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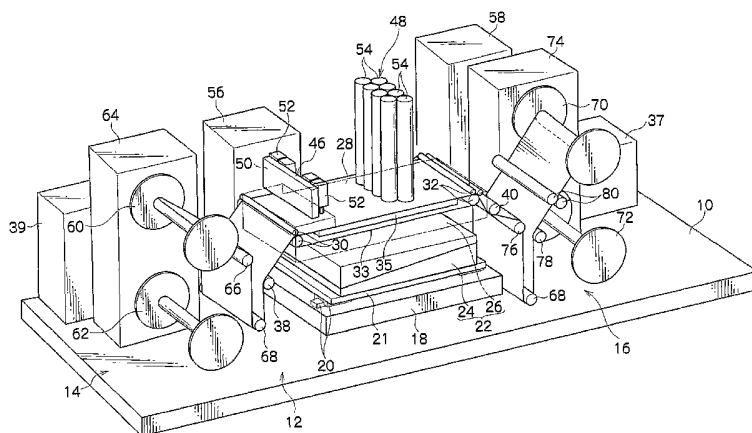
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(54) Title: ELONGATED FLEXIBLE RECORDING MEDIUM, AND IMAGE RENDERING METHOD AND IMAGE RENDERING APPARATUS THEREWITH



(57) Abstract: An image rendering apparatus method in which an image can be rendered on a flexible recording medium by correcting for an expanded/contracted state of the recording medium, the method comprising: detecting at least two marks serving as a feature for detection in a state in which the flexible recording medium is tensioned for conveying and image rendering purposes, the marks being provided on the flexible recording medium placed in a reference state and spaced apart from each other with a pre-determined spacing in at least one of a conveying direction and/or a direction perpendicular to the conveying direction; comparing a distance value between the marks measured when the flexible recording medium is tensioned and a distance value between the marks in the reference state thereby determining longitudinal and/or lateral expansion/contraction factors when the flexible recording medium is in a tensioned state; and rendering an image in accordance with a rendering pattern subjected to a deforming process so as to offset a deformation of the flexible recording medium due to the tension based on the longitudinal and/or lateral expansion/contraction factors.

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DESCRIPTION

ELONGATED FLEXIBLE RECORDING MEDIUM, AND IMAGE RENDERING
METHOD AND IMAGE RENDERING APPARATUS THEREWITH

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention generally relates to an elongated flexible recording medium, an image rendering method, and an image rendering apparatus.

Description of the Related Art

[0002] Among commonly used image rendering apparatuses is an exposure apparatus such as a scanning type print substrate (flexible substrate) exposure apparatus in which a desired image is rendered on a recording medium by scanning the recording medium with a light beam, a laser photo-plotter, a laser printer or the like.

[0003] In such an exposure apparatus, for example, in the case of a print substrate exposure apparatus, laser light is scanned with respect to a substrate material usable as a printed circuit board as the recording medium, thereby rendering an image on the printed circuit board. Substrate materials usable as a printed circuit board include a semiconductor thin film formed on an insulation layer and covered with a photoresist.

[0004] The above print substrate exposure apparatus is structured such that the photoresist layer is exposed in accordance with a desired substrate pattern by scanning laser light, modulated based on image data, with respect to the substrate material.

[0005] The substrate material thus exposure-processed is removed from the print substrate exposure apparatus, and then photoetched so as to be finished as a print substrate.

[0006] In a conventional print substrate (flexible substrate) exposure apparatus, in order to stabilize the behavior of the recording medium around the exposure surface, a tension in a direction pulling the recording medium is applied to the recording medium such that the recording medium is spanned between a loader, that feeds out the recording medium which is in the form of a rolled sheet, and an unloader that retrieves

the recording medium

[0007] It is structured that in a state in which the portion of the recording medium which is tensioned and spanned is placed on the image rendering surface of a image rendering table and fixed thereto by fixing means, the image rendering table can be slid with high accuracy by sliding means. Further, a scanning optical system that scans laser light is provided immediately above the recording medium spanned between the loader and the unloader.

[0008] Thus, while the image rendering table, to which the portion of the recording medium which is tensioned and spanned is fixed by the fixing means, is being conveyed with high accuracy by the sliding means, the scanning optical system scans laser light modulated based on image data with respect to the tensioned and spanned recording medium being slid with high accuracy along with the image rendering table, thereby rendering an image.

[0009] Further, in a conventional print substrate exposure apparatus, in order to start an image rendering process again, after the initial image rendering process has been completed: the fixing means of the rendering table is released; the recording medium is fixed by a clamp roller pair of the loader and also fixed by a driving roller pair of the unloader, such that the recording medium tensioned and spanned between the loader and the unloader is placed in a immovable state; and then the rendering table is moved toward the loader by the sliding means. Subsequently, the tensioned and spanned recording medium is fixed onto the image rendering surface of the image rendering table by the fixing means of the image rendering table.

[0010] Next, the clamp roller pair of the loader is released, and the recording medium is supplied by a supply roller pair of the loader such that a slackened portion of the recording medium is formed. Then, while the image rendering table is being moved toward the unloader by the slide means, the recording medium fixed on the image rendering surface of the image rendering table in a tensioned and spanned state is scanned by the scanning optical system, and the recording medium is retrieved into the unloader by the driving roller pair of the unloader. In this manner, the second image rendering process is finished. In order to perform a further rendering process, the

above-described operation is repeated the necessary number of times. For example, refer to JP-A No. 2000-235267.

[0011] In such a conventional print substrate (flexible substrate) exposure apparatus, when rendering a given image through scanning by the scanning optical system, since the recording medium placed on the rendering surface of the rendering table is tensioned, the recording medium is deformed such that this portion of the recording medium is expanded in the conveying direction and contracted in a direction perpendicular to the conveying direction (widthwise direction).

[0012] For this reason, in a conventional print substrate (flexible substrate) exposure apparatus, the scanning optical system renders a proper image with respect to the recording medium which is expanded in the conveying direction and contracted in the widthwise direction. Thus, the recording medium which is exposure-processed is elastically returned to its original shape when the recording medium is removed from the conveying system and external load is released.

[0013] The result is that the image rendered on the recording medium, elastically returned to its original shape, is distorted since it is contracted in the conveying direction and expanded in the widthwise direction. Further, difficulty is experienced in predicting and correcting the quantity of distortion by calculation since the quantity of expansion/contraction varies depending on the type and thickness of the recording medium, the pattern recorded on the recording medium, the lot/batch of the recording medium roll or the like. Therefore, when an exposing process is performed in a state in which the recording medium is tensioned, a distorted image may be formed due to the fact that an image rendered on the recording medium in a state in which the recording medium is untensioned does not accurately correspond to a given image scanned by the scanning optical system.

SUMMARY OF THE INVENTION

[0014] A first aspect of the present invention provides an elongated flexible recording

medium comprising a feature for detection of an expanded/contracted state of the recording medium, the feature for detection being structured such that marks are provided in at least one portion in a conveying direction and at at least two positions spaced apart from each other with a predetermined spacing in at least one of the conveying direction and/or a direction perpendicular to the conveying direction and an distance between positions of the marks when the recording medium is placed in a reference state is established.

[0015] A second aspect of the present invention provides an image rendering method in which an image can be rendered on a flexible recording medium by correcting for an expanded/contracted state of the recording medium, the method comprising: detecting at least two marks serving as a feature for detection in a state in which the flexible recording medium is tensioned for conveying and image rendering purposes, the marks being provided on the flexible recording medium placed in a reference state and spaced apart from each other with a predetermined spacing in at least one of a conveying direction and/or a direction perpendicular to the conveying direction; comparing a distance value between the marks measured when the flexible recording medium is tensioned and a distance value between the marks in the reference state thereby determining longitudinal and or lateral expansion/contraction factors when the flexible recording medium is in a tensioned state; and rendering an image in accordance with a rendering pattern subjected to a deforming process so as to offset a deformation of the flexible recording medium due to the tension based on the longitudinal and/or lateral expansion/contraction factors.

[0016] A third aspect of the present invention provides an image rendering method in which an image can be rendered on a flexible recording medium by correcting for an expanded/contracted state of the recording medium, the method comprising: providing marks, to serve as a feature for detection of an expanded/contracted state of an elongated flexible recording medium on the elongated flexible recording medium placed in a reference state and at at least two positions spaced apart from each other with a predetermined spacing in one of a conveying direction and/or a direction perpendicular to the conveying direction such that a distance between the mark positions is established; detecting the at least two marks, provided on the elongated

flexible recording medium placed in the reference state and spaced apart from each other in at least one of the conveying direction and/or the direction perpendicular to the conveying direction, in a state in which the flexible recording medium is tensioned for conveying and image rendering purposes; and comparing a distance value between the marks measured when the flexible recording medium is in an tensioned state and a distance value between the marks when the flexible recording medium is placed in the reference state thereby determining longitudinal and/or lateral expansion/contraction factors when the flexible recording medium is in a tensioned state, and rendering an image in accordance with a rendering pattern subjected to a deforming process so as to offset a deformation of the flexible recording medium due to the tension based on the longitudinal and/or lateral expansion/contraction factors.

[0017] A fourth aspect of the present invention provides an image rendering method in which an image can be rendered on a flexible recording medium by correcting for an expanded/contracted state of the recording medium, the method comprising: detecting when the flexible recording medium is placed in a reference state at least two marks provided on a flexible recording medium in a state in which the flexible recording medium is tensioned for conveying and image rendering purposes and spaced apart from each other with a predetermined spacing in at least one of a conveying direction and/or a direction perpendicular to the conveying direction; comparing a predetermined distance value between the marks when the marks are formed in the state in which the flexible recording medium is tensioned with a distance value between the marks measured when the flexible recording medium is placed in the reference state thereby determining longitudinal and/or lateral expansion/contraction factors in a state in which the flexible recording medium is tensioned, and rendering an image in accordance with a rendering pattern subjected to a deforming process so as to offset a deformation of the flexible recording medium due to the tension based on the longitudinal and/or lateral expansion/contraction factors.

[0018] A fifth aspect of the present invention provides an image rendering method in which an image can be rendered on a flexible recording medium by correcting for an expanded/contracted state of the recording medium, the method comprising: providing at least two marks on an elongated flexible recording medium which is tensioned when

conveyed for image rendering purposes, the marks being spaced apart from each other with a predetermined spacing in at least one of a conveying direction and/or a direction perpendicular to the conveying direction; detecting in a state in which the flexible recording medium is placed in a reference state the at least two marks provided on the elongated flexible recording medium in a state in which the elongated flexible recording medium is tensioned for conveying and image rendering purposes and spaced apart from each other with the predetermined spacing in at least one of the conveying direction and/or the direction perpendicular to the conveying direction; and comparing a predetermined distance value between the marks when the marks are formed in the state in which the flexible recording medium is tensioned with a distance value between the marks measured when the flexible recording medium is placed in the reference state, thereby determining longitudinal and/or lateral expansion/contraction factors in a state in which the flexible recording medium is tensioned, and rendering an image in accordance with a rendering pattern subjected to a deforming process so as to offset a deformation of the flexible recording medium due to the tension based on the longitudinal and/or lateral expansion/contraction factors.

[0019] A sixth aspect of the present invention provides an image rendering apparatus in which an image can be rendered on an elongated flexible recording medium provided with a feature for detection of an expanded/contracted state of the recording medium by correcting for the expanded/contracted state, the rendering apparatus comprising:

a conveyance path for conveying in a predetermined conveying direction an elongated flexible recording medium provided with a feature for detection of a expanded/contracted state of the recording medium, the feature for detection comprising marks provided on at least one portion of the recording medium in a conveying direction and at at least two positions spaced apart from each other with a predetermined spacing in one of the conveying direction and/or a direction perpendicular to the conveying direction wherein a distance between the mark positions when the recording medium is placed in a reference state is established; a tension setting unit for tensioning the elongated flexible recording medium on the conveyance path; a mark detecting unit that detects a distance between the marks in the

feature for detection of the expanded/contracted state which is provided on the elongated flexible recording medium which is tensioned to be conveyed on the conveyance path; a control unit that compares the distance value between the marks detected by the mark detecting unit in a state in which the recording medium is tensioned with the distance value between the marks established in the reference state, thereby determining longitudinal and/or lateral expansion/contraction factors of the flexible recording medium when the recording medium is tensioned, and generates an image rendering pattern subjected to a deforming process so as to offset a deformation of the recording medium due to the tension based on the longitudinal and/or lateral expansion/contraction factors; and an image rendering unit that renders an image in accordance with the image rendering pattern generated in the control unit and subjected to a deforming process so as to offset the deformation of the recording medium due to the tension.

[0020] Other aspects, features and advantages of the present invention will become apparent from the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Preferred embodiments of the present invention will be described in detail based on the following figures, in which:

Fig. 1 is a perspective view schematically showing the structure of a main portion of the image rendering apparatus according to an embodiment of the present invention;

Fig. 2 is a side view schematically showing the structure of main portions of the rendering apparatus according to the embodiment of the present invention;

Fig. 3 is a side view schematically showing the structure of main portions of the rendering apparatus according to the embodiment of the present invention in a state in which a detection unit equipped scanning conveying portion is moved to an alignment camera calibrating position.

Fig. 4 is a side view schematically showing the structure of main portions of the rendering apparatus according to the embodiment of the present invention in a state in which the detection unit equipped scanning conveying portion is moved to a beam

position detecting position.

Fig. 5 is a side view schematically showing the structure of main portions of the rendering apparatus according to the embodiment of the present invention in a state in which the detection unit equipped scanning conveying portion is moved to an surface-exposure power calibrating position.

Fig. 6 is a plan view showing by way of example main portions of a flexible printed circuit board material which is exposure-processed in the image rendering apparatus according to the embodiment of the present invention.

Fig. 7 is a flow chart useful for explaining the operation when an exposing process is performed in the image rendering apparatus according to the embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0022] The rendering apparatus according to an embodiment of the present invention will be described with reference to Figs. 1-6.

[0023] The image rendering apparatus according to the embodiment of the present invention is structured as a flexible printed circuit board exposure apparatus such that the image rendering apparatus is automatically controlled by a control unit so that a flexible printed circuit board material, which is a flexible recording medium in the form of an elongate band-like sheet, is moved in the main scanning direction while at the same time a multibeam emitted from a light source is spatially modulated based on a modulation signal generated from image data at the control unit, and irradiated onto the flexible printed circuit board material, thereby performing an exposing process.

[0024] As shown in Fig. 1, the rendering apparatus includes an exposure processing section 12 which is centrally provided on a floor base 10, an unexposed recording medium feeding section 14, which is provided at one side of the exposure processing section (on the left-hand side as viewed in Fig. 1), and an exposed recording medium retrieving section 16, which is provided at the opposite side of the exposure processing section 12 (at the right-hand side as viewed in Fig. 1)

[0025] The exposure processing section 12 includes a substrate transporting portion 22

which is installed via a linear motion mechanism 20 on a planar surface of an apparatus base 18 having a capability of eliminating vibrations and provided on the floor base 10 [0026] The linear motion mechanism 20 is structured by mounting a linear motor or any other feeding means between the top planar portion of the apparatus base 18, having a capability of eliminating vibrations, and a movable table 21, on which the substrate transporting portion 22 is mounted.

[0027] When the linear motion mechanism 20 is comprised of a linear motor, for example, an unillustrated rod-like stator portion (magnet portion) is provided along the transporting direction on the apparatus base 18, having a capability of eliminating vibrations, and an unillustrated coil portion is provided on the bottom surface side of the movable table 21. The linear motor permits the movable table 21 to be moved in the transporting direction due to a driving force resulting from the interaction of a magnetic field generated by energizing the coil portion and a magnetic field of the stator portion.

[0028] This linear motor is capable of electrically controlling, with high accuracy, the speed constancy, positioning accuracy, torque change at the time of starting or stopping, during the conveying operation of the substrate conveying portion 22.

[0029] The linear motion mechanism 20 is structured such that it can be moved from an exposing process position shown in Figs. 1 and 2 to an alignment camera calibrating position shown in Fig. 3, a beam position detecting position shown in Fig. 4, or an exposure surface power calibrating position shown in Fig. 5.

[0030] As shown in Figs. 1 and 2, the substrate conveying portion 22 is structured by providing a substrate-thickness adjusting Z stage 24 on the movable table 21 and by providing a scanning conveying portion 26 equipped with a detection unit on the substrate thickness adjusting Z stage 24.

[0031] The substrate-thickness adjusting Z stage 24 is structured such that the entire detection unit equipped scanning conveying portion 26 can be moved parallel to the height-wise direction (the direction of the Z-axis) by a fine manipulator mechanism which uses an inclined surface in order to adjust the height position of an exposed surface of the recording medium.

[0032] As shown in Fig. 2, the detection unit equipped scanning conveying portion 26 is provided with a belt conveyor mechanism for conveying a flexible printed circuit board material 28, which is an elongated belt-like flexible recording medium. The belt conveyor mechanism includes a nip roller pair 30 provided at an upstream side in the conveying direction, a nip driving roller pair 32, and an endless belt 33 entrained therebetween.

[0033] The nip driving roller pair 32 is comprised of a driving roller 32A, and plural (here two) nip rollers 32B which are placed in contact with the outer circumference of the driving roller 32A via the endless belt 33. Between the driving roller 32A and the nip rollers 32B is nipped the flexible printed circuit board material 28 with the endless belt 33 such that rotation of the driving roller 32A results in the endless belt 33 and the flexible printed circuit board material 28 being conveyed without occurrence of slip.

[0034] A rotary driving force having a predetermined rate of rotation, which is outputted from the driving motor 34 and speed-reduced by a speed reduction mechanism 36, is transmitted to the driving roller 32A via a belt transmission mechanism. Thus, the nip driving roller pair 32 causes the flexible printed circuit board material 28 to be conveyed at a predetermined scanning speed.

[0035] The nip roller pair 30 provided in the detection unit-equipped scanning conveying portion 26 is comprised of two nip rollers about which the endless belt 33 is entrained. It is structured that the while a state is maintained in which the flexible printed circuit board material 28 is nipped with the endless belt 33 between the nip rollers of the nip roller pair 30, the nip rollers are rotated so as to feed out the flexible printed circuit board material 28 along with the endless belt 33.

[0036] Meanwhile, although not shown, the endless belt 33 is perforated with suction apertures such, for example, as a multiplicity of circular through-apertures in an evenly distributed manner.

[0037] Further, the detection unit equipped scanning conveying portion 26 includes a suction box 35 located so as to provide a suction means adjacent to the rear surface of the upper run portion of the endless belt 33, which is located along the conveyance path, so that the flexible printed circuit board material 28 is placed and held thereon.

[0038] The suction box 35 is disposed over a predetermined range including an area immediately below a detection unit 46 and an exposure head unit (image rendering unit) 48, an area where detection is made of alignment or the like and an exposure area.

[0039] The suction box constituting the above suction means is configured in a lidless rectangular box-like shape, and located adjacent to the rear surface of the upper run portion of the endless belt 33 such that a semi-hermetical suction space is defined which is enclosed by the endless belt 33 and the suction box 35.

[0040] Further, in this suction means, an unillustrated intake pipe led out from a blower 37 (shown in Fig. 1) is coupled at the fore end to the suction box 35. The blower 37 forming this suction means is structured such that it suctions air from the semi-hermetical space enclosed by the endless belt 33 and the suction box 35 and thus an operation causing the flexible printed circuit board material 28 to be suctioned to the front surface of the endless belt 33 is performed.

[0041] In the detection unit equipped scanning conveying portion 26 structured as above, a portion of the flexible printed circuit board material 28 which is conveyed from the nip roller pair 30 into the conveyance path of the exposure processing section 12 is suctioned onto the endless belt 33 due to a negative pressure which is caused at the respective suction apertures of the endless belt 33 as a result of the blower 37 being driven so as to suction air from the semi-hermetical space enclosed by the endless belt 33 and the suction box 35. In such a state, the flexible printed circuit board material 28 is conveyed together with the endless belt 33 and fed from the nip driving roller pair 32.

[0042] In this way, the flexible printed circuit board material 28, when it is conveyed from the nip roller pair 30 to the nip driving roller pair 32, is continuously conveyed in a predetermined conveying direction while being suctioned to the endless belt 33. As can be seen, since the detection unit equipped scanning conveying portion 26 is structured such that an exposure process can be performed while the endless belt 26 on which the flexible printed circuit board material 28 rests is being continuously driven, it is possible to perform an exposure process without interruption at all times and thus achieve increased productivity.

[0043] Further, since the detection unit equipped scanning conveying portion 26 is structured such that the flexible printed circuit board material 28 is extended along and in close contact with the endless belt 33 having a high degree of planarity, it is possible to keep constant the focal distance from the exposure head unit that exposes by laser the flexible printed circuit board material 28.

[0044] In particular, when the endless belt 33 is made from metal instead of cloth, since the planarity of the flexible printed circuit board material 28 suctioned to endless belt 33 can be increased by structuring the endless belt 33 such that it obtains a high degree of planarity by being provided with high tension, it is possible to keep constant the focal distance from an exposure head unit 48 with high accuracy.

[0045] With the structure such that exposure is continuously performed on a conveyance path having a continuous planar surface established by extending the flexible printed circuit board material 28 along the endless belt 33, for example when so called surface exposure processing is performed in which a two-dimensional pattern is irradiated by a two-dimensional spatial modulation element (Digital Micromirror Device, DMD), it is possible to prevent the focal distance from being changed in the substrate conveying direction within the exposure area and thus obtain an excellent image by virtue of the fact that the flexible printed circuit board material 28 obtains a high degree of planarity, irrespective of the exposure area having a width in the conveying direction of the flexible printed circuit board material 28.

[0046] In this image rendering apparatus, as shown in Fig. 4, an exhaust pipe 41 connected at one end to an exhaust port of the blower 37 is coupled at the other end to a precision air conditioner 39 in order that exhaust air from the blower 37 can be allowed to circulate into a clean room in which the rendering apparatus is placed, after removing dust by passing the exhaust air through the precision air conditioner 39.

[0047] By the structure mentioned above, the air suctioned by the blower 37, in order to cause the flexible printed circuit board material 28 to be attracted by the suction box 35 and attached to the endless belt 33, is regenerated to the precision air conditioner 39 through the exhaust pipe 41. Although not shown, the precision air conditioner is structured such that the air delivered from the blower 37 and air suctioned from the

housing interior of the rendering apparatus is cleaned through a so called HEPA filter and then allowed to circulate into the clean room.

[0048] Thus, by adopting the above structure, it is possible to avoid a cost increase which would be incurred if a large quantity of air delivered from the blower 37 is exhausted outside the clean room, since that would necessitate an increase in the air conditioning capacity in order to supply fresh clean air into the clean room. In addition, it is also possible to prevent contamination by dust of the clean room which would be caused if the exhaust air of the blower 37 is exhausted directly into the clean room.

[0049] Further, in the conveyance path of the detection unit equipped scanning conveying portion 26, a guide roller 38 is provided at the upstream side of the nip roller pair 30, and another guide roller 40 is provided at the downstream side of the nip driving roller pair 32.

[0050] As shown in Fig. 2, a calibration scale 42 to serve as a calibration member is provided on the outer side of the nip roller pair 30 of the detection unit equipped scanning conveying portion 26 at a predetermined position on an extension line, at an upstream side with respect to conveying direction, of the conveyance path for exposure of the flexible printed circuit board material 28 (on the same plane as a plane for photographing various marks formed on the flexible printed circuit board material 28 on the exposure conveyance path in the detection unit equipped scanning conveying portion 26).

[051] Further, a beam position detecting device 44 and an exposure surface power measuring device 45 are provided on the outer side of the nip driving roller pair 32 of the detection unit equipped scanning conveying portion 26 at a predetermined position on an extension line, at an upstream side with respect to the conveying direction, of the conveyance path for exposure of the flexible printed circuit board material 28 (on the same plane as an exposure plane in the exposure area on the exposure conveyance path in the detection unit equipped scanning conveying portion 26).

[0052] More specifically, the present image rendering apparatus is structured such that a detection unit 46 is provided, which is an alignment portion doubling as mark

detecting means for detecting longitudinal/lateral expansion/contraction of the recording medium of the flexible printed circuit board material 28 which tends to occur when tension is applied thereto; and a camera portion 52 of the detection unit 46 is moved relative to the detection unit equipped scanning conveying portion 26 so as to be set at a position in an area in which alignment is effected on the exposure conveyance path for the flexible printed circuit board material 28, which is provided in the detection unit equipped scanning conveying portion 26; and the camera portion 52 can be set at a position of the calibration scale 42 of the alignment portion of the detection unit equipped scanning conveying portion 26.

[0053] Meanwhile, the present image rendering apparatus may use any type of relative motion mechanism which is capable of causing the camera portion to be relatively moved such that the camera portion 52 corresponds to the area in which alignment is effected on the exposure conveyance path and also to the position of the calibration scale 42 which is a calibration member. For example, as shown in Figs. 1 through 5, it may be structured that the camera portion 52 is fixed and the detection unit equipped scanning conveying portion 26 is moved by the linear motion mechanism 20 which is a relative motion mechanism. Alternatively, it may also be structured that the detection unit equipped scanning conveying portion 26 is fixed such that the position of the area in which alignment is effected and the position of the calibration scale 42 are immovable while the camera portion 52 is movable between the position for photographing a mark or the like and the position for photographing the calibration scale 42.

[0054] Further, the present image rendering apparatus may use any type of relative motion mechanism which is capable of effecting relative motion such that each head assembly of the exposure head unit 48 corresponds to the beam position detecting device 44 and also to the surface-exposure power measuring device 45. For example, as shown in Figs. 1 through 5, it may be structured that each head assembly of the exposure head unit 48 is fixed while the beam position detecting device 44 is moved to the exposure position and also the scanning conveying portion 26 equipped with the surface-exposure power measuring device 45 is moved to the exposure position.

Alternatively, it may also be structured that the beam position detecting device 44 and the scanning conveying portion 26 equipped with the surface-exposure power measuring device 45 are fixed so as to be immovable while each head assembly of the exposure head unit 48 is moved.

[0055] That is, in the present rendering apparatus, the linear motion mechanism 20 serving as the relative motion mechanism for moving the substrate conveying portion 22 constitutes means for moving the calibration scale 42, the beam position detecting device 44 and the surface-exposure power measuring device 45 to respective predetermined positions.

[0056] As shown in Figs. 1 and 2, in the exposure processing section 12, the detection unit 46, which is an alignment portion, is located above the substrate conveying portion 22 at an upstream side of the conveying direction, and the exposure head unit 48, as a rendering unit, is located above the substrate conveying portion 22 at a down stream side of the conveying direction.

[0057] The detection unit 46 as an alignment portion is installed with a base portion 50 thereof secured to a stationary structure such as the housing of the image rendering apparatus. The base portion 50 is provided with a pair of parallel rails (not shown) to which the plural (four in this embodiment) camera portions 52 are attached such that they can be moved through a camera base, which is moved by a ball-screw mechanism, so that the optical axis of a lens portion is aligned with a desired position in the widthwise direction of the flexible printed circuit board material 28.

[0058] Although not shown, each camera portion 52 is structured such that the lens portion is provided on the lower surface of a camera body and a ring-like strobe light source (LED strobe light source) is attached to a protruding fore end portion of the lens portion. In this camera portion 52, light emitted from the strobe light source is irradiated onto the flexible printed circuit board material 28 such that the light thus reflected is captured by the camera main body through the lens portion, thereby detecting marks for detecting an edge of the flexible printed circuit board material 28 or marks for detecting a longitudinal/lateral expansion/contraction which tends to occur when tension is applied to the flexible printed circuit board material 28, and alignment

marks or the like.

[0059] The exposure head unit 48 provided as a rendering unit in the exposure processing section 12 as shown in Figs. 1 and 2 is mounted on unillustrated supporting columns which are standingly provided outside of the opposite widthwise edges of the flexible printed circuit board material 28.

[0060] The exposure head unit 48 serving as an image rendering unit is structured as a laser exposure device such that plural head assemblies 54 are arranged in an approximate matrix form (m rows $\times$ n columns) (in this embodiment, 2 rows $\times$ 4 columns, total 8) and the rows of the matrix of the plural head assemblies are located along the widthwise direction of the flexible printed circuit board material 28 (corresponding to the direction perpendicular to the main scanning direction that is the conveying direction of the flexible printed circuit board material 28).

[0061] As shown in Fig. 1, a light source unit 56 is provided in the interior of the present rendering apparatus. The light source unit 56 accommodates plural laser (semiconductor laser) sources (not shown) such that a light beam emitted from each laser light source is passed into a respective one of the head assemblies 54 via an optical fiber.

[0062] Each head assembly 54 is structured such that light passed therein is modulated by an unillustrated digital micromirror device (DMD) which is a spatial light modulating element, and then focused on the flexible printed circuit board material 28 by an auto-focusing mechanism, thereby performing irradiation of a two-dimensional pattern (so-called surface exposure process).

[0063] The digital micromirror device (DMD) is controlled on a dot-unit basis based on image data in the image processing portion of the control unit 58, thereby exposing a dot pattern onto the flexible printed circuit board material 28.

[0064] The exposure head unit 48 serving as an image rendering unit performs an exposure process by irradiating plural light beams emitted from the respective head assemblies with a predetermined timing onto the flexible printed circuit board material 28 while conveying the flexible printed circuit board material 28 at a constant speed. At this point, during exposure each head assembly 54 performs exposure after focusing

has been effected by the auto-focusing mechanism, and thus an appropriate exposure process can be performed irrespective of some variation in the heightwise position of the flexible printed circuit board material 28.

[0065] In the exposure head unit 48, although not shown, the exposure area defined by one head assembly 54 is configured so as to be inclined at a predetermined angle of inclination with respect to the main scanning direction and in a rectangular shape in which the minor sides are oriented in the main scanning direction such that a band-like exposed region is formed on a per head assembly basis on the flexible printed circuit board material 28 conveyed in the main scanning direction.

[0066] In addition, in the exposure head unit 48, since exposure is performed with the exposure area inclined at a predetermined angle of inclination with respect to the main scanning direction, a two-dimensionally arrayed dot pattern to be exposed is inclined with respect to the main scanning direction so that the respective dots lined up in the main scanning direction pass between the dots lined up in a direction across the main scanning direction. Thus, the effective pitch of the dots is decreased and therefore increased resolution can be achieved.

[0067] Further, in the present image rendering apparatus, when a relative positional deviation occurs between the flexible printed circuit board material 28 being conveyed and the exposure head unit 48, the camera portion 52 takes an image of a mark or the like which is provided on the flexible printed circuit board material 28 and detects the amount of the positional deviation between the flexible printed circuit board material 28 and the exposure head unit 48, whereby the exposure process performed by the exposure head unit 48 is corrected so that an appropriate exposure process can be performed with respect to the flexible printed circuit board material 28.

[0068] As shown in Figs. 1 and 2, in the present rendering apparatus, in order to continuously perform an exposure process while conveying the flexible printed circuit board material 28 on the conveyance path set in the exposure processing section 12, the unexposed recording medium feeding portion 14 is provided, which connects to an upstream side of the conveyance path of the exposure processing section 12, and the exposed recording medium retrieving section 16 is provided, which connects to a

downstream side of the conveyance path of the exposure processing section 12.

[0069] The unexposed recording medium feeding section 14 is comprised of a supply reel 60 on which the unexposed elongated flexible printed circuit board material 28 is wound in a roll-like shape and a spacer tape take-up reel 62, with the reels 60 and 62 being attached to a driving unit 64.

[0070] The unexposed recording medium feeding section 14 is structured such that the flexible printed circuit board material 28 unwound from the supply reel 60 is conveyed in the entrance of the recording medium conveyance path of the exposure processing section 12 via a dancer roller mechanism to serve as tension setting means for enabling the unwound flexible printed circuit board material 28 to be conveyed in a manner that the substrate material 28 is extended along the endless belt 33 in close surface contact therewith. That is, in the present rendering apparatus, it is structured that the flexible printed circuit board material 28 can be stably conveyed by applying a certain amount of tension thereto.

[0071] Meanwhile, although not shown, it may be structured that a first dancer roller mechanism which adjusts the difference in the conveying speed is provided between the supply reel 60 and the entrance of the recording medium conveyance path of the exposure processing section 12 and a second dancer roller mechanism to serve as tension setting means is provided via a clean roller.

[0072] The dancer roller mechanism is structured such that for example, a dancer roller 68 is provided between a roller 66 located on the exit side of the unexposed recording medium feeding section 14 and a guide roller 38 located on the entrance side of the exposure processing section 12 in a manner so that it is entrained by a portion of the flexible printed circuit board material which is sagging in a U-shaped form. Meanwhile, this dancer roller mechanism may be substituted with a so-called air dancer structured so as to suction the flexible printed circuit board material 28 with air. Further, the second dancer roller mechanism to serve as tension setting means is structured so as to apply a relatively weak tension necessary to cause the flexible printed circuit board material 28 to be adhered to the endless belt 33 in close surface contact therewith.

[0073] The unexposed recording medium feeding section 14 having the above structure is structured such that the flexible printed circuit board material 28 is unwound due to the supply roll 60 being rotated by the driving unit 64 and conveyed in between the nip roller pair 30 of the exposure processing section 12 and the endless belt 33 via the dancer roller mechanism so that the flexible printed circuit board material 28 is continuously fed without slipping on the endless belt 33.

[0074] The flexible printed circuit board material 28 is wound on the supply reel 60 in a manner such that a spacer tape 61 is held between adjacent turns of the wound substrate material 28 thereby preventing such adjacent turns from directly contacting each other. Thus, in the unexposed recording medium feeding section 14, the spacer tape take-up reel 62 is rotated by the driving unit 64 so that the spacer taper 61 which is extended out along with the flexible printed circuit board material 28 being conveyed out is wound onto the spacer tape take-up reel 62.

[0075] Further, the exposed recording medium retrieving section 16 includes a take-up reel 70 on which is wound the exposed elongated flexible printed circuit board material 28, and a spacer tape supply reel 72, with these reels being mounted to a driving unit 74.

[0076] In the exposed recording medium retrieving section 16, the exposed flexible printed circuit board material 28 conveyed from the exposure processing section 12 is wound onto the take-up reel 70 via the dancer roller mechanism to serve as tension setting means connected to the outlet of the recording medium conveyance path of the exposure processing section 12.

[0077] The dancer roller mechanism to serve as tension setting means causes the flexible printed circuit board material 28 to be stably conveyed by applying a certain amount of tension thereto. For example, the dancer roller mechanism is comprised of a dancer roller 68 entrained by a portion of the flexible printed circuit board material 28 which is sagging in a U-shape between a retaining roller 76, located at a downstream side of the conveying direction as viewed from an outlet guide roller 40 of the exposure processing section 12, and an inlet side roller 78 of the exposed recording medium retrieving section 16.

[0078] Further, in the exposed recording medium retrieving section 16, a nip roller pair 80 is provided between the inlet side roller 78 and the take-up reel 70 such that tension applied due to the exposed flexible printed circuit board material 28 being pulled by the take-up reel 70 is absorbed by the nip roller pair 80, thereby preventing the tension being transmitted to the dancer roller mechanism located at an upstream side of the conveyance path of the exposed recording medium retrieving section 16.

[0079] Thus, the exposed recording medium retrieving section 16 is structured such that the flexible printed circuit board material 28 fed out from the exposure processing section 12 via the dancer roller mechanism is continuously retrieved as a result of the take-up reel 70 being rotated by the driving unit 74.

[0080] Further, in the exposed recording medium retrieving section 16, when the flexible printed circuit board material 28 is taken up by the take-up reel 70, a spacer tape 61 is interleaved in between adjacent turns of the flexible printed circuit board material 28 being wound onto the take-up reel 70, thereby preventing the adjacent turns of the substrate material 28 from being directly contacted with each other. To this end, in the exposed recording medium retrieving section 16, the spacer tape supply reel 72 is rotated by the driving unit 74 in order to draw out the spacer tape 61 from the spacer tape supply reel 72 such that the flexible printed circuit board material 28 can be wound up with the spacer tape 61 being extended therealong.

[0081] As shown in Figs. 1 and 2, in the image rendering apparatus structured as above, a belt conveyor mechanism is provided between the nip roller pair 30 on the exposing conveyance path of the exposure processing section 12 and the nip driving roller pair 32.

[0082] In the exposing conveyance path of the exposure processing section 12, the portion of the flexible printed circuit board material 28 which is conveyed on the endless belt 33 of the belt conveyor mechanism is conveyed in the traveling direction (main scanning direction) at a predetermined speed due to the rotary driving force of the nip driving roller pair 32, while being suctioned to the surface of the endless belt 33 by suctioning air from a semi-hermetic space surrounded by the endless belt 33 and the suctioning box 35 and suctioning air through the suctioning apertures of the endless

belt 33, and is subjected to an exposing process by the exposure head unit 48.

[0083] When an exposing process is performed at the exposure processing section 12, the flexible printed circuit board material 28 is planarly supported on the exposing conveyance path by the endless belt 33, at a position below the detection unit 46 and at a position below the exposure head unit 48. Meanwhile, the flexible printed circuit board material 28 extended on the exposing conveyance path of the exposure processing section 12 is provided with a predetermined tension by the dancer roller mechanism located at an upstream side of the conveying direction and the dancer roller mechanism located at a downstream side of the conveying direction so as to be stably retained on the endless belt 33 without sagging.

[0084] Thus, in the exposure processing section 12, an appropriate exposing process is performed by the respective head assemblies 54 of the exposure head unit 48 in a two-dimensional pattern with respect to the surface of the flexible printed circuit board material 28 which is planarly retained on the endless belt 33.

[0085] Further, in the exposure processing section 12, the flexible print circuit material 28 being conveyed in the traveling direction at a constant speed can be continuously subjected to an exposing process by the exposure head unit 48. Thus an operation can be eliminated for causing the flexible printed circuit board material 28 to be reciprocatingly moved immediately below the exposure head unit 48, and an exposing process can be performed rapidly and rationally so that an improved operational efficiency can be achieved.

[0086] Further, in the present image rendering apparatus, the control unit 58 determines correction factors (factors X, Y, and θ , where X is a correction factor for the conveying direction, Y is a correction factor for the conveying direction, and θ is a rotational angle on the conveyance path) relating to an exposure starting position when an exposure process is performed by the exposure head unit 48 and a shift position of a dot in the widthwise direction of the flexible printed circuit board material 28, based on the positional data of a mark or an edge portion which is obtained by imaging the flexible printed circuit board material 28. Consequently, the control unit 58 performs control such that an exposure process is performed by correcting the rendering of a

two-dimensional pattern, an image recording starting time or the like set by the respective head assemblies of the exposure head unit 48, so that the position of an image exposed onto the flexible printed circuit board material 28 is corrected to an appropriate position based on the above-mentioned correction factors.

[0087] In the exposure processing section 12 of the present rendering apparatus, a portion to be detected of the flexible printed circuit board material 28 which is located immediately below the detection unit and a portion to be detected of the flexible printed circuit board material 28 which is located immediately below the exposure head unit 48 are both conveyed in the traveling direction (main scanning direction) at the same speed so that the result of detection by the detection unit 46 can be applied to the exposure head unit 48 without any error, thereby providing a further improved accuracy of the exposing process.

[0088] Next, description will be made of the procedure for calibrating the detection unit 46 used in the present rendering apparatus. In the present rendering apparatus, alignment is carried out for appropriately adjusting the relative positional relationship between the flexible printed circuit board material 28 and the exposure head unit 48 by means of the detection unit 46.

[0089] In the alignment of the present rendering apparatus, when size data of the flexible printed circuit board material 28 is inputted by an unillustrated input portion, the position of the camera portion 52 of the detection unit 46 is moved and adjusted so as to conform to the widthwise position of the flexible printed circuit board material 28.

[0090] Further, in the present image rendering apparatus, a predetermined longitudinal range of the flexible printed circuit board material 28 being moved in the main scanning direction is photographed by the respective camera portions 52; a mark formed on the flexible printed circuit board material 28 in order to detect a predetermined exposing position is detected and compared with the reference position of each camera portion 52 so that correction data for exposure is generated; and an exposure processing operation is performed by measuring a timing with which the exposure starting position of the flexible printed circuit board material 28 reaches a

exposure beam irradiating position of the exposure head unit 48 based on the correction data by use of an unillustrated pulse counter or the like.

[0091] Further, in the present rendering apparatus, a positional calibration of the camera portions 52 for alignment is carried out using the calibration scale 42.

[0092] To this end, in the present rendering apparatus, the entire substrate conveying portion 22 (scanning conveying portion 26 in which there are provided the moving table 21, the substrate thickness adjusting Z stage 24, the nip roller pair 30, the nip driving roller pair 32, and the calibration scale 42) is moved from the exposure waiting position shown in Fig. 2 in the rightward direction as viewed in the figure so as to be set to the alignment camera calibrating position shown in Fig. 3.

[0093] That is, in the present rendering apparatus, the calibration scale 42 equipped scanning conveying portion 26 located in the substrate conveying portion 22 is moved such that the calibration scale 42 conforms to the camera portion 52, by means of the linear motion mechanism that causes the substrate conveying portion 22 to be moved.

[0094] At the alignment camera calibrating position shown in Fig. 3, each camera portion 52 and the corresponding calibration scale 42 are placed in opposing relationship to each other. In such a state, based on the widthwise position information of a designated alignment mark, each camera 52 is moved in the widthwise direction of the substrate.

[0095] In the present image rendering apparatus, since the calibration scale 42 is positioned more toward the camera portion 52 than the conveyance path of the flexible printed circuit board material 28, a positional calibration of the alignment camera portion 52 can be carried out in a state in which the flexible printed circuit board material 28 is conveyed in the conveyance path of the detection unit equipped scanning conveying portion 26. That is, in the present rendering apparatus, a positional calibration of the alignment camera portion 52 can be carried out without removing the flexible printed circuit board material 28 on the conveyance path of the detection unit equipped scanning conveying portion 26.

[0096] Further, in the present rendering apparatus, the calibration scale 42 is photographed by the alignment camera portion 54, and the positional relationship

between the camera portion 52 and the calibration scale 42 is calibrated from the position where the pattern of the calibration scale 42 is photographed.

[0097] Meanwhile, in the present image rendering apparatus, after the alignment camera calibrating operation has been completed, the linear motion mechanism 20 is driven such that an operation is performed for returning the entire substrate conveying portion 22 from alignment camera calibrating position shown in Fig. 3 to the exposure waiting position shown in Fig. 2.

[0098] Next, description will be made of calibrating means relating to the exposure position and the power distribution in the exposure area of each head assembly 54 used with the present rendering apparatus.

[0099] In the present rendering apparatus, firstly, in order to measure the beam position of each head assembly 54, the detection unit equipped scanning conveying portion 26 is moved in the leftward direction as viewed in the figure from the exposure waiting position shown in Fig. 2 to the beam position detecting position shown in Fig. 4 where each head assembly 54 and the corresponding beam position detecting device 44 are placed in opposing relationship to each other.

[0100] In the present rendering apparatus, as in the case where the calibration scale 42 is moved to the camera portion 52 as mentioned above, the beam position detecting device 44 located in the detection unit equipped scanning conveying portion 26 of the substrate conveying portion 22 is moved so as to be aligned with each head assembly 54 by the linear motion mechanism 20 that causes the substrate conveying portion 22 to be moved,

[0101] Further, the beam position of each head assembly 54 is measured by the beam position detecting device 44, and thus the exposure position of each head assembly 54 is calibrated.

[0102] Next, in the present rendering apparatus, in order to measure the power distribution in the exposure area of each head assembly 54, the detection unit equipped scanning conveying portion 26 is moved in the leftward direction as viewed in the figure from the beam position detecting position shown in Fig. 4 to the exposure surface power calibrating position where each head assembly 54 and the corresponding

exposure surface power measuring device 45 are placed in opposing relationship to each other, as shown in Fig.5.

[0103] Meanwhile, in the present rendering apparatus, as in the case where the calibration scale 42 is moved to the camera portion 52 as above, the exposure surface power measuring device 45 is moved so as to be aligned with each head assembly by the linear motion mechanism 20 that causes the substrate conveying portion 22 to be moved.

[0104] Further, the power distribution in the exposure area of each head assembly 54 is measured by the corresponding exposure surface power measuring device 45, and the power in the entire exposure area is calibrated so that an appropriate two-dimensional pattern can be rendered.

[0105] The present rendering apparatus is structured such that the beam position detecting device 44 and the exposure surface power measuring device 45 are positioned more toward the exposure head unit 48 than the conveyance path for the flexible printed circuit board material 28. Accordingly, even in a state in which the flexible printed circuit board material 28 is conveyed onto the conveyance path of the detection unit equipped scanning conveying portion 26, there is no likelihood that the flexible printed circuit board material 28 exists between each head assembly and the beam position detecting device 44 or exposure surface power measuring device 45, and thus calibration of the exposure position each head assembly and power calibration in the entire exposure area of each head assembly 54 can be carried out. That is, in the present rendering apparatus, calibration of the exposure position each head assembly and power calibration in the entire exposure area of each head assembly 54 can be carried out without removing the flexible printed circuit board material 28 on the conveyance path of the detection unit equipped scanning conveying portion 26.

[0106] Further, in the present rendering apparatus, after the operation for calibrating the exposing position of each head assembly and the operation for calibrating power in the entire exposure area have been completed, the linear motion mechanism is driven such that the entire substrate conveying portion 22 is returned from the exposure surface power calibrating position shown in Fig. 5 to the exposure waiting position

shown in Fig. 2.

[0107] In the present rendering apparatus, it is required that a restraint be made such that the flexible printed circuit board material 28 is prevented from moving when the alignment camera calibrating operation, the exposure position calibrating operation or the operation for calibrating power in the entire exposure area is performed.

[0108] Therefore, in the present rendering apparatus, when the detection unit equipped scanning conveying portion 26 is moved, the blower 37 to serve as suction means is driven such that air in the semi-hermetic space enclosed by the suction box 35 is suctioned and thus air is suctioned from the suctioning apertures of the endless belt 33, which itself is braked, and due to such suctioning operation, the flexible printed circuit board material 28 is kept in an immovable state on the conveyance path of the detection unit equipped scanning conveying portion 26 while being suctioned to the surface of the endless belt 33.

[0109] Alternatively, in the present invention, when the detection unit equipped scanning conveying portion 26 is moved, the nip roller pair 30, located at an upper side of the conveying direction of the detection unit equipped scanning conveying portion 26, is braked so as to restrain the flexible printed circuit board material 28 held between the nip roller pair 30, and further the nip roller pair 32, on the downstream side of the detection unit equipped scanning conveying portion 26, printed circuit board is braked so as to restrain the flexible printed circuit board material 28 between the nip roller pair 32.

[0110] Next, description will be made of an elongated flexible recording medium provided with means for detecting an expanded/contracted state thereof; an image rendering method capable of rendering an image on the flexible recording medium by correcting for the expanded/contracted state; and a processing operation which is performed to render an image with the present rendering apparatus using the elongated flexible recording medium provided with means for detecting an expanded/contracted state thereof, all of which can be utilized in the structure of the above-described image rendering apparatus.

[0111] The elongated flexible recording medium provided with means for detecting an

expanded/contracted state thereof is structured such that an exposed elongated flexible printed circuit board material 28 is wound on a supply reel 60 in the form of a roll and a lead tape 27 (comprising, for example, a flexible sheet material having a belt-like shape which is equal in width to the flexible printed circuit board material 28 and about 2-3m in length) is connected to the end of the lead-out portion of the wound flexible printed circuit board material 28.

[0112] As shown in Fig. 6, this elongated flexible recording medium is formed with small circular through-apertures (which may be substituted with rendered marks or the like) which become marks 25 to serve as means for detecting an expanded/contracted state of the recording medium, with the through-apertures being located in the vicinity of the four corners of rectangular unit exposure areas L which are defined at a position that is most adjacent to the end of the portion of the flexible printed circuit board material 28 which is connected to the lead tape 27 (a position where the foremost unit exposure area L in the conveying direction is located).

[0113] The marks 25 may be provided only with respect to the foremost unit exposure area L, or alternatively they may be provided on a per unit exposure basis. Further, the marks 25 may be constituted by small circular through-apertures (which may be substituted with a rendered mark or the like) which are formed at four positions spaced apart from each other with a predetermined spacing in the vicinity of the end of the portion of the flexible printed circuit board material 28 which is connected to the lead tape 27 in the conveying direction (substrate feeding direction) and in a direction perpendicular to the conveying direction (widthwise direction of the substrate).

Meanwhile, the elongated flexible recording medium may be exposed to plural types of rendering patterns at plural types of unit exposure area.

[0114] Further, the marks 25 may be provided at respective positions which are spaced apart from each other with a predetermined spacing in the conveying direction on the flexible printed circuit board material 28. That is, the marks 25 may be provided at respective positions where a predetermined plurality of unit exposure areas L are located in the conveying direction of the flexible print substrate material 28. Further, the marks 25 may be provided at any arbitrary positions on the flexible printed circuit

board material.

[0115] Further, the marks 25 may be formed during fabrication of the flexible printed circuit board material 28 which is an elongated flexible recording medium.

Alternatively, the marks 25 may be formed by a working operation which is part of an operation for perforating apertures for inter-layer connection which is previous to the exposure process with respect to the flexible printed circuit board material 28. Further, the marks 25 may be substituted with via-holes (hole for inter-layer connection) or alignment marks which are produced during a process prior to the exposing process with respect to the flexible printed circuit board material 28.

[0116] When the marks 25 are constituted by via-holes or alignment marks, for example, the flexible printed circuit board material 28 is slightly fed on the conveyance path; the marks 25 are read by the camera portion 52; the substrate material 28 is slightly returned on the conveyance path; data processing is performed such that a rendered pattern is deformed; alignment processing is performed while feeding the substrate material 28 again; and thereafter an exposing process is performed.

Meanwhile, an exposing process may be rapidly performed, without the operation for slightly returning the flexible printed circuit board material 28 on the conveyance path, by using the marks 25 such as via-holes, alignment marks or the like which are located at the position of the unit exposure area L which is ahead by a predetermined plurality of unit exposure areas.

[0117] Next, description will be made of an image rendering method which is capable of rendering an image by correcting an expanded/contracted state of a flexible recording medium to which a tension is applied.

[0118] In this image rendering method, in a reference state, marks to serve as means for detecting an expanded/contracted state at a step prior to the image rendering process are provided at four predetermined positions (positions where the distance between the marks becomes a predetermined distance) which are spaced apart from each other with a predetermined spacing in the conveying direction and in a direction perpendicular to the conveying direction with respect to the elongated flexible recording medium.

[0119] Meanwhile, the term “reference state” used in the present specification refers not only to a state including a state in which no tension is applied to a flexible recording medium but also a state in which a tension is applied to the flexible recording medium in an environment (conditions such as temperature, moisture or the like) in which a flexible recording medium having an image rendered thereon is to be used. For example, in a case where a flexible recording medium having an image rendered thereon is loaded into the apparatus, when it is known that a predetermined tension is to be applied, the reference state refers to the state in which the predetermined tension is applied to the flexible recording medium.

[0120] Next, in this image rendering method, at a stage prior to the image rendering process, in a state in which the tension applied to the flexible recording medium is the tension when conveying the recording medium in order to perform an image rendering process with respect to the recording medium, the distance between plural (here, four) marks, provided on the flexible recording medium, to serve as means for detecting an expanded/contracted state of the recording medium, is measured by measuring means such as using a camera or the like.

[0121] Further, in this image rendering method, the value of the measured distance between the marks in the tension-applied state is compared with the value of the distance between the marks in the preset reference state; the longitudinal/lateral expansion/contraction factors of the flexible recording medium in the tension-applied state is determined; data processing to cause a rendered pattern to be deformed in accordance with the longitudinal/lateral expansion/contraction factors is performed; and subsequently, image rendering is carried out so that appropriate rendering is carried out with high accuracy, while at the same time the elongate recording medium can be stably conveyed in a state in which an appropriate tension is applied thereto.

[122] Further, in this image rendering method, it may also be arranged that marks are formed on the flexible recording medium by exposure means or the like in a state of tension-applied for stable conveyance of the recording medium; the value of the distance between marks is then measured in a reference state in which the tension for stable conveyance of the recording medium is released; an expansion/contraction factor

of the flexible recording medium is determined from the difference between the measured distance between the marks and the dimension when the marks were formed; and an exposed pattern is deformed accordingly.

[0123] Further, in this image rendering method, use may be made of a method for determining the quantity of longitudinal/lateral deformation from the distance between marks provided as two crosses when determining the expansion/contraction factor of the flexible recording medium or a method for calculating an expansion/contraction factor from a quantity of deformation determined from the distance between marks provided two longitudinal or lateral points, and the Poisson's ratio of the material of the recording medium.

[0124] Next, referring to a flow chart shown in Fig.7, description will be made of means for rendering an image with the above-mentioned rendering apparatus shown in Figs. 1 to 5 using an elongated flexible recording medium provided with means for detection of the expanded/contracted state of the recording medium.

[0125] In the present rendering apparatus, when starting an image rendering process, the operator previously measures the positional information (such as the distance between the marks 25) of the respective marks 25 in a state in which no tension is applied to the flexible printed circuit board material 28, and stores the obtained positional information of the marks 25 (such as the distance between the marks 25) in a memory of the control unit 58 by means of an unillustrated input device (ST1).

Meanwhile, the positional information of the respective marks 25 which is inputted to the control unit 58 may be any type of information which can specify the distance between the marks 25 or the position of each mark 25.

[0126] In this rendering apparatus, the unexposed elongated flexible printed circuit board material 28 provided with means for detecting an expanded/contracted state thereof is drawn out from the supply reel 60, and passed through the dancer roller mechanism serving as tension setting means, fed into the conveyance path through the detection unit 46 and the exposure head unit 48, passed through the other dancer roller mechanism serving as tension setting means, and then taken up by the take-up reel 70 (ST2). The flexible printed circuit board material 28 thus set is in a state that is

elastically deformed due to a predetermined tension being applied thereto by the dancer roller mechanism serving as tension setting means.

[0127] In this rendering apparatus, in a state in which the flexible printed circuit board material 28 is elastically deformed as mentioned above (conveying state), each mark 25 is photographed by the camera portion 52, and thus the positional information of each mark (such as the distance between the marks 25) is detected (ST3).

Meanwhile, in this image rendering apparatus, the structure can be simplified since the camera 52 is used also as means for detecting the marks 25.

[0128] Further, the control unit 58 is structured such that the positional information of each mark 25 (such as the distance between the marks 25) in a state in which no tension is applied, which is stored in the memory of the control unit 58, is read out and compared with the positional information of each mark 25 (such as the distance between the marks 25) which is detected in a state in which the substrate material is elastically deformed; expansion/contraction factors for the elastically deformed state caused by applying a tension to the flexible printed circuit board material 28 (longitudinal/lateral expansion/contraction factors in a tension-applied state) is determined based on the result of the comparison; the expansion/contraction factors are stored in the storage portion (memory) of the control unit 58; and the expansion/contraction factors are set as expansion/contraction factors for the flexible printed circuit board material 28 wound on the take-up reel 70 (ST4).

[0129] In this image rendering apparatus, the expansion/contraction factors obtained as above are applied to the entire flexible printed circuit board material 28. Thus, in the control unit 58, data processing is performed such that the exposure pattern of all images rendered on the flexible printed circuit board material 28 is deformed on the basis of the expansion/contraction factors determined as above, and a rendering pattern, subjected to deformation processing so as to offset the deformation caused due to the applied tension, is stored in the storage portion (memory) of the control unit 58.

[0130] Meanwhile, it is also possible that an expansion/contraction factor may be measured for each image or each type of image to be rendered on the flexible printed circuit board material 28, and data processing may be performed such that an exposure

pattern is deformed based on the result of the measurement so that a rendering pattern subjected to the deforming process is exposure-processed. Further, it is also possible that an expansion/contraction factor may be sought for each of predetermined zones.

[0131] Further, in this image rendering apparatus, an operation for exposure-processing each rendering pattern subjected to a deforming process, so as to offset the deformation caused in a tension-applied state, is performed by the exposure head unit 48 with respect to the flexible printed circuit board material 28 (ST6).

[0132] Next, description will be made of the operation and effect of the image rendering apparatus structured as above.

[0133] In this image rendering apparatus, a calibration process for the camera portion 52 and calibration of the exposure position and the power distribution in the exposure area for each head assembly 54 are performed before the exposing process is started. Meanwhile, it is also possible that the calibration process for the camera portion 52 and calibration of the exposure position and the power distribution in the exposure area for each head assembly 54 may be performed as required.

[0134] Next, in this image rendering apparatus, the flexible printed circuit board material 28 to be exposure-processed is set on the conveyance path extending from the unexposed recording medium feed section 14 to the exposed recording medium retrieving section 16 via the exposure processing section 12. To this end, the flexible printed circuit board material, or the recording medium, is unwound from the supply reel 60, extended on the conveyance path leading to the exposed recording medium retrieving section 16 via the exposure processing section 12, and fixed at the fore end to the take-up reel 70.

[0135] Thereafter, in the rendering apparatus, the flexible printed circuit board material 28 set on the conveyance path is slackened between the outlet side roller 66 on the supply reel 60 side and the inlet guide roller 38 on the exposure processing section 12 side, and the supply reel 60 is rotatively driven until it is detected that the slack in which the recording medium becomes equal to a predetermined upper slackness quantity (the upper limit slack value), and the dancer roller 68 is set at the sagging portion of the recording medium. Thereafter, adjustment is made such that when it is

detected that the slack becomes equal to the lower limit value of slackness (a state in which the substrate material is of minimum slackness), the supply reel 60 is rotated until it is detected that the slack has become equal to the upper limit value.

[0136] Next, in this rendering apparatus, the nip driving roller pair 32 is rotatively driven until it is detected that the slack in which the recording medium is least slackened between the retaining roller 76 on the outlet side of the conveyance path of the exposure processing section 12 and the roller 78 on the inlet side of the exposed recording medium retrieving section 16 has become equal to the predetermined quantity (the lower limit slack value), and the dancer roller 68 is set at the sagging portion of the recording medium. Thereafter, adjustment is made such that when it is detected that the slack has become equal to the upper limit slack value (a state in which the recording medium is most slack), the take-up reel 70 is rotatively driven until it is detected that the slack has become equal to the lower limit slack value.

[0137] Next, in this rendering apparatus, while the flexible printed circuit board material 28 is being conveyed by the nip driving roller pair 32 being rotatively driven, the surface of the flexible printed circuit board material 28 is photographed at predetermined intervals by the camera portion 52, and when an exposure starting position mark provided on the flexible printed circuit board material 28 is photographed (detected), the nip driving roller pair 32 is stopped so as to be placed in a waiting state.

[0138] Next, in this image rendering apparatus, the nip driving roller pair 32 is rotated, and when a predetermined quantity of the flexible printed circuit board material 28 is conveyed, the marks 25 in the unit exposure area L provided on the flexible printed circuit board material 28 at a prior operational step are photographed, and the position of the marks 25 in the unit exposure area L is measured. Meanwhile, the measurement of the mark position in the unit exposure area L is preferably made with respect to two or more positions in the unit exposure area L (preferably four or more positions around the unit exposure area L) in the conveying direction of the flexible printed circuit board material 28 as shown in Fig. 6.

[0139] Next, the control unit 58 reads out the rendering pattern subjected to the

deforming process so as to offset the deformation due to tension and which is stored in the storage portion (memory) and is now to be subjected to an exposing process.

[0140] Next, when the measurement of the mark position in the unit exposure area L is finished, the control unit 58 makes preparations for the exposing process by performing a process for image recording position correction (alignment such as exposure starting time correction) for the rendering pattern subjected to the deforming process so as to offset the deformation due to the tension, based on the measured value of the mark positions in the unit exposure area L. Meanwhile, in this image rendering apparatus, since time is taken to perform data processing of the rendering pattern by the control unit 58 such that the deformation due to the tension is offset, the rendering pattern subjected to the deforming process is prepared, such that the deformation due to the tension is offset, by performing such data processing in advance prior to the exposing process. Further, the control unit 58 operates such that correction for alignment registration which can be data-processed in a relatively short period of time is carried out with respect to the previously prepared rendering pattern subjected to the deforming process so as to offset the deformation due to the tension so that the exposing process can be performed with the appropriately corrected rendering pattern. Thus, in this rendering apparatus, since there is no need when the exposing process is performed, to set aside as waiting time the time taken for performing data processing in order to produce a rendering process that offsets the deformation due to the tension, the entire exposing process can be rationally performed, and thus an increased productivity can be achieved.

[0141] Next, the control unit 58 operates such that when the leading one of the unit exposure areas L is conveyed to the position of the exposure head unit 48, exposure of the two-dimensional rendering pattern, corrected so as to register with the alignment and with the rendering pattern subjected to the deforming process so as to offset the deformation due to the tension, is started with respect to the flexible printed circuit board material 28 by each head assembly 54 and when the rear end of this unit exposure area L arrives at a predetermined position past the exposure head unit 48, the exposing process for this unit exposure area L is stopped.

[0142] In this exposing process, each head assembly 54 irradiates laser light to the DMD based on the exposure data corrected so as to offset the deformation due to the tension and register alignment, and when the micromirror of the DMD is turned on, reflected laser light is caused to pass through an optical path set by an optical system so as to be focused on the flexible printed circuit board material 28.

[0143] In this image rendering apparatus, the aforementioned exposing process is continuously performed, and when the unit exposure areas L are exposed a pre-specified number of times, the nip driving roller 32 is stopped so that the exposing process is finished.

[0144] As mentioned above, in this rendering apparatus, the flexible printed circuit board material 28 is placed on and along the endless belt 33 of the belt conveyor mechanism, which is entrained between the nip roller pair 30 and the nip driving roller pair 32, and continuously conveyed integrally with the endless belt 33 by the nip driving roller pair 32 being rotated at a constant speed. In this manner, laser-exposure is continuously performed by the head assembly 54 with respect to that portion of the flexible printed circuit board material 28 which is spanned between the nip roller pair 30 and the nip driving roller 32 through the endless belt 33, so that an image is rendered thereon. Thus, as compared with a structure in which an alignment adjustment process is performed when a recording medium is conveyed outward and an exposing process is performed when the recording medium is conveyed inward, this rendering apparatus can achieve increased productivity since the exposing process can be performed continuously at all times.

[0145] Further, the rendering apparatus according to this embodiment may be structured such that the structure for causing the flexible printed circuit board material 28 to be suctioned to the endless belt 33 (such as the suction box 35, the suctioning apertures formed in the endless belt 33, the blower 37, etc.) is eliminated and the endless belt 33 is also eliminated so that exposure is performed while the flexible printed circuit board material 28 alone is being conveyed in a state in which a predetermined tension is applied thereto.

[0146] Meanwhile, although in this embodiment, a DMD is used as a spatial

modulation element to be used in the head assembly of the exposure head unit 48 structured as a laser exposure device and a dot pattern is generated by turning on and off the DMD with the lighting time kept constant, it is also possible that pulse width modulation may be effected through control of the on-time ratio (duty). Alternatively, a dot-pattern may be generated in accordance with the number of times of illumination by making each lighting time extremely short.

[0147] Further, although in the present embodiment, a head assembly including a DMD (reflective type spatial light modulating element) as a spatial light modulating element has been described, it is also possible that in lieu of the DMD, for example, use may be made of a MEMS (Micro Electro Mechanical Systems) type spatial light modulating element (SLM), a transmissive type spatial light modulating element (LCD), an optical element that modulates transmitted light by an electro-optical effect (PLZT element), and a spatial light modulating element of another type other than the MEMS type, such as a liquid crystal shutter array of a liquid crystal optical shutter (FLC) or the like. Further, use may be made of a two-dimensional structure in which plural grating light valves (GLVs) are arrayed. In a structure using the above reflective type spatial light modulating element (GLV) or the above transmissive type spatial light modulating element (LCD), a lamp or the like may be used as the light source in place of the aforementioned laser.

[0148] Further, as the light source of this embodiment, use may be made of a fiber array light source including plural multiplexed laser light sources, a fiber array light source formed by an array of fiber light sources each including a single optical fiber that outputs laser light inputted from a single semiconductor laser having a single light emitting point (for example, an LD array, an organic EL array, and etc.) or the like.

[0149] The present rendering apparatus may be structured such that a laser exposure device is employed in which an exposing process is performed in a line manner using a polygon mirror or the like, for example.

[0150] Further, the present rendering apparatus may use any photon mode photosensitive material that is directly recorded with information due to exposure or heat mode photosensitive material that is recorded with information due to heat

resulting from exposure. When a photon mode photosensitive material is used, a GaN system semiconductor laser, a wavelength converting solid later or the like is used as the laser device, while when a heat mode photosensitive material is used, an AlGaAs system semiconductor laser (infrared laser) or a solid laser is used as the laser device.

[0151] Further, although in the above-mentioned embodiment, it has been structured such that the flexible printed circuit board material 28 spanned between the nip roller pair 30 and the nip driving roller pair 32 is held under a constant tension by the dancer roller mechanism to serve as tension setting means which is located at an upstream side of the conveying direction of the nip roller pair 30 and the dancer roller mechanism to serve as tension setting means which is located at a downstream side of the conveying direction of the nip driving roller pair 32, the tension setting means to be used herein may be structures such that one nip roller pair and another nip roller pair are rotatively driven at different speeds so that a constant tension is applied. Alternatively, the tension setting means may be structured such that a nip roller pair is braked with a predetermined braking force and a nip driving roller pair is rotatively driven so that a predetermined tension is applied.

[0152] Meanwhile, the present invention is as equally applicable to a display substrate as to the flexible printed circuit board material 28 in the form of an elongate band-like flexible recording medium. Further, the present invention is by no means limited to the above-described embodiment, and other various structures can be adopted without departing from the spirit and scope of the present invention.

CLAIMS:

1. An elongated flexible recording medium comprising a feature for detection of an expanded/contracted state of the recording medium, the feature for detection being structured such that marks are provided in at least one portion in a conveying direction and at at least two positions spaced apart from each other in at least one of the conveying direction and/or a direction perpendicular to the conveying direction and a distance between positions of the marks when the recording medium is placed in a reference state is established.

2. An image rendering method in which an image can be rendered on a flexible recording medium by correcting for an expanded/contracted state of the recording medium, the method comprising:

detecting at least two marks serving as a feature for detection in a state in which the flexible recording medium is tensioned for conveying and image rendering purposes, the marks being provided on the flexible recording medium placed in a reference state and spaced apart from each other with a predetermined spacing in at least one of a conveying direction and/or a direction perpendicular to the conveying direction;

comparing a distance value between the marks measured when the flexible recording medium is tensioned and a distance value between the marks in the reference state thereby determining longitudinal and/or lateral expansion/contraction factors when the flexible recording medium is in a tensioned state; and

rendering an image in accordance with a rendering pattern subjected to a deforming process so as to offset a deformation of the flexible recording medium due to the tension based on the longitudinal and/or lateral expansion/contraction factors.

3. An image rendering method in which an image can be rendered on a flexible recording medium by correcting for an expanded/contracted state of the recording medium, the method comprising:

providing marks, to serve as a feature for detection of an expanded/contracted state of an elongated flexible recording medium, on the elongated flexible recording

medium placed in a reference state and at at least two positions spaced apart from each other with a predetermined spacing in one of a conveying direction and/or a direction perpendicular to the conveying direction such that a distance between the mark positions is established;

detecting the at least two marks, provided on the elongated flexible recording medium placed in the reference state and spaced apart from each other in at least one of the conveying direction and/or the direction perpendicular to the conveying direction, in a state in which the flexible recording medium is tensioned for conveying and image rendering purposes; and

comparing a distance value between the marks measured when the flexible recording medium is in an tensioned state and a distance value between the marks when the flexible recording medium is placed in the reference state thereby determining longitudinal and or lateral expansion/contraction factors when the flexible recording medium is in a tensioned state, and rendering an image in accordance with a rendering pattern subjected to a deforming process so as to offset a deformation of the flexible recording medium due to the tension based on the longitudinal and/or lateral expansion/contraction factors.

4. An image rendering method in which an image can be rendered on a flexible recording medium by correcting for an expanded/contracted state of the recording medium, the method comprising:

detecting when the flexible recording medium is placed in a reference state at least two marks provided on a flexible recording medium in a state in which the flexible recording medium is tensioned for conveying and image rendering purposes and spaced apart from each other with a predetermined spacing in at least one of a conveying direction and/or a direction perpendicular to the conveying direction;

comparing a predetermined distance value between the marks when the marks are formed in the state in which the flexible recording medium is tensioned with a distance value between the marks measured when the flexible recording medium is placed in the reference state thereby determining longitudinal and/or lateral expansion/contraction factors in a state in which the flexible recording medium is tensioned, and rendering an

image in accordance with a rendering pattern subjected to a deforming process so as to offset a deformation of the flexible recording medium due to the tension based on the longitudinal and/or lateral expansion/contraction factors.

5. An image rendering method in which an image can be rendered on a flexible recording medium by correcting for an expanded/contracted state of the recording medium, the method comprising:

providing at least two marks on an elongated flexible recording medium which is tensioned when conveyed for image rendering purposes, the marks being spaced apart from each other with a predetermined spacing in at least one of a conveying direction and/or a direction perpendicular to the conveying direction;

detecting in a state in which the flexible recording medium is placed in a reference state the at least two marks provided on the elongated flexible recording medium in a state in which the elongated flexible recording medium is tensioned for conveying and image rendering purposes and spaced apart from each other with the predetermined spacing in at least one of the conveying direction and/or the direction perpendicular to the conveying direction; and

comparing a predetermined distance value between the marks when the marks are formed in the state in which the flexible recording medium is tensioned with a distance value between the marks measured when the flexible recording medium is placed in the reference state, thereby determining longitudinal and/or lateral expansion/contraction factors in a state in which the flexible recording medium is tensioned, and rendering an image in accordance with a rendering pattern subjected to a deforming process so as to offset a deformation of the flexible recording medium due to the tension based on the longitudinal and/or lateral expansion/contraction factors.

6. An image rendering method according to claim 2, wherein the image rendering comprises comparing a measured distance value between the marks in a state in which the recording medium is tensioned with a distance value between the marks in a state in which the recording medium is placed in the reference state thereby determining longitudinal and/or lateral expansion/contraction factors when the flexible recording

medium is in a tensioned state; applying an alignment registration process based on an alignment mark of each exposure area to a rendering pattern subjected to a deforming process so as to offset a deformation of the recording medium due to the tension based on the longitudinal and/or lateral expansion/contraction factors, thereby offsetting the deformation due to the tension; and rendering an image in accordance with the rendering pattern subjected to the alignment registration.

7. A rendering method according to claim 2, wherein the rendering comprises comparing a measured distance value between the marks in a state in which the recording medium is tensioned with a distance value between the marks in a state in which the recording medium is placed in the reference state, thereby determining longitudinal and/or lateral expansion/contraction factors of the recording medium when the recording medium is tensioned; and rendering an image in accordance with the rendering pattern subjected to a deforming process so as to offset a deformation of the recording medium due to the tension based on the longitudinal and/or lateral expansion/contraction factors with respect to at least two types of the rendering pattern.

8. An image rendering apparatus comprising:

a conveyance path for conveying an elongated flexible recording medium comprising marks provided on at least one portion of the recording medium in a conveying direction and at least two positions spaced apart from each other in at least one of the conveying direction and a direction perpendicular to the conveying direction, wherein a distance between the marks when the recording medium is placed in a reference state is established;

a tension setting unit for tensioning the elongated flexible recording medium on the conveyance path;

a mark detecting unit that detects a distance between the marks on the elongated flexible recording medium which is tensioned to be conveyed on the conveyance path;

a control unit that compares the distance value between the marks detected by the mark detecting unit in a state in which the recording medium is tensioned with the distance value between the marks established in the reference state, determines

longitudinal and/or lateral expansion/contraction factors of the flexible recording medium when the recording medium is tensioned, and generates an image rendering pattern subjected to a deforming process so as to offset a deformation of the recording medium due to the tension based on the longitudinal and/or lateral expansion/contraction factors; and

an image rendering unit that renders an image in accordance with the image rendering pattern generated in the control unit.

9. The image rendering apparatus according to claim 8, wherein the marks are substituted by alignment marks which are provided for exposure regions of the elongated flexible recording medium.

10. The image rendering apparatus according to claim 9, wherein the control unit determines the expansion/contraction factor for a pattern in a given exposure region using a result obtained by measuring alignment marks provided for an exposure region preceding the given region by at least one pattern.

11. The image rendering apparatus according to claim 9, wherein the mark detecting unit detects the alignment marks for a plurality of exposure regions, and the control unit applies an alignment registration process based on the alignment marks for each exposure region to the rendering pattern which has been subjected to the deforming process, thereby preparing the rendering pattern for each exposure region.

12. The image rendering apparatus according to claim 8, wherein the marks each comprises a via hole.

13. The image rendering apparatus according to claim 8, wherein the marks are provided on a portion of the elongated flexible recording medium which is near the leading exposure region in the conveying direction.

14. The image rendering apparatus according to claim 9, wherein the marks are

provided on a portion of the elongated flexible recording medium which is near the leading exposure region in the conveying direction.

15. The image rendering apparatus according to claim 10, wherein the marks are provided on a portion of the elongated flexible recording medium which is near the leading exposure region in the conveying direction.

16. The image rendering apparatus according to claim 11, wherein the marks are provided on a portion of the elongated flexible recording medium which is near the leading exposure region in the conveying direction.

17. The image rendering apparatus according to claim 12, wherein the marks are provided on a portion of the elongated flexible recording medium which is near the leading exposure region in the conveying direction.

18. The image rendering apparatus according to claim 8, wherein the rendering unit comprises a laser exposure device.

19. The rendering apparatus according to claim 8, wherein the rendering unit is structured such that a light beam is modulated by a spatial modulating element and a two-dimensional pattern is exposure-processed.

FIG.1

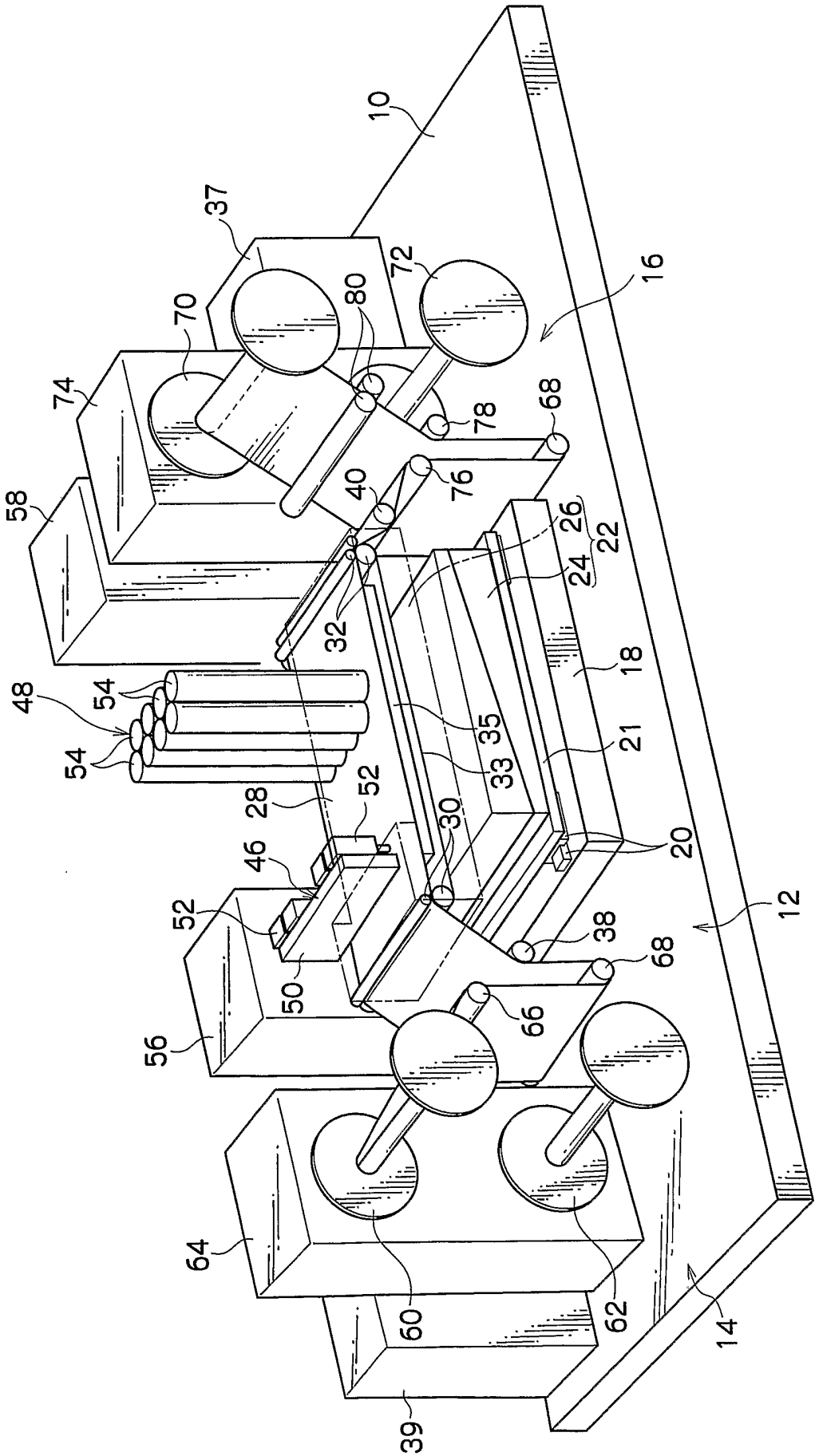


FIG.2

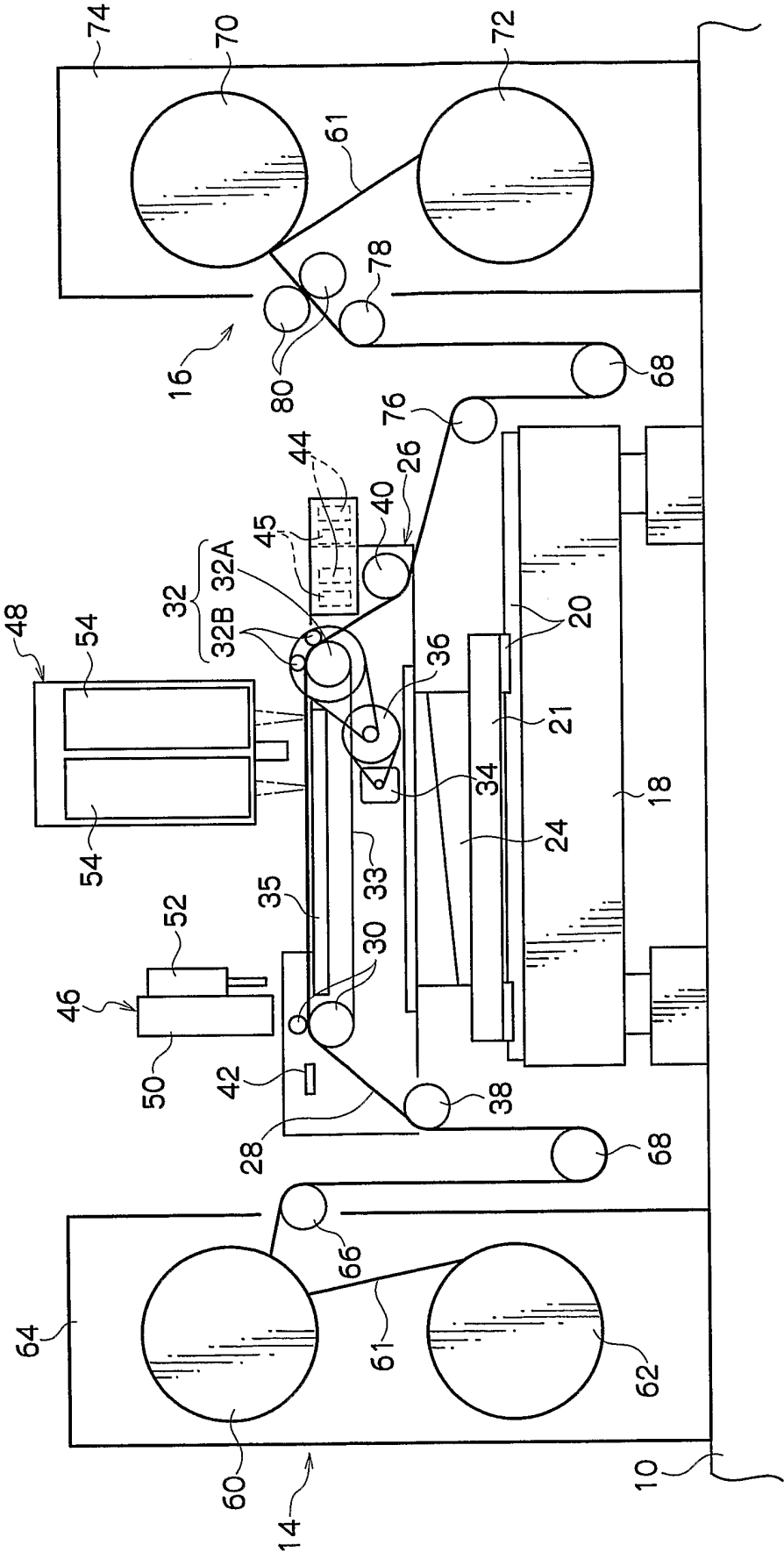


FIG.3

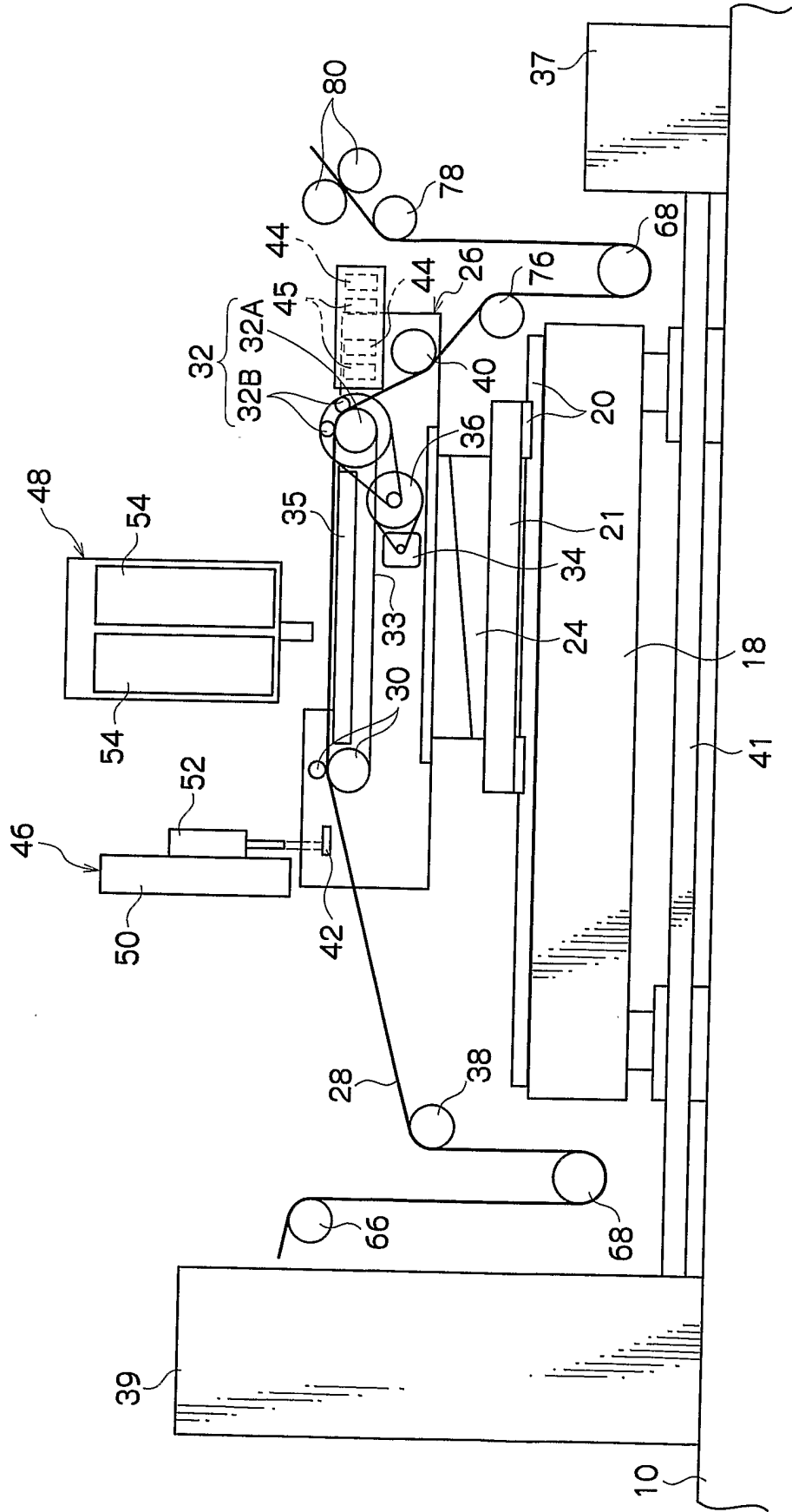


FIG.4

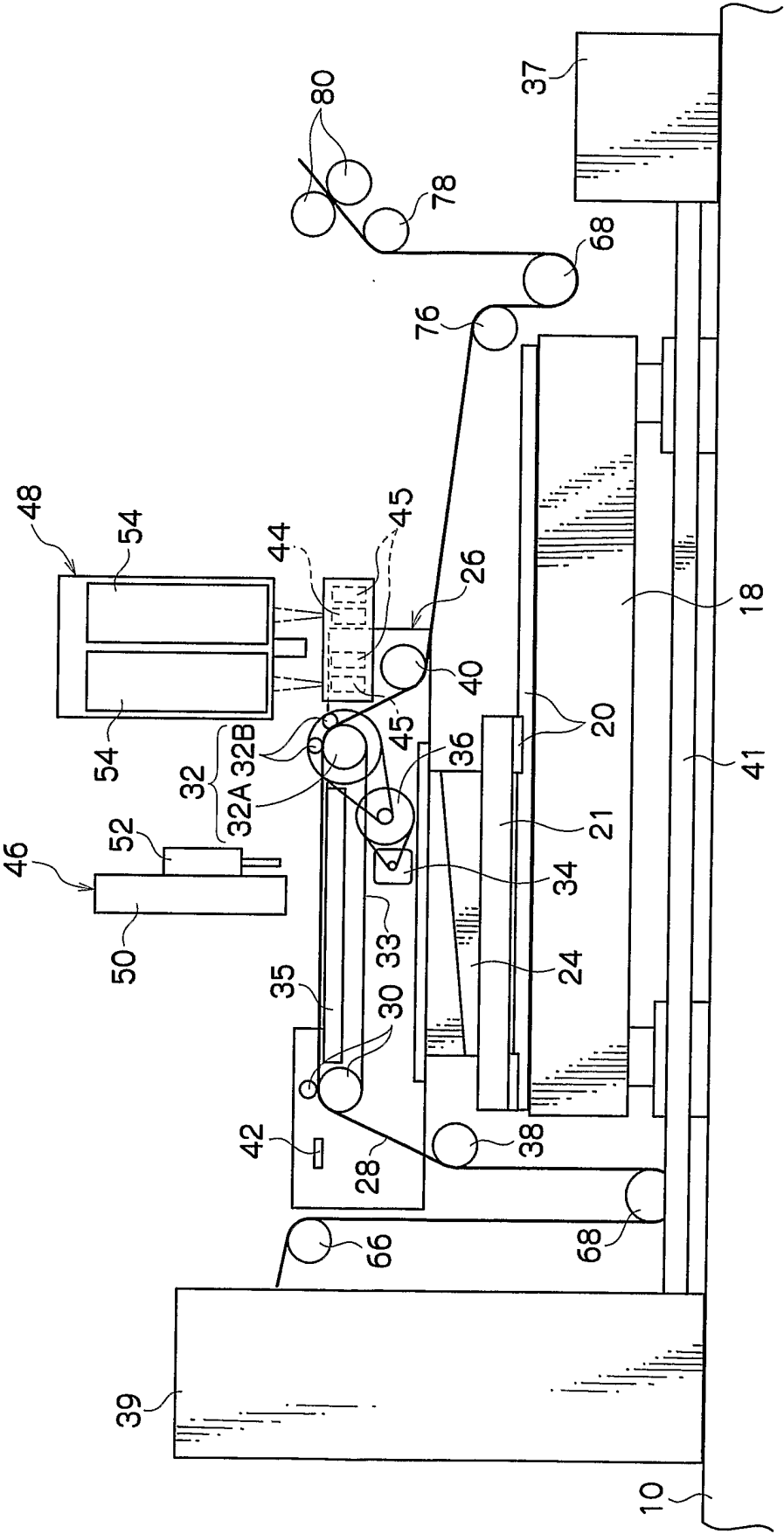


FIG. 5

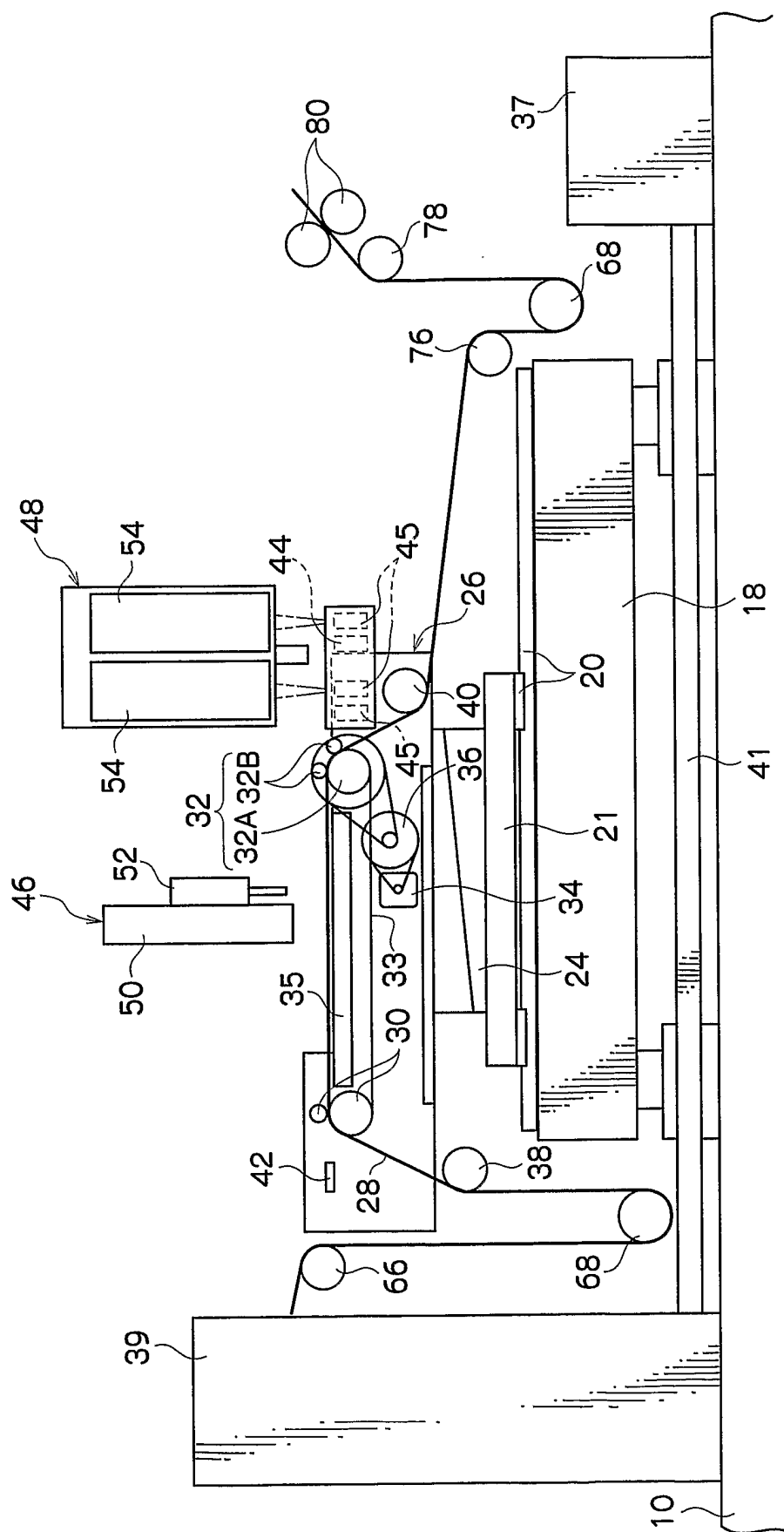


FIG.6

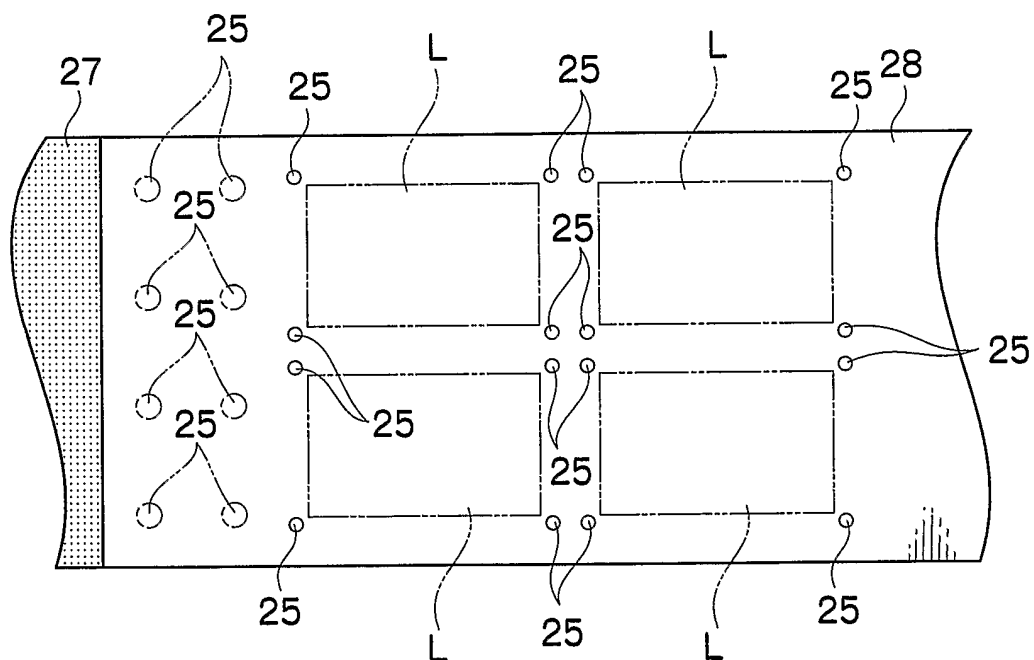
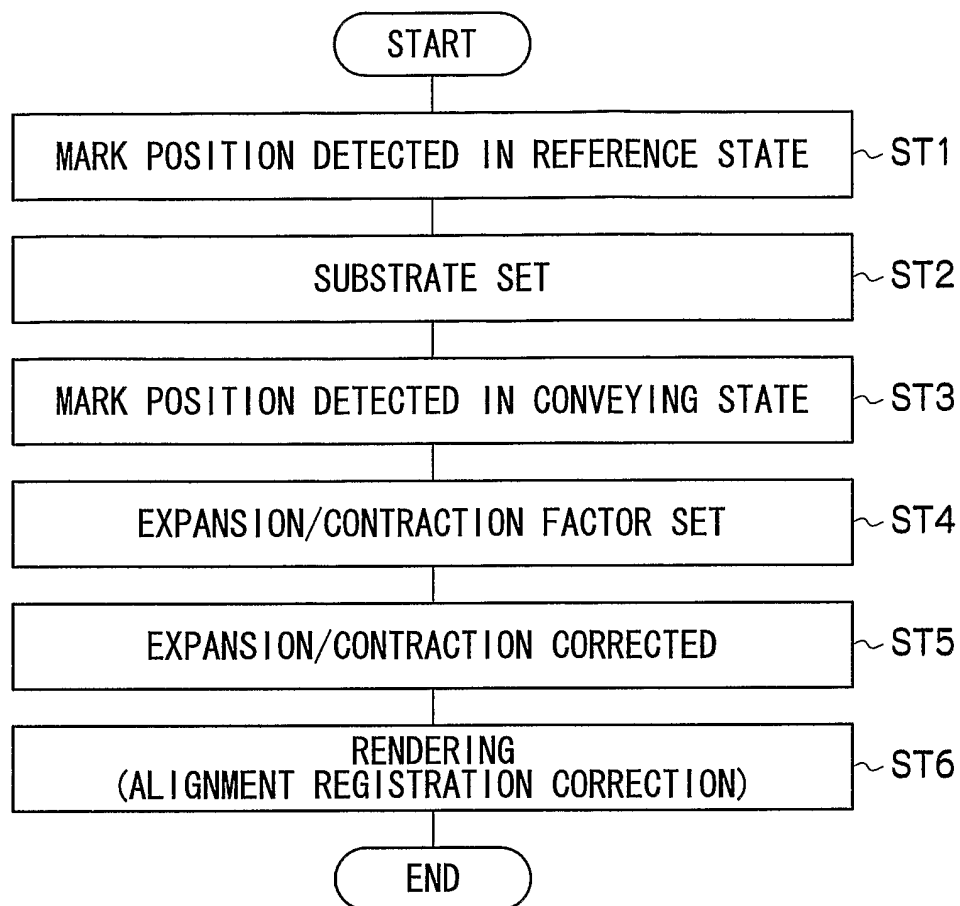


FIG.7



INTERNATIONAL SEARCH REPORT

International Application No
JP2005/018501

A. CLASSIFICATION OF SUBJECT MATTER B41J11/00 B41J2/44 B41J2/455		
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) B41J		
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) EPO-Internal, PAJ, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 012, no. 031 (M-663), 29 January 1988 (1988-01-29) & JP 62 184871 A (OLYMPUS OPTICAL CO LTD), 13 August 1987 (1987-08-13) abstract	1
X	US 6 375 296 B1 (MCGARRY MARK ET AL) 23 April 2002 (2002-04-23) column 4, line 43 - column 5, line 17; figure 2	1
A	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 11, 3 January 2001 (2001-01-03) & JP 2000 235267 A (ASAHI OPTICAL CO LTD), 29 August 2000 (2000-08-29) cited in the application abstract	1-19
☐ Further documents are listed in the continuation of box C. ☒ Patent family members are listed in annex.		
* Special categories of cited documents : *A* document defining the general state of the art which is not considered to be of particular relevance *E* earlier document but published on or after the international filing date *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) *O* document referring to an oral disclosure, use, exhibition or other means *P* document published prior to the international filing date but later than the priority date claimed *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. *G* document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
13 December 2005		23/12/2005
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer Axters, M

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
/JP2005/018501

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
JP 62184871	A	13-08-1987	NONE	
US 6375296	B1	23-04-2002	MX PA02001833 A	23-01-2003
JP 2000235267	A	29-08-2000	NONE	