfaces 200 and 202 in accordance with another embodiment of the disclosed technique. In Figure 3A, diffusing surface 200 includes a single layer of diffusing material (e.g., cellophane or Sellotape®). In Figure 3B, diffusing surface 202 includes two un-separable layers of different materials. Layer 204 is a layer of diffusing material (e.g., glue) and layer 206 is a transparent substrate layer. It is noted that, in general the diffusing surface may include any number of material layers.

In accordance with another embodiment of the disclosed technique, the diffusing surface exhibits lateral (i.e., perpendicular to the direction in which the web rolls) strips, each exhibiting a different density, located at known offsets from the origin of the diffusing surface material roll. Thus, when the diffusing surface material is brought in to close contact with an optical manipulating surface, the degree of diffusion of the light reflected from the optical manipulating surface web can be controlled (e.g., from 0% to 100%) by shifting the diffusing surface web, and thus the strip, over the optically manipulating surface web. Accordingly the printed surface may be viewed at different degrees of diffusion. Reference is now made to Figure 4, which is a schematic illustration of a material roll, generally referenced 210 of a diffusing surface 212 in accordance with a

further embodiment of the disclosed technique. Diffusing surface 212 includes lateral strips 216, 218 and 220, each exhibiting a different density. The beginning of each strip is at a known offset from the origin 214 of diffusing surface 212. The beginning of strip 216 is at origin 214. The beginning of strip 218 is at a distance L_1 from origin 214 and the beginning of strip 220 is at a distance L_2 from origin 218. Alternatively, the length of each strip is known. Thus by shifting the diffusing surface web over a printed optically manipulating surface (i.e., according to the offset of strips 213, 214 and 215) the printed optically manipulating surface may be viewed at different degrees of diffusion. It is noted that the pattern of diffusion level of the strips may be repetitive over the length of the roll. For example, the next three strips after strip 220 will exhibit the same densities as strips 216, 218 and 220 respectively. It is further noted that strips 216, 218 and 220 need not be equal in width. The width of each strip may depend on the frequency of usage of the strip (e.g., frequently used strips will be wider).

The diffusing and transparent surfaces discussed hereinabove and herein below with reference to Figures 2A, 2B, 3A, 3B, 4, 5, 6, 7, 8A, 8B, and 9 may each be embodied as an optically diffusing web exhibiting durability to wear due to mechanical strain, heat strain and flexibility. The diffusing surface exhibits a friction coefficient enabling the printed surface to move while in contact with the diffusing surface without damaging the printed objects. The diffusing surface further exhibits optical density and transparency, enabling a sufficient amount of light (i.e., sufficient to acquire an image of the printed surface) to be transmitted there through. The diffusing surface also exhibits optical diffusivity which sufficiently diffuses the light transmitted there through without hindering the resolution of the acquired image. As mentioned above, the diffusing surface is usually made of polymeric materials such as cellophane or Sellotape®.

As mentioned above, applying a diffusing surface onto an optical manipulating surface (e.g., a micro-prism surface) enables image

acquisition and inspection of printed objects on the micro-prism surface. Reference is now made to Figure 5A, which is a schematic illustration of a print image acquisition and inspection system, generally referenced 220, constructed and operative in accordance with another embodiment of the disclosed technique. Print inspection system 250 includes a processor 252, a camera 254. System 250 may further include a lighting (not show) illuminating the printed surface (i.e., either from above or below the printed surface). Processor 252 is coupled with camera 254. A First roller 260 and a second roller 262 roll a printed web 256 through printing equipment (not shown). A Third roller 266 and a fourth roller 268 roll a diffusing surface web 264. Diffusing surface web 264 corresponds to either one of the diffusing surfaces described herein above in conjunction with Figures 2A, 2B, 3A, 3B and 4. Third roller 266 and fourth roller 268 are positioned slightly lower than first roller 260 and second roller 262 such that diffusing surface web 264 is in controlled contact with printed web 256 in the region between first roller 260 and second roller 262, depicted in Figure 5A as a dashed line 270. Alternatively, diffusing surface web 264 may be held in controlled contact with optical manipulating surface web 256 by passing diffusing surface web 264 under two rotating rods, each positioned on either side of region 270 and lower than the top of first roller 260 and second roller 262. In Figure 5A, third roller 266 is the supplying roller (i.e., the roller supplying diffusing surface web) and fourth roller 268 is the collecting roller. It is noted that the contact between printed surface web 256 and diffusing web substrate 264 is temporary (i.e., diffusing surface web 264 does not coat printed surface web 256 and thus, printed surface web 256 and diffusing web substrate 264 are not permanently attached to each other).

First roller 260 and second roller 262 roll printed surface web 256 past the region depicted by dashed line 270 in the direction indicated by arrow 258. Third roller 266 and fourth roller 268 roll diffusing surface web 264 past the region depicted by dashed line 270. Thus, both printed

surface web 256 and diffusing surface web 264 roll past the region depicted by dashed line 270. Diffusing surface web 264 optically diffuses the light reflected from printed surface web 256. Camera 254 acquires an image of printed surface web 256. Camera 254 provides the image to processor 252. Since diffusing surface web 264 moderates the optical manipulating effects from printed surface web 256, processor 252 can use the image to properly control and monitor the quality of the printed surface and set up the printing equipment. In one embodiment, as depicted in Figure 5A, diffusing surface web 264 is an open web which rolls past the region depicted by dashed line 270 until the diffusing surface web is finished, at which point, the diffusing surface substrate may be reused or a new diffusing web substrate may be used. In another embodiment, diffusing surface web 256 is a closed web, like a continuous track, which rolls over the region depicted by dashed line 270. The continuous track can be used until diffusing surface web 264 is worn out. It is noted that third roller 266 and fourth roller 268 do not necessarily rotate at the same angular velocity as first roller 260 and second roller 262. To prevent frequent replacement of diffusing web substrate 264(e.g., due to wear and dirt), third roller 266 and fourth roller 268 may rotate much slower than first roller 260 and second roller 262. Furthermore, third roller 266 and fourth roller 268 do not necessarily rotate continuously. In other words, third roller 266 and fourth roller 268 may move diffusing surface web 264 a determined distance at determine intervals. The determined distance and intervals are either predetermined or dynamically determined (e.g., according to the parameters such as the wear of the material of the print surface). Furthermore, according to the disclosed technique, diffusing surface web 264 should be kept at a tension which is high enough to prevent diffusing surface web 264 from moving, either laterally or away from the printed web, yet low enough to maintain the friction with printed surface web 256 to a minimum. Accordingly, brakes (not shown) are applied (i.e., either manually or automatically) to third roller 266 (i.e., the

supplying roller) thus controlling the angular velocity of third roller 266, and consequently the tension of diffusing surface web 264 at the desired level.

Reference is now made to Figure 5B, which is a schematic illustration of another print image acquisition and inspection system, generally referenced 300, constructed and operative in accordance with a further embodiment of the disclosed technique. Print inspection system 300 includes a processor 302, a camera 304. System 300 may further include a lighting (not show) illuminating the printed surface (i.e., either from above or below the printed surface). Processor 302 is coupled with camera 304. A first roller 308 rolls an optical manipulating surface web 306 through printing equipment (not shown). A second roller 312 and a third roller 314 roll a diffusing surface web 310. Diffusing surface web 310 corresponds to either one of the diffusing surfaces described herein above in conjunction with Figures 2A, 2B, 3A, 3B and 4. Second roller 312 and third roller 314 are positioned slightly lower than first roller 308 such that diffusing surface web 310 is in controlled contact with optical manipulating surface web 306 in the region above first roller 308, depicted in Figure 5B as a dashed line 316. Alternatively, diffusing surface web 310 may be held in controlled contact with optical manipulating surface web 306 by passing diffusing surface web 310 under two rotating rods, each positioned on either side of region 316 and lower than the top of first roller 308. In Figure 5B, second roller 312 is the supplying roller and third roller 314 is the collecting roller. It is noted that the contact between optical manipulating surface web 306 and diffusing surface web 310 is temporary.

First roller 308 rolls optical manipulating surface web 306 past the region depicted by dashed line 316. Second roller 312 and third roller 314 roll diffusing surface web 310 past the region depicted by dashed line 316. Optical manipulating surface web 306 and diffusing surface web 310 are rolled past the region depicted by dashed line 316. Diffusing surface web 310 optically diffuses the light reflected from optical manipulating surface web 306. Camera 304 acquires an image of optical manipulating

surface web 306. Camera 304 provides the image to processor 302. Since diffusing surface web 310 moderates the optical manipulating effects, processor 302 can use the image to properly control and monitor the quality of the printed surface and set up the printing equipment. In one embodiment, as depicted in Figure 5B, diffusing surface web 310 is an open web which is rolled past the region depicted by line 316 until the web is finished. In another embodiment, diffusing surface web 310 is a closed web, like a continuous track, which is rolled over the region depicted by line 316. It is noted that second roller 312 and third roller 314 do not necessarily rotate at the same angular velocity as first roller 308. To prevent frequent replacement of diffusing surface web 310 (e.g., due to wear and dirt), second roller 312 and third roller 314 may rotate much slower than first roller 308. Furthermore, second roller 312 and third roller 314 do not necessarily rotate continuously. In other words, second roller 312 and third roller 314 may move diffusing surface web 310 a determined distance at determine intervals. As mentioned above, the determined distance and intervals are either predetermined or dynamically determined (e.g., according to the parameters such as the wear of the material of the print surface). Furthermore, diffusing surface web 310 should be kept at a tension which high enough to prevent diffusing surface web 310 from moving yet low enough to maintain the friction with optical manipulating surface web 306 to a minimum. Accordingly, brakes are applied (i.e., either manually or automatically) to second roller 312 (i.e., the supplying roller) thus controlling the angular velocity of second roller 312, and consequently the tension of diffusing surface web 310 at the desired level.

According to another embodiment of the disclosed technique, a transparent layer may be positioned between the optical manipulating surface web and the diffusing surface web. Accordingly, the transparent layer is a buffer between the optical manipulating surface web and the diffusing surface web. Thus, the transparent layer is subject to the wear due to the friction with the optical manipulating surface web instead of the

diffusing surface web. Furthermore, the transparent layer prevents air from being trapped between the optical manipulating surface web and the diffusing surface web. Reference is now made to Figure 6, which is a schematic illustration of another print image acquisition and inspection system, generally referenced 320, constructed and operative in accordance with another embodiment of the disclosed technique. Print inspection system 320 includes a processor 322 and a camera 324. System 320 may further include a lighting (not show) illuminating the printed surface (i.e., either from above or below the printed surface).

Processor 322 is coupled with camera 324.

A first roller 326 and a second roller 328 roll an optical manipulating surface web 330 through printing equipment (not shown) such as a printing press or finishing equipment. A third roller 332 and a fourth roller 334 roll a transparent surface web 336. Transparent surface web 336 is made, for example, from polyethylene. Third roller 332 is the supplying roller of transparent surface web 336 and fourth roller 334 is the collecting rollers of transparent surface web 336. Third roller 332 and fourth roller 334 are positioned lower than first roller 326 and second roller 328 such that transparent surface web 336 is in controlled contact with optical manipulating surface web 330 in the region above first roller 326 and second roller 328, depicted in Figure 6 as a dashed line 346. Alternatively, transparent layer surface web 336 may be held in controlled contact with optical manipulating surface web 330 by passing transparent layer surface web 336 under two rotating rods, each positioned on either side of region 346 and lower than first roller 326 and second roller 328.

A fifth roller 338 and a sixth roller 340 roll a diffusing surface web 342 over the transparent layer surface web. Thus, transparent surface web 336 is a buffer between optical manipulating surface web 330 and diffusing surface web 342. Diffusing surface web 342 corresponds to either one of the diffusing surfaces described herein above in conjunction with Figures 2A, 2B, 3A, 3B and 4. Fifth roller 338 is the supplying roller of

diffusing surface web 342 and sixth roller 340 is the collecting roller of diffusing surface web 342. Fifth roller 338 and sixth roller 340 are positioned slightly lower than first roller 326 and second roller 328 and above third roller 332 and fourth roller 334 such that diffusing surface web 342 is in controlled contact with transparent surface web 336 in region 346 above first roller 326 and second roller 328. Alternatively, diffusing surface web 342 may be held in controlled contact with optical transparent layer surface web 336 by passing diffusing surface web 342 under two rotating rods, each positioned on either side of region 346, lower than first roller 326 and second roller 328 and above the rods corresponding to transparent surface web 330. Alternatively, both transparent surface web 336 and diffusing surface web 342 may alternatively be held in controlled contact with optical manipulating surface web 330 by passing them both under two rotating rods, each positioned on either side of region 346 and lower than first roller 326 and second roller 328.

First roller 326 and second roller 328 roll optical manipulating surface web 330 past the region depicted by dashed line 344 in the direction indicated by arrow 344. Third roller 332 and fourth roller 334 roll transparent surface web 336 past the region depicted by dashed line 346. Fifth roller 338 and sixth roller 340 roll diffusing surface web 342 past the region depicted by dashed line 346. Thus, optical manipulating surface web 330, transparent surface web 336 and diffusing surface web 342 roll past the region depicted by dashed line 346. Diffusing surface web 342 optically diffuses the light reflected from optical manipulating surface web 330. Camera 324 acquires an image of optical manipulating surface web 330. Camera 324 provides the image to processor 322. Since diffusing surface web 342 moderates the optical manipulating effects, processor 322 can use the image to properly control and monitor the quality of the printed surface and set up the printing equipment. In one alternative of the disclosed technique, as depicted in Figure 6, diffusing surface web 342 and transparent surface web 336 are open webs which are rolled past the

region depicted by line 346 until the web is finished. In another embodiment of the disclosed technique, diffusing surface web 342 and transparent surface web 336 are closed webs, each like a continuous track, which roll over the region depicted by line 346.

5 It is noted that the contact between optical manipulating surface web 330 and transparent surface web 336 is temporary (i.e., transparent surface web 336 does not coat the printed surface web 330 and thus, printed surface web 330 and transparent surface web 336 are not permanently attached to each other). Similarly, the contact between
10 transparent surface web 336 and diffusing surface web 342 is also temporary.

It is further noted that third roller 332, fourth roller 334, fifth roller 338 and sixth roller 340 do not necessarily rotate at the same angular velocity and direction as first roller 328 and second roller 330.
15 Furthermore, third roller 332 and fourth roller 334 do not necessarily rotate at the same angular velocity and direction as fifth roller 338 and sixth roller 340. To prevent frequent replacement of diffusing surface web 342 (e.g., due to wear and dirt), third roller 332, fourth roller 334, fifth roller 338 and sixth roller 340 may rotate at a substantially lower angular velocity than
20 first roller 326 and second roller 328. Additionally, fifth roller 338 and sixth roller 340 may rotate at a substantially lower angular velocity than third roller 332 and fourth roller 334. Thus, the wear caused to diffusive surface web 342 due to the friction between diffusing surface web 342 and transparent surface web 336 is substantially smaller had diffusing surface
25 342 been in direct contact with optical manipulating surface web 330. The wear to diffusing surface web 342 is caused due to the friction with transparent surface web 336. Furthermore, third roller 332 and fourth roller 334 as well as fifth roller 338 and sixth roller 340 do not necessarily rotate continuously. In other words, third roller 332 and fourth roller 334
30 may move transparent surface web 336 a determined distance at determined intervals. Similarly fifth roller 338 and sixth roller 340 may

move diffusing surface web 342 a determined distance at determined intervals. As mentioned above, the determined distance and intervals are either predetermined or dynamically determined (e.g., according to the parameters such as the wear of the material of the print surface). Similar to system 250 (Figure 5A) and system 300 (Figure 5B), brakes may be applied to third roller 332 and fifth roller 338 (i.e., the supplying rollers) for controlling their angular velocity and thus the tension of transparent surface web 336 and diffuse surface web 342 at the desired level. It is also noted that first roller 326 and second roller 328 may be replaced with a single roller similar to first roller 308 in Figure 5B.

According to a further embodiment of the disclosed technique, the diffusing surface is a stationary sheet of diffusive material placed over the region of optical manipulation which is imaged by the camera. Reference is now made to Figure 7, which is a schematic illustration of a print image acquisition and inspection system, generally referenced 380, in accordance with a further embodiment of the disclosed technique. System 380 includes a processor 382 and camera 384. System 380 may further include a lighting (not shown) illuminating the printed surface (i.e., either from above or below the printed surface). Camera 382 is coupled with processor 384. A first roller 386 and a second roller 388 rolls an optical manipulating surface web 390 past the region depicted by dashed line 396 in the direction indicated by an arrow 394. A transparent layer surface 391 is placed over optical manipulating surface web 390 in the region 396. An optical diffusing layer surface 392 is placed above transparent layer surface 391. Optical diffusing layer surface 392 optically diffuses the light reflected from optical manipulating surface web 390. Camera 384 acquires an image of optical manipulating surface web 390. Camera 384 provides the image to processor 382. Since optical diffusing layer surface 392 moderates the optical manipulating effects, processor 382 can use the image to properly control and monitor the quality of the printed surface and set up the printing equipment. It is noted that transparent layer surface

391 is optional and optical diffusing layer surface 392 may be placed directly above optical manipulating surface web 390.

Reference is now made to Figure 8A, which is a schematic illustration of a printing press using the print image acquisition and inspection system of Figures 4A, 4B, 5, 6, and 7 generally referenced 420, constructed and operative in accordance with another embodiment of the disclosed technique. It is noted that any of the print image acquisition and inspection systems depicted in Figures 4A, 4B, 5, 6 or 7 can be included in printing press 420. Printing press 420 includes a processor 422, a camera 424, an actuator interface 426, printing stations #1, #2, #3 and #N, respectfully numbered 428₁, 428₂, 428₃ and 428_N, printed surface web 430, diffusing surface web 434 and rollers 436 and 438. Printing press 420 may further include a lighting (not show) illuminating the printed surface (i.e., either from above or below the printed surface). Processor 422 is coupled with camera 424 and actuator interface 426. Actuator interface 426 is coupled with each of printing stations 428₁, 428₂, 428₃ and 428_N. Printed surface web 430 moves through each of printing stations 428₁, 428₂, 428₃ and 428_N in the direction of an arrow 432. Rollers 436 and 438 roll diffusing surface web 434 over printed surface web 430. Rollers 436 and 438 are positioned such that diffusing surface web 434 is in controlled contact with printed surface web 430 in the region directly above camera 424. Roller 438 is the supplying roller and roller 436 is the collecting roller. It is noted that the contact between printed surface web 430 and diffusing surface web 434 is temporary. Camera 424 acquires an image IM of printed surface web 430.

Printed surface web 430 moves through each of printing stations 428₁, 428₂, 428₃ and 428_N, where each printing station prints another element of the print job. For example, each printing station may print one of the basic colors making up the printed image, according to the color gamut used in the print job (e.g., RGB or CMYK). Whereas printing press 420 can print various types of jobs, in particular, printing press 420 can

print color images on printed surface web 430 which includes an optical manipulating surface (not shown). In the example in Figure 8A, printed surface web 430, on which an image is printed, includes an optical manipulating surface. When printing press 420 is being set up for a print job of a color image, each of printing stations 428₁, 428₂, 428₃ and 428_N prints its respective element of the print job on printed surface web 430. Printed surface web 430 is then moved under the region of camera 424, which acquires image IM of printed surface web 430 through diffusing surface web 434, which is moved along by rollers 436 and 438, and which optically diffuses the light reflected from printed surface web 430. Camera 424 provides image IM to processor 422 which inspects, analyzes and compares the image, for example, to a reference image. As another example, processor 422 analyzes the image for color values and compares those values to target values. Depending on the results of the analysis, processor 422 can provide instructions to actuator interface 426 to adjust various settings in the printing stations. Actuator interface 426 can adjust various elements in each printing station, such as the position of the rollers in each printing station (not shown) for registration purposes, as well as the pressure between them. Once each printing station has been adjusted according to the instructions from processor 422 via actuator interface 426, additional images are taken of the print job by camera 424 and provided to processor 422. This process continues until the analysis yields an acceptable result (e.g., until the image of the print job matches a reference image within a predefined degree of accuracy). With the printing press set up, the full print job can be completed. Similar to system 200 (Figure 4A) and Figure 240 (Figure 4B) brakes are applied to roller 438 (i.e., the supplying rollers) for controlling its angular velocity and thus the tension of the diffusing surface web at the desired level.

Reference is now made to Figure 8B, which is a schematic illustration of an image printed on a surface, generally referenced 443, inspected and verified according to another embodiment of the disclosed

technique. Figure 8B includes the printed surface web 430 of Figure 8A, the diffusing web substrate of Figure 8A as well as three images, each including a background image 400₁, 400₂ and 400₃, as well as a respective foreground image 402₁, 402₂ and 402₃. Figure 8B shows a top view of the printed surface web of Figure 8A. Due to the optical manipulating effects of the optical manipulating surface (not shown) of printed surface 430, background images 400₁ and 400₂ as well as foreground images 402₁ and 402₂ exhibit additional colors not originally printed and also exhibit specular reflection. In contrast, background image 400₃ and foreground image 402₃, which are viewed via diffusing surface web 434, only exhibit the original colors printed and exhibit diffuse reflection (i.e., diffusing surface web 434 optically diffuses the light reflected from the web substrate 430). In prior art systems, the images taken of the web substrate would resemble background images 400₁ and 400₂ as well as foreground images 402₁ and 402₂. As depicted above in conjunction with Figure 1A, using these images for adjusting the printing stations (not shown) in a printing press (not shown) may yield erroneous results. According to the disclosed technique, background image 400₃ and foreground image 402₃ are used for adjusting the printing stations in the printing press.

In the systems described herein above in conjunction with Figures 5A, 5B, 6, 7, 8A and 8B, the diffusing surface web and the transparent surface web should be in close contact to optical manipulating surface web. However, air may inadvertently fill the gap between the optical manipulating surface web and either the diffusing surface web or the transparent surface web thereby reducing the resolution of the acquired image. Therefore, according to one alternative of the disclosed technique, the diffusing surface web and the transparent surface web may be brought in substantially close contact with the optical manipulating surface web by creating a voltage difference there between. For example, by grounding optical manipulating surface web and applying one voltage to

the transparent surface web and another voltage to the diffusing surface web. According to another alternative of the disclosed technique, the diffusing surface web and the transparent surface web may be brought to in close contact with the optical manipulating surface web by suctioning air
5 from between the optical manipulating surface, the diffusing surface web and the transparent surface web.

Reference is now made to Figure 9, which is a schematic illustration of a method for acquiring an inspectable image of a printed surface, operative in accordance with a further embodiment of the
10 disclosed. In procedure 500, an optically diffusing surface is temporarily applied to an inspected section of a printed surface. The optically diffusing surface can be a transparent polymeric surface or diffusing surface web. With reference to Figure 8A, rollers 436 (Figure 8A) and 438 (Figure 8A) roll diffusing surface web 434 (Figure 8A) over printed surface web 430
15 (Figure 8A). Rollers 436 and 438 are positioned such that diffusing surface web 434 (Figure 8A) is in controlled, yet temporary, contact with printed surface web 430 in the region directly above camera 424 (Figure 8A).

In procedure 502, an image of the inspected section of the
20 printed surface is acquired through the optically diffusing surface. With reference to Figure 8A, printed surface web 430 (Figure 8A) is moved under the region of camera 424 (Figure 8A), which acquires image IM of printed surface web 430 through diffusing surface web 294 (Figure 8A), which is moved along by rollers 436 (Figure 8A) and 438 (Figure 8A). In
25 procedure 504, the image of the inspected section is inspected and analyzed. With reference to Figure 8A, image IM is provided to processor 422 (Figure 8A) which inspects, analyzes and compares the image to a reference image.

In procedure 506, the differences between characteristics of the
30 image of the inspected section and a set of reference characteristics are determined. The reference characteristics may come from a reference

image. With reference to Figure 8A, processor 422 (Figure 8A) inspects, analyzes and compares the image to a reference image. If differences, beyond a predetermined threshold or degree of accuracy, are found between the image and the reference, then, procedure 508 is executed. If
5 differences, beyond a predetermined threshold or degree of accuracy, are not found between the image and the reference, then, the method returns to procedure 500 and another section of the printed surface is inspected.

In procedure 508, the printed surface production process is adjusted. For example, the adjustment of a printing press may include
10 adjusting the position as well as the pressure of rollers involved in the printing process. The method then returns to procedure 500. With reference to Figure 8A, depending on the results of the analysis, processor 422 (Figure 8A) can provide instructions to actuator interface 426 (Figure 8A) to adjust various settings in the printing stations. Actuator
15 interface 428 can adjust various elements in each printing station, such as the position of the rollers in each printing station (not shown), as well as the pressure between them. Once each printing station has been adjusted according to the instructions from processor 422 via actuator interface 428, additional images are taken of the print job by camera 424 (Figure
20 8A) and provided to processor 422 (Figure 8A).

It will be appreciated by persons skilled in the art that the disclosed technique is not limited to what has been particularly shown and described hereinabove. Rather the scope of the disclosed technique is defined only by the claims, which follow.

CLAIMS

1. In a print image acquisition and inspection system, an apparatus for enabling acquisition of an image of a section of a printed surface, the printed surface including a carrier surface and an optical manipulating surface, said optical manipulating surface optically manipulating light impinging on the printed surface, the apparatus comprising a diffusing surface, being in temporary contact with said printed surface, said diffusing surface diffusing the light transmitted therethrough, thereby moderating the optical manipulation effects.
2. The apparatus according to claims 1, wherein said optically manipulating light impinging on the printed surface includes manipulating a subgroup of properties of said light, said subgroup of properties is selected from group consisting of
 - amplitude;
 - phase; and
 - frequency.
3. The apparatus according to claim 1, wherein said printed surface rolls over at least one roller, and
 - wherein, said diffusing surface rolls over at least two other rollers with said printed surface, one of said at least two other rollers is a supplying roller and the other one of said at least two rollers is collecting roller.
4. The apparatus according to claim 3, wherein said at least two other rollers are positioned lower than said at least one roller thereby holding said diffusing surface in controlled contact with said printed surface.
5. The apparatus according to claim 4, wherein at least two other rollers

are replaced with rotating rods

6. The apparatus according to claim 5, wherein said diffusive surface is an open web.

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7. The apparatus according to claim 5, wherein said diffusive surface is a closed web.

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8. The apparatus according to claim 5, wherein said diffusing surface is be kept at a determined tension by applying brakes to said supplying roller.

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9. The apparatus according to claim 5, wherein said at least two other rollers rotate at a slower rate than said one roller.

10. The apparatus according to claim 6, wherein said two other rollers rotate a determined distance at determine intervals.

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11. The apparatus according to claim 2, further comprising a transparent layer is positioned between said printed surface and said diffusing surface web.

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12. The apparatus according to claim 11, wherein said transparent layer rolls over at least two other rollers with said printed surface, one of said at least tow other rollers is a supplying roller and the other one of said at least two rollers is collecting roller .

30

13. the apparatus according to claim 12, wherein said at least two other rollers are positioned lower than said at least one roller thereby holding said transparent layer in controlled contact with said printed surface.

14. The apparatus according to claim 13 wherein at least two other rollers are replaced with rotating rods
- 5 15. The apparatus according to claim 12, wherein said transparent layer is an open web.
16. The apparatus according to claim 12, wherein said transparent layer is a closed web.
- 10 17. The apparatus according to claim 12, wherein said transparent layer is be kept at a determined tension by applying brakes to said supplying roller.
- 15 18. The apparatus according to claim 12, wherein said at least two other rollers rotate at a slower rate than said one roller.
19. The apparatus according to claim 18, wherein said two other rollers rotate a determined distance at determine intervals.
- 20 20. The apparatus according to claim 12, wherein said transparent layer is a stationary sheet placed over said printed surface.
21. The apparatus according to claim 11, wherein said transparent layer
25 is brought in substantially close contact with said printed surface by creating a voltage difference there between.
22. The apparatus according to claim 11, wherein said transparent layer
30 is brought in substantially close contact with said printed surface by suctioning air therebetween.

23. The apparatus according to claim 11, wherein said diffusing surface web is brought in substantially close contact with said transparent layer by creating a voltage difference there between.
- 5 24. The apparatus according to claim 11, wherein said diffusing surface web and is brought in substantially close contact with said transparent layer by suctioning air therebetween.
- 10 25. The apparatus according to claim 1, wherein said diffusing surface is a stationary sheet placed over said printed surface.
- 15 26. The apparatus according to claim 1, wherein the diffusing surface exhibits lateral strips, each lateral strip exhibiting a different density, each lateral strip is located at known offsets from the origin of said diffusing surface.
27. The apparatus according to claim 1, wherein said diffusing surface includes a single layer of diffusing material.
- 20 28. The apparatus according to claim 1, wherein said diffusing surface includes two un-separable layers of different materials.
- 25 29. The apparatus according to claim 1, wherein said diffusive surface is made of cellophane.
- 30 30. The apparatus according to claim 1, wherein said diffusive surface is made of Sellotape.
31. The apparatus according to claim 1, wherein said diffusing surface web is brought in substantially close contact with said printed surface by creating a voltage difference there between.

32. The apparatus according to claim 1, wherein said diffusing surface web and is brought in substantially close contact with said printed surface are by suctioning air therebetween.

5

33. A print image acquisition and inspection system for inspecting a section of a printed surface, the printed surface including a carrier surface and an optical manipulating surface, said optical manipulating surface optically manipulating light impinging on the printed surface, said system comprising:

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an apparatus for enabling acquisition of an image of said section of said printed surface, said apparatus including diffusing surface, being in temporary contact with said printed surface, said diffusing surface diffusing the light transmitted therethrough, thereby moderating the optical manipulation effects; and

15

a camera, acquiring an image of said printed surface through said diffusive surface.

34. The system according to claim 33, further comprising a processor, coupled with said camera, for inspecting the acquired image of said printed surface.

20

35. The system according to claim 33, further comprising a lighting illuminating said printed surface.

36. The system according to claim 33, wherein said printed surface is printed with printing equipment and rolls over at least one roller of said printing equipment.

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37. The system according to claim 33, wherein the resolution of said image is controlled by controlling the distance between said diffusing surface and said printed surface.

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38. A method for inspecting a printed surface, the printed surface includes a carrier surface and an optical manipulating surface, said optical manipulating surface optically manipulating light impinging on the printed surface, the method includes the procedures of:

temporarily applying an optically diffusing surface to an inspected section of a printed surface, said diffusing surface diffusing the light transmitted therethrough, thereby moderating the optical manipulation effects; and

acquiring an image of an inspected section of said printed surface through said diffusing surface.

39. The method according to claim 38, further comprising the procedures of:

inspecting said image of said inspected section;
determining the differences between said image characteristics and reference characteristics;

adjusting the production process of said printed surface when the difference between said image characteristics and reference characteristics is above a threshold.

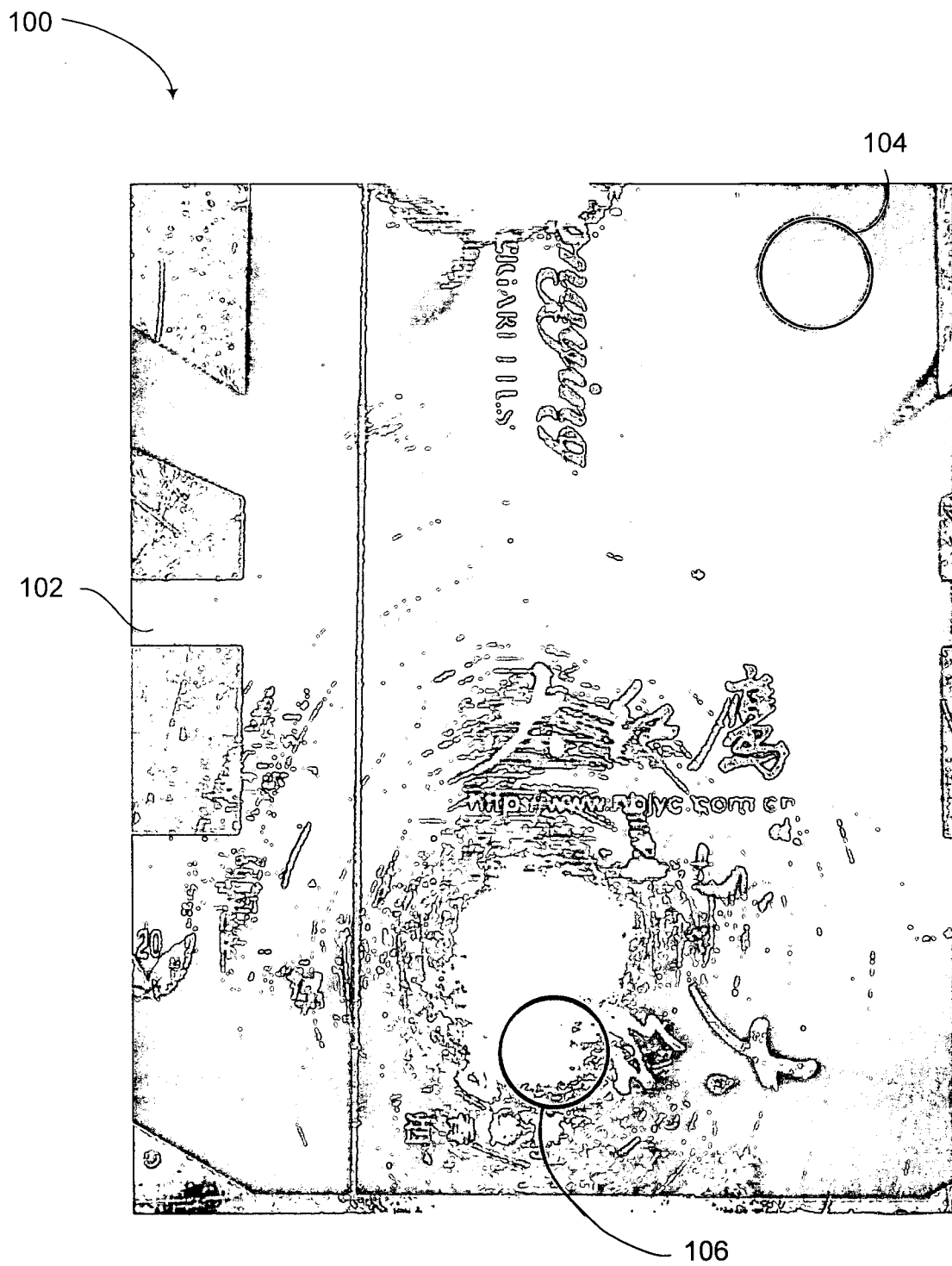


FIG. 1A

120 →

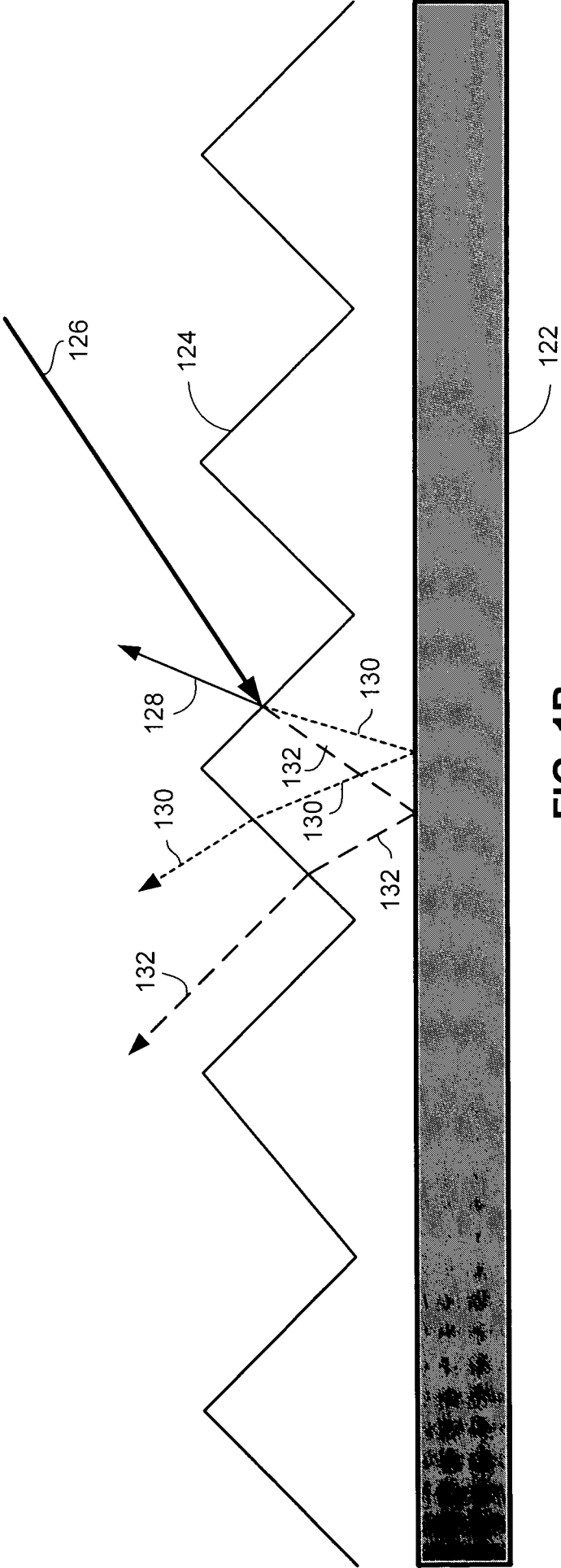


FIG. 1B

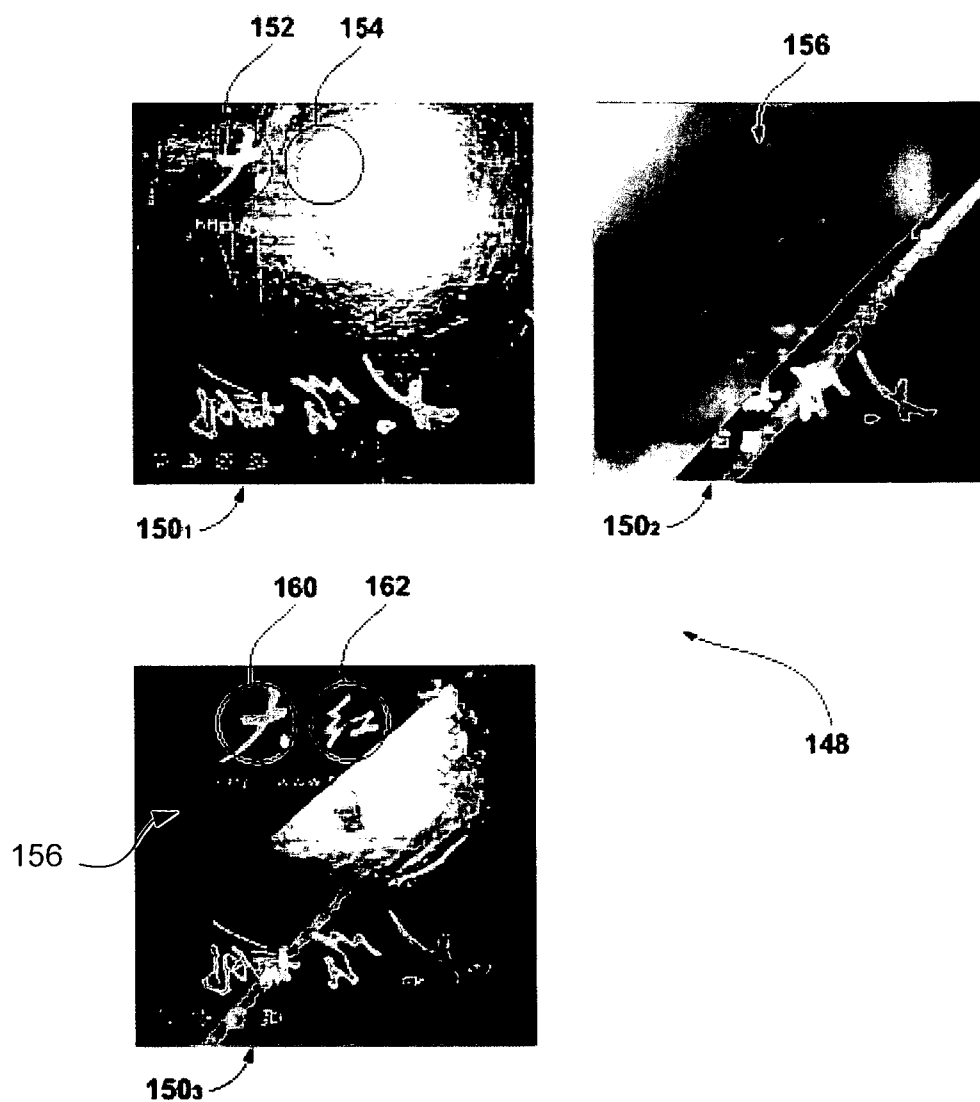


FIG. 2A

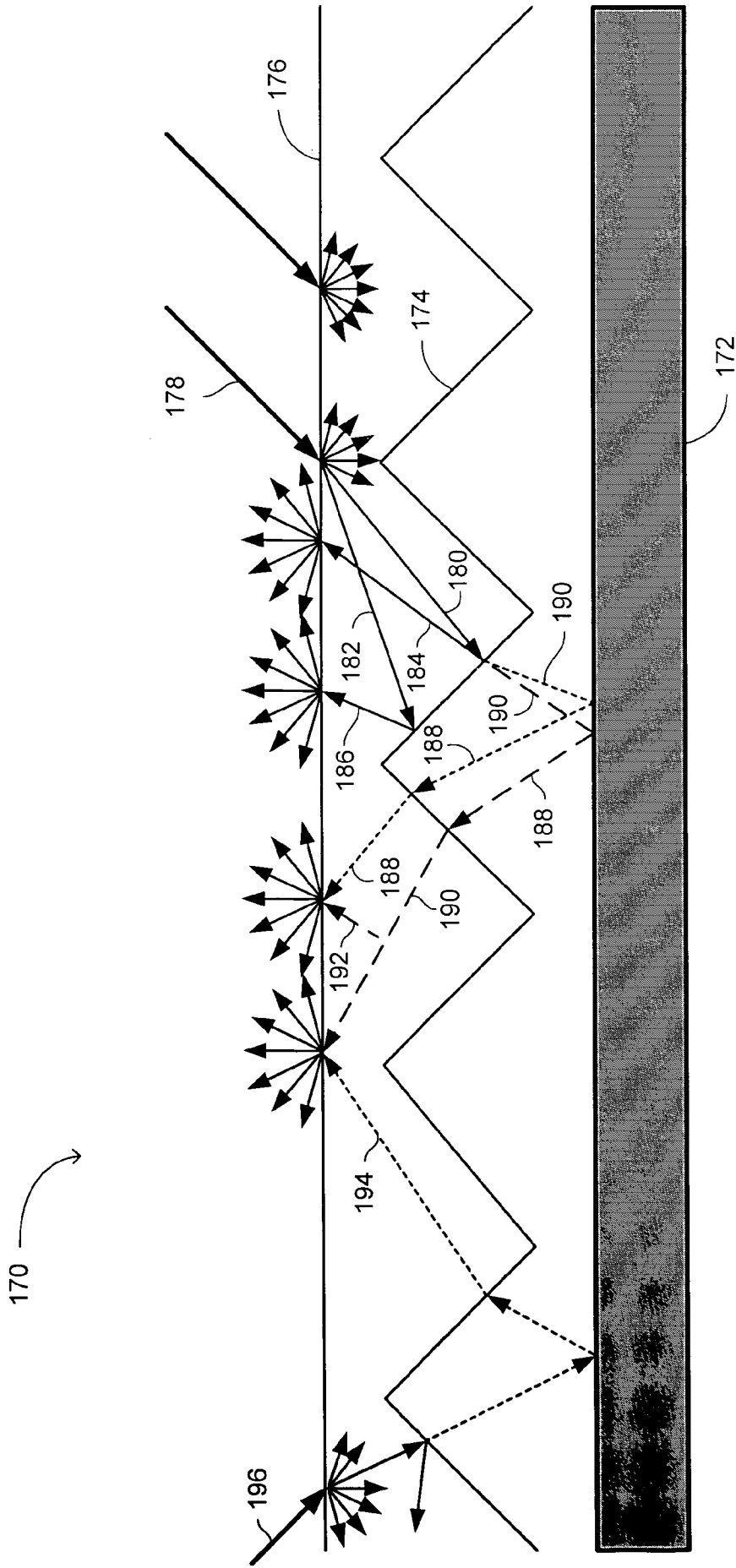


FIG. 2B

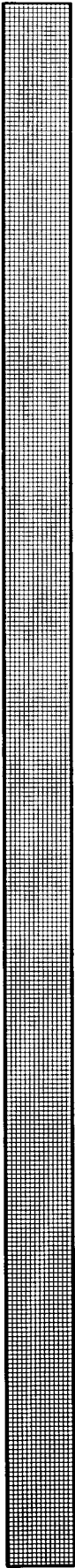


FIG. 3A

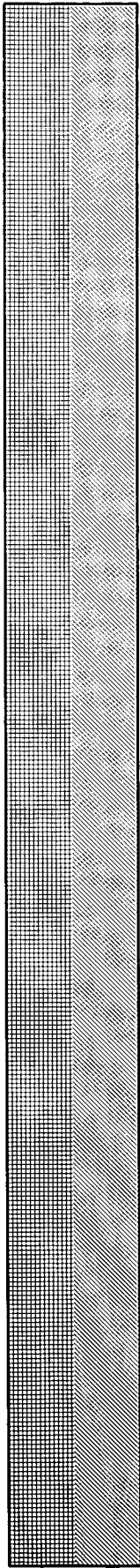


FIG. 3B

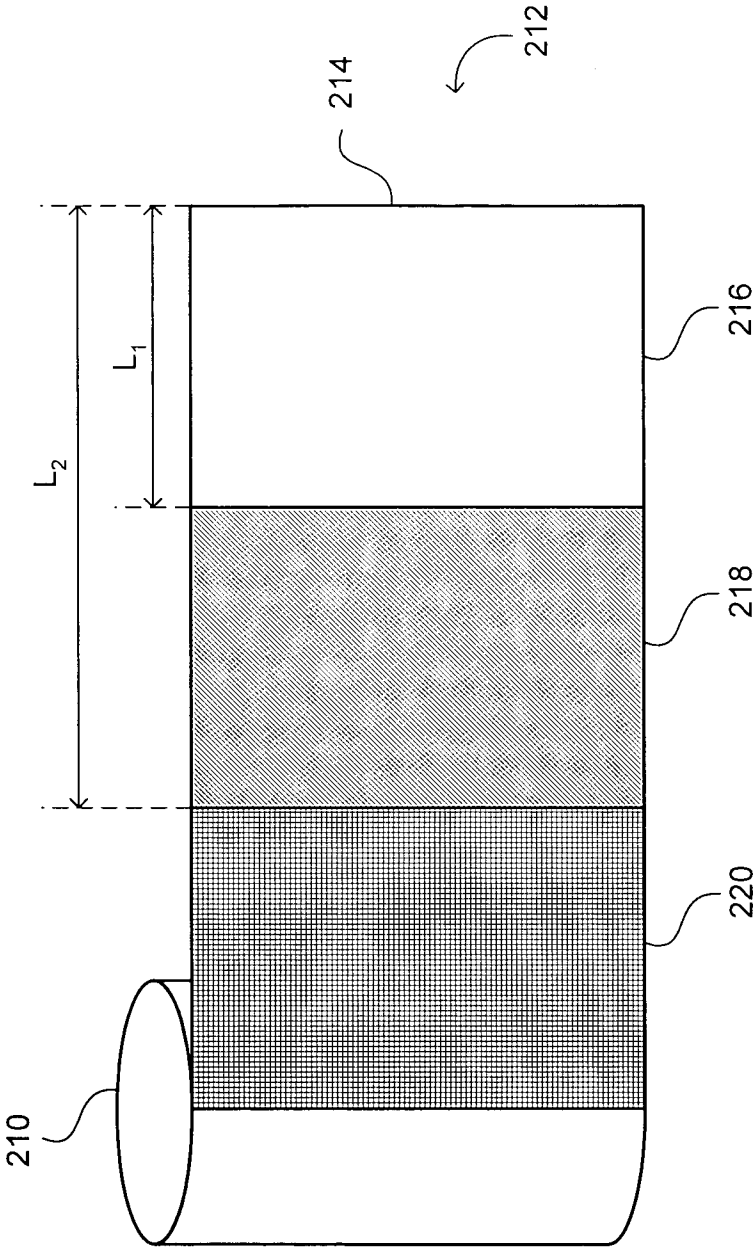


FIG. 4

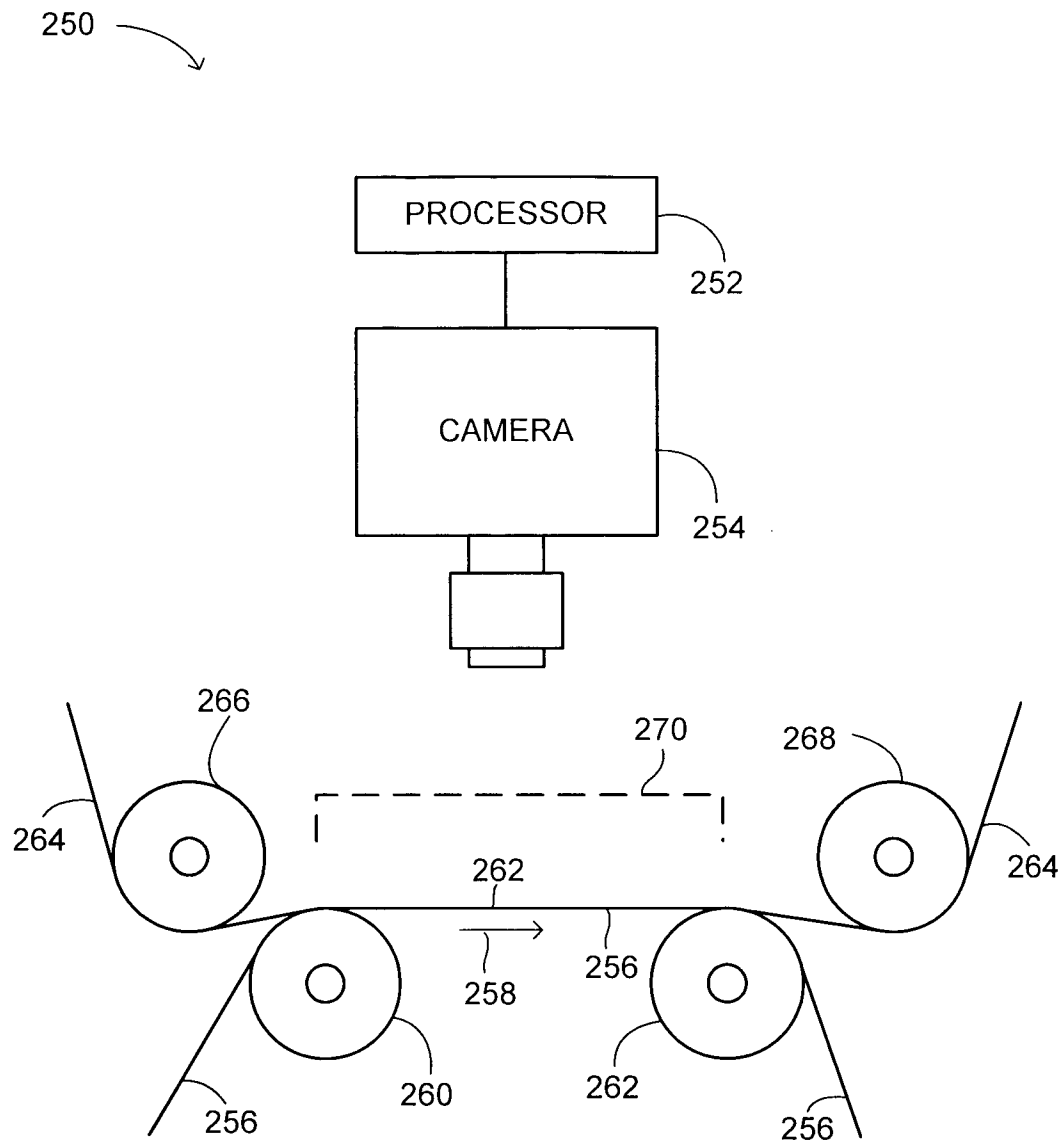
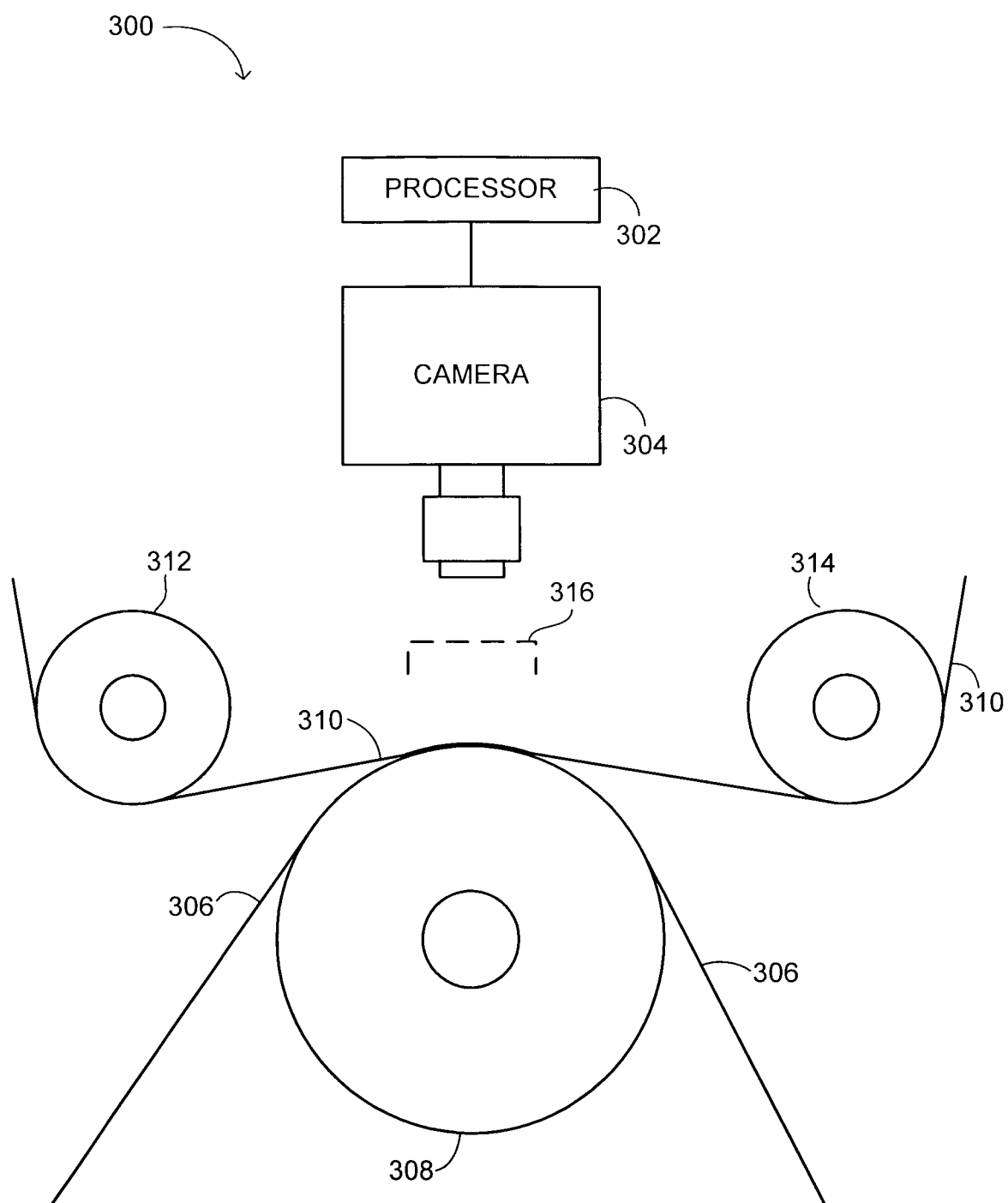
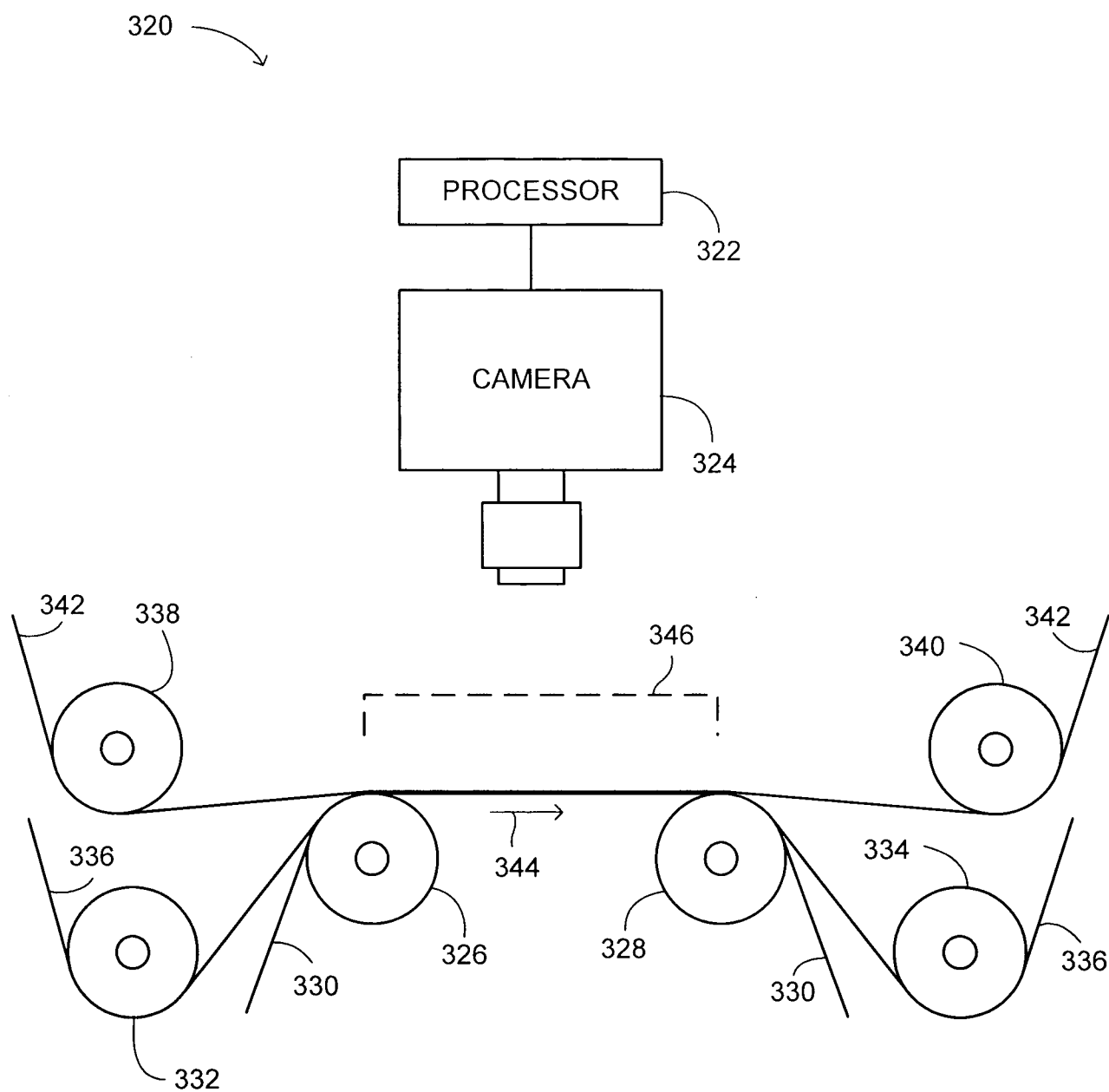
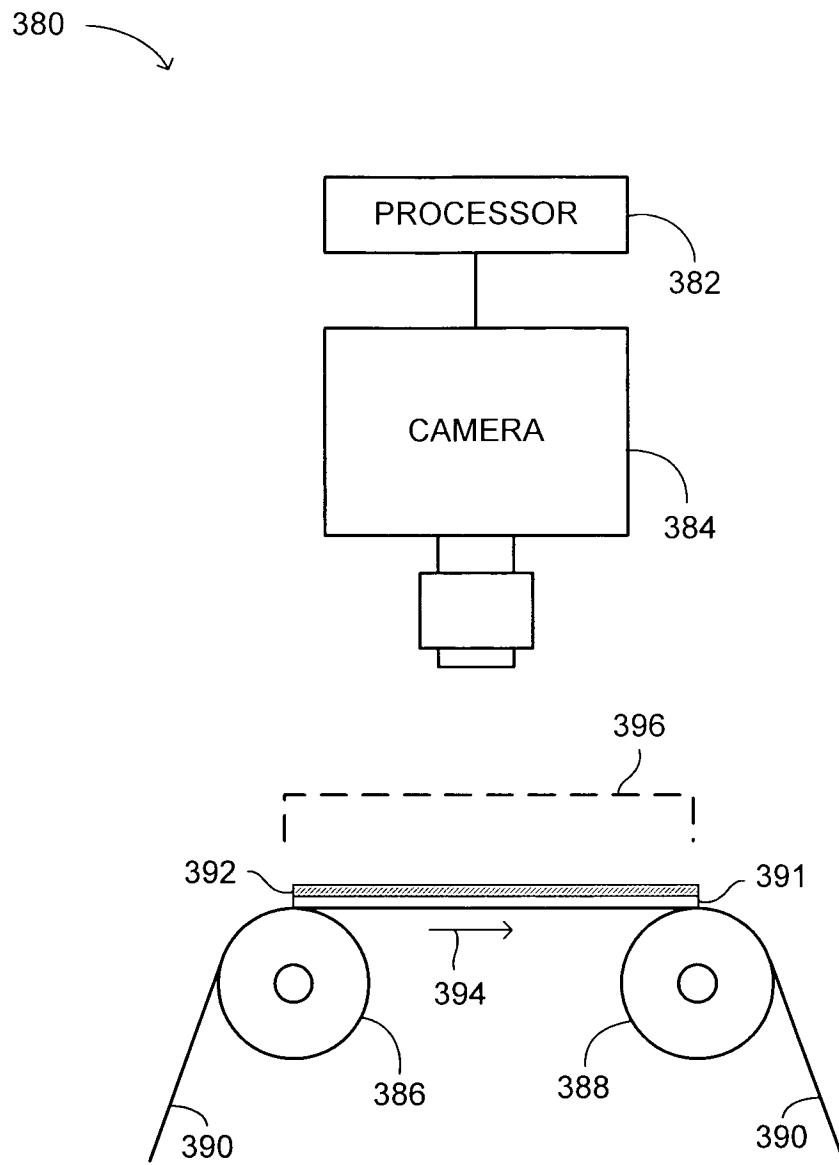
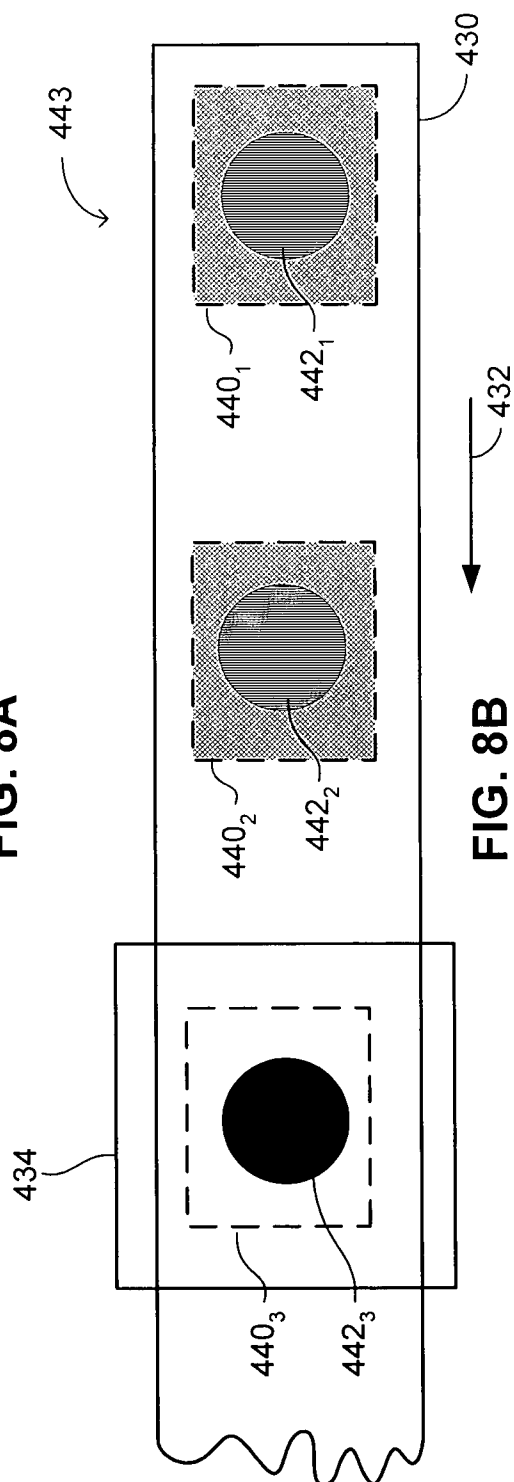
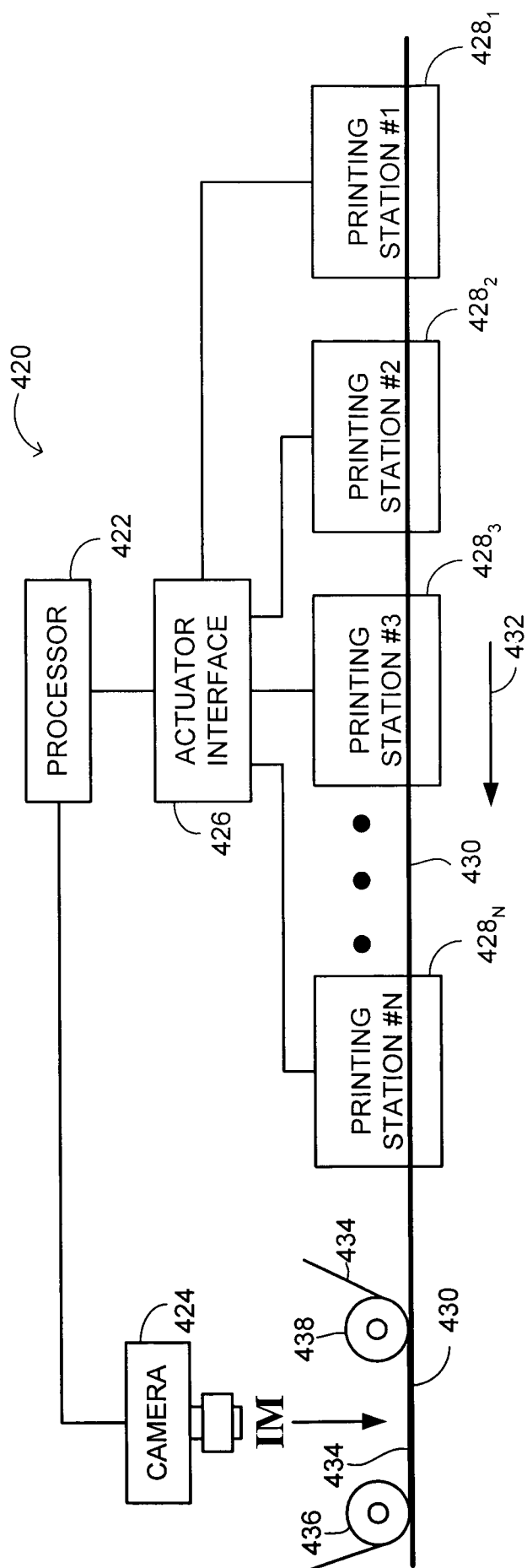


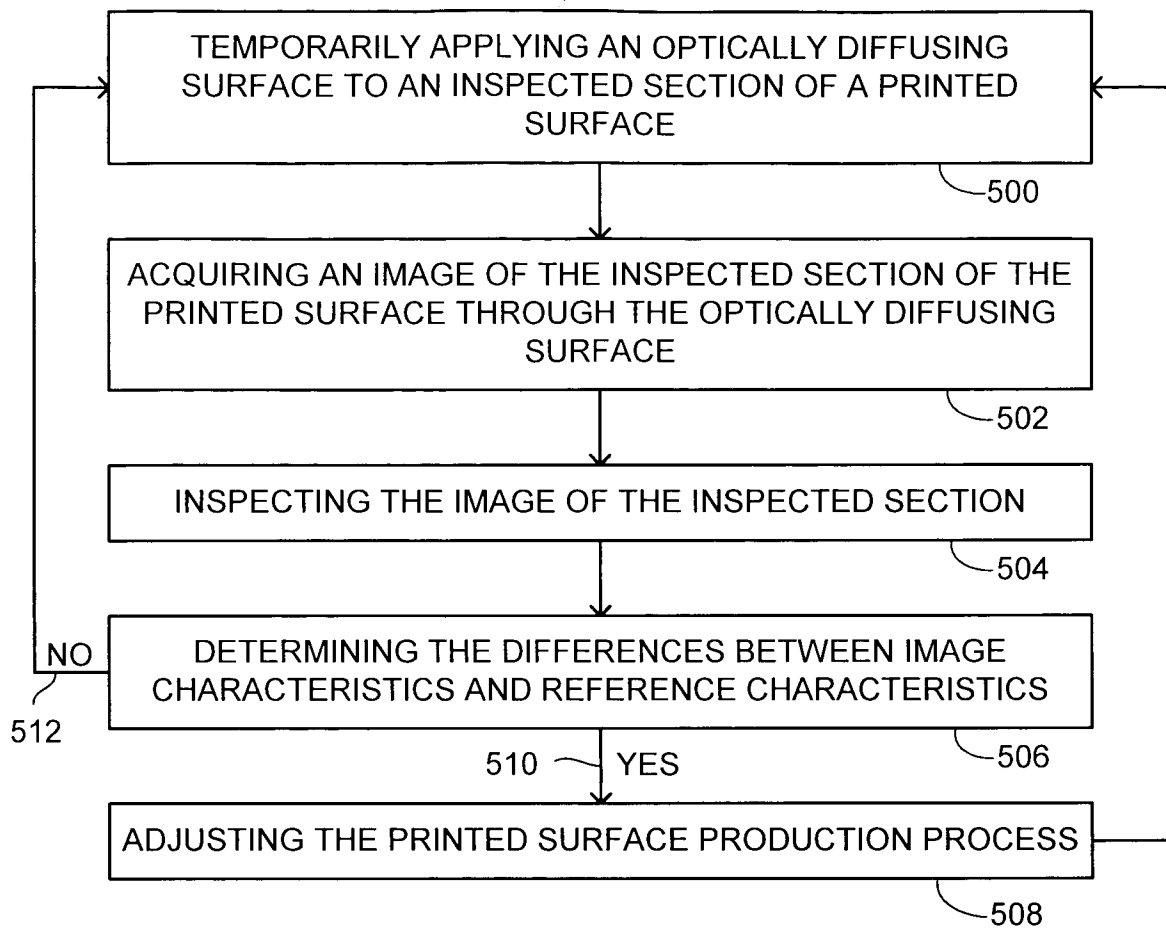
FIG. 5A

**FIG. 5B**

**FIG. 6**

**FIG. 7**



**FIG. 9**

INTERNATIONAL SEARCH REPORT

International application No
PCT/IL2009/001192

A. CLASSIFICATION OF SUBJECT MATTER
INV. B41F33/00 G01N21/89
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B41F G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 781 655 A1 (ADVANCED VISION TECH LTD [IL] ADVANCED VISION TECHNOLOGY A V [IL]) 2 July 1997 (1997-07-02) figure 2 column 6, lines 24-40 column 6, line 49 - column 7, line 22 column 8, lines 20-49	1-39
Y	EP 1 607 220 A2 (KOENIG & BAUER AG [DE]) 21 December 2005 (2005-12-21) paragraphs [0103], [0115]	1-39

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

9 April 2010

Date of mailing of the international search report

20/04/2010

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Authorized officer

Hajji, Mohamed-Karim

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IL2009/001192

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
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			JP 9290503 A	11-11-1997
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EP 1607220	A2	21-12-2005	NONE	