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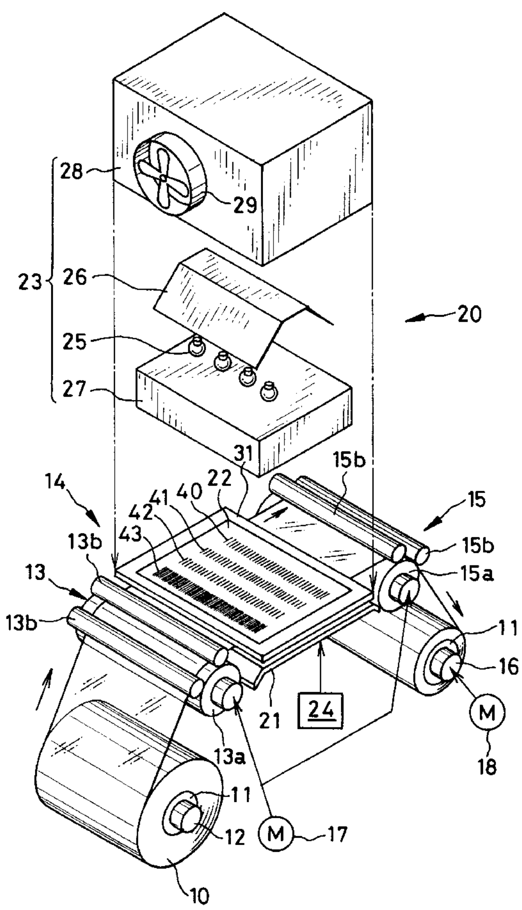
(54) Exposure mask for producing color filter, and method and apparatus for producing color filter

(57) A color filter (49, 55) has blue, green and red pixel patterns (50-52, 56-58) and a black matrix (53, 59). To produce the color filter from silver halide photosensitive film (10), an exposure mask (22, 83) is used. The exposure mask includes a first group (40, 90) of light-transmitting slits adapted to exposure of the blue pixel pattern. A second group (41, 91) of light-transmitting slits are adapted to exposure of the green pixel pattern. A third group (42, 92) of light-transmitting slits are adapted to exposure of the red pixel pattern. A fourth group (43, 93) of light-transmitting slits are adapted to exposure of the black matrix. First to third auxiliary filters (36, 45-47) respectively cover the first to third groups of the light-transmitting slits.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an exposure mask for producing a color filter, and a method and apparatus for producing the color filter. More particularly, the present invention relates to an exposure mask for optically producing a color filter by use of photosensitive material, and a method and apparatus for producing the color filter.

2. Description Related to the Prior Art

A color filter is used in forms of a color face plate for display of Braun tube or cathode-ray tube (CRT), a photoelectric conversion element plate for photocopying, a filter for a single-tube type of color television camera, a flat panel display for use with a liquid crystal display (LCD) device, a color solid-state pickup element, and the like. In general, a color filter includes segments of three primary colors, red (R), green (G) and blue (B). Known color filters include segments of four or more colors. For example black is used in addition for various purposes in a form of a black matrix, typically in color filters for an image pickup tube or a liquid crystal display (LCD) device.

Known methods of producing a color filter are a deposition method, a dye deposition method, an electrodeposition method, a printing method, a pigment dispersion method, a resist electrodeposition/transfer method and the like. In any of the methods, a color stripe pattern of each single color is formed, and similar operation is repeated for a number of times until color stripe patterns of all the required colors are formed. For example a process according to the pigment dispersion method or etching method consists of a repetition of a cycle, which includes application of a coating of resist or pigment-dispersed solution, exposure, development, removable of the resist, post-hardening and the like.

There are various known methods for producing a color filter from silver halide color photosensitive material. Among those, JP-A 55-6342 discloses a processing method for a coupler-in-developer type of photosensitive film. JP-A 62-148952 and 62-71950 disclose a processing method for a coupler-in-emulsion type of color photosensitive film. JP-A 63-261361 discloses silver halide color photosensitive material suitable for a color filter and improved in color reproduction. Also for producing a color filter, there is a suggestion of silver halide color photosensitive material in which a fourth silver halide emulsion layer includes coupler for color compensation to reproduce black with high quality, for the purpose of raising light-shielding performance of a black matrix. With the silver halide color photosensitive material used, a multi-color filter can be obtained with great ease inclusive of a black matrix.

The use of a laser printer is known as a method of exposing silver halide photosensitive material by scanning a laser beam. It is easy with the laser printer to produce a color filter with an area equal to or smaller than 150 x 150 mm. If a color filter with an area equal to or larger than 300 x 300 mm is desired, there occur various problem in the use of the laser printer. Precision in peripheral portions is low. Excessively long time is required for effecting an exposure, and inconsistent to improving efficiency.

SUMMARY OF THE INVENTION

In view of the foregoing problems, an object of the present invention is to provide an exposure mask for producing a color filter, and a method and apparatus for producing the color filter, with which precision in the production is heightened, and the efficiency in the production is improved.

In order to achieve the above and other objects and advantages of this invention, an exposure mask for producing a color filter from silver halide photosensitive material, the color filter having blue, green and red pixel patterns and a black matrix, is characterized by:

- a first group of light-transmitting regions for exposing the blue pixel pattern;
- a second group of light-transmitting regions for exposing the green pixel pattern;
- a third group of light-transmitting regions for exposing the red pixel pattern;
- a fourth group of light-transmitting regions for exposing the black matrix; and
- first to third auxiliary filters respectively disposed to cover the first to third groups of the light-transmitting regions.

In the present invention, a method of producing a color filter from silver halide photosensitive material, the color filter having blue, green and red pixel patterns and a black matrix, is characterized by comprising steps of:

- moving an exposure mask and silver halide photosensitive material in a manner relative to each other, the exposure mask including first to fourth groups of light-transmitting regions, respectively for exposing the blue, green and red pixel patterns and the black matrix, and first to third auxiliary filters respectively disposed to cover the first to third groups of the light-transmitting regions, the relative moving being crosswise to a serial direction in which the light-transmitting regions are arranged in each of the first to third groups; and
- illuminating the photosensitive material through the exposure mask to form the blue, green and red pixel patterns and the black matrix.

Furthermore in the present invention, an apparatus for producing a color filter from silver halide photosensitive material, the color filter having blue, green and red pixel patterns and a black matrix, is characterized by:

an exposure mask, including:

(A) first to fourth groups of light-transmitting regions, respectively for exposing the blue, green and red pixel patterns and the black matrix, the light-transmitting regions being respectively extended in one longitudinal direction, and arranged in plural arrays respectively associated with the first to fourth groups, the arrays being oriented crosswise to the longitudinal direction; and
(B) first to third auxiliary filters respectively disposed to cover the first to third groups of the light-transmitting regions;

an exposure unit for forming the blue, green and red pixel patterns and the black matrix on the photosensitive material by illumination through the exposure mask; and
a conveyor for continuously conveying the photosensitive material to the exposure unit in the longitudinal direction of the light-transmitting regions.

Moreover according to the present invention, an apparatus for producing a color filter from silver halide photosensitive material, the color filter having blue, green and red pixel patterns and a black matrix, is characterized by:

an exposure mask, including:

(A) first to fourth groups of light-transmitting regions, respectively for exposing the blue, green and red pixel patterns and the black matrix, the light-transmitting regions being respectively extended in one longitudinal direction, and arranged in plural arrays respectively associated with the first to fourth groups, the arrays being oriented crosswise to the longitudinal direction; and
(B) first to third auxiliary filters respectively disposed to cover the first to third groups of the light-transmitting regions;

a conveyor for intermittently conveying the photosensitive material;
an exposure unit for forming the blue, green and red pixel patterns and the black matrix on the photosensitive material by illumination through the exposure mask;
a shifter for shifting the exposure unit and the conveyor in a manner relative to each other; and
a controller for causing the shifter to shift the exposure unit and the conveyor in a manner relative to each other after the conveyor intermittently conveys the photosensitive material, the controller causing the exposure unit to form the blue, green and red pixel patterns and the black matrix on an unexposed region of the photosensitive material during the relative shifting, the controller causing the conveyor to convey the photosensitive material intermittently to supply the shifter with an unexposed region thereof.

Consequently in the present invention, precision in the production of a color filter is heightened. The efficiency in the production is improved.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objects and advantages of the present invention will become more apparent from the following detailed description when read in connection with the accompanying drawings, in which:

Fig. 1 is an exploded perspective view illustrating a color filter producing apparatus of the present invention;
Fig. 2 is an exploded perspective view illustrating an exposure unit with photosensitive film;
Fig. 3 is a plan, partially cutaway, illustrating an exposure mask;
Fig. 4 is a perspective illustrating a color filter or exposed photosensitive film;
Fig. 5 is a top plan illustrating another preferred color filter producing apparatus;
Fig. 6 is a vertical section taken on line VI-VI illustrating the color filter producing apparatus;
Fig. 7 is a perspective illustrating a color filter or exposed photosensitive film; and
Fig. 8 is a perspective illustrating still another preferred color filter producing apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE PRESENT INVENTION

In Fig. 1, an apparatus for producing a color filter is illustrated. Silver halide photosensitive film 10 as photosensitive material is wound about a core 11 in a form of a roll. The core 11 is set on a supply shaft 12. The photosensitive film 10 at the supply shaft 12 is drawn and unwound by conveyor roller sets 13 and 15, and fed to an exposure stage 14. The photosensitive film 10 moved past the exposure stage 14 is wound about another core 11, which is set on a winder shaft 16. The conveyor roller sets 13 and 15 are disposed respectively in positions upstream and downstream from the exposure stage 14. Rotation of a conveyor motor 17 causes the conveyor roller sets 13 and 15 to supply the exposure stage 14 with the photosensitive film 10 at a constant speed. The core 11 is fitted on each of the supply shaft 12 and the winder shaft 16 in a removable manner.

The conveyor roller set 13 is constituted by a drive roller 13a and a nip roller 13b. The conveyor roller set 15 includes a drive roller 15a and a nip roller 15b. The drive rollers 13a and 15a are rotated by the conveyor motor 17. The winder shaft 16 is rotated by a winder motor 18 or torque motor, and winds the photosensitive film 10 about the core 11 of the winder shaft 16.

An exposure unit 20 is disposed on the exposure stage 14, and is constituted by a pressure plate 21, an exposure mask 22 and a light source 23. The pressure plate 21 supports the photosensitive film 10. The pressure plate 21 is shiftable between an exposure position and a retracted position, and when in the exposure position, is pushed by a nip guide mechanism 24 to the exposure mask 22, and when in the retracted position, is moved away from the exposure position. The nip guide mechanism 24 keeps the pressure plate 21 moved down in the retracted position in the course of passage of the photosensitive film 10, and sets the pressure plate 21 in the exposure position in effecting an exposure.

The light source 23 includes halogen lamps 25, a reflector 26, a diffuser box 27, a lamp housing 28 and a cooler fan 29. The light source 23 applies light to each of openings in the exposure mask 22 at a uniform amount of the light. The exposure mask 22 is removably mounted on the exposure stage 14 by a mask mounting frame 31.

In Fig. 2, the exposure mask 22 is constituted by a base plate 35, an auxiliary filter set 36 and a mask plate 37. The base plate 35 consists of a transparent grass plate, and is 1 mm thick. Note that the base plate 35 can have any thickness different from 1 mm in a manner suitable for its purpose.

The mask plate 37 is constituted by a thin plate of chromium steel, and is 2 mm thick. The mask plate 37 has a group of light-transmitting regions or slits 40 for blue pixels, a group of light-transmitting regions or slits 41 for green pixels, a group of light-transmitting regions or slits 42 for red pixels, and a group of light-transmitting regions or slits 43 for a black matrix. As depicted in Fig. 3, the light-transmitting slit group 40 is formed for exposing a stripe pixel pattern of the blue (B) color, and consists of an array of slits which are narrow and long in their common direction. The light-transmitting slit group 41 is formed for exposing a stripe pixel pattern of the green (G) color, and consists of an array of slits. The light-transmitting slit group 42 is formed for exposing a stripe pixel pattern of the red (R) color, and consists of an array of slits. The directions of the arrays of the light-transmitting slit groups 40-42 are in parallel with one another, and vertical to the longitudinal direction of each slit. The slits have a width corresponding to a width of each stripe pixel pattern of the color filter to be produced. The slits are arranged with such deviation of a pitch S1 that, as viewed in the conveying direction of the photosensitive film, none of slits of different colors is in the same position.

The light-transmitting slit group 43 is adapted to expose a black matrix disposed between stripe pixel patterns of the three colors. To raise black density of the black matrix, a slit length of the light-transmitting slit group 43 is two (2) times as great as that of the other light-transmitting slits. Note that the mask plate 37 can have any thickness different from 2 mm in a manner suitable for its purpose. The thickness of the mask plate 37 is greater than a width of the light-transmitting slit groups 40-43. If there is influence of shadows of edges of the light-transmitting slits, it is preferable to facet or round off edges of the light-transmitting slit groups 40-43 on the side nearer to the light source. Moreover, a contact surface of the mask plate 37 in contact with the photosensitive film 10 may be laminated with a protective film or membrane for the purpose of raising lubricity or smoothness in contact with the photosensitive film 10. Such a protective film can preferably have high optical transmittance and small friction of coefficient, so as to reduce possibility in scratching the exposure mask and the photosensitive film.

In Fig. 3, various dimensions related to the light-transmitting slit groups 40-43 are indicated. Each slit of the light-transmitting slit groups 40-42 has a width W1 = 0.37 mm and a length L1 = 5 mm. The slits of the light-transmitting slit groups 40-42, as viewed in the slit width direction, are arranged at a pitch P1 = 1.20 mm. The arrays of the light-transmitting slit groups 40-42 are arranged at a pitch P2 = 70 mm. The deviation between of slits of adjacent two of the arrays of the light-transmitting slit groups 40-42 is at the pitch S1 = 0.40 mm. Each slit of the light-transmitting slit group 43 has a width W2 = 0.05 mm and a length L2 = 10 mm. The slits of the light-transmitting slit group 43, as viewed in the slit width direction, are arranged at a pitch P3 = 0.40 mm. The values of the dimension can be varied according to specifics of the color filter.

In Fig. 2, the auxiliary filter set 36 is disposed between the base plate 35 and the mask plate 37. An auxiliary filter 45 is disposed to cover all of the light-transmitting slit group 40 for the same color. Similarly auxiliary filters 46 and 47 are disposed respectively commonly at the light-transmitting slit groups 41 and 42. The auxiliary filters 45-47 are 2 mm thick. The auxiliary filter 45 is adapted to forming a blue stripe pixel pattern. The auxiliary filter 46 is adapted to forming a green stripe pixel pattern. The auxiliary filter 47 is adapted to forming a red stripe pixel pattern. The auxiliary filters 45-47 are previously produced with a uniform characteristic. If it is remarkably different to produce them as single members, it is possible to produce, combine and arrange a plural number of auxiliary filters which are equal in characteristic. Of course the auxiliary filters can be arranged in such a manner that none of borderlines between them is located inside each of the light-transmitting slits.

In the present embodiment, the auxiliary filter 45 consists of an interference filter characteristically having a peak at 470 nm. The auxiliary filter 46 consists of an interference filter characteristically having a peak at 530 nm. The auxiliary filter 47 consists of an interference filter characteristically having a peak at 650 nm. A transparent film 48 is disposed at the light-transmitting slit group 43 so as to expose the photosensitive film 10 with white light. Note that the auxiliary filters 45-47 and the transparent film 48 may be modified suitably in consideration of a photosensitive characteristic of the photosensitive film 10, and are previously constructed for the purpose of obtaining blue, green and red stripe pixel patterns and a black matrix.

Note that the photosensitive film 10 is reversal photo film or positive photo film. The auxiliary filters 45-47 are translucent plates having the colors of blue, green and red. Alternatively negative photo film may be used as the photosensitive film, for which auxiliary filters may have colors of yellow, magenta and cyan which are complementary to blue, green and red.

In Fig. 1, the exposure mask 22 is secured to the exposure stage 14 by the mask mounting frame 31 in such a manner that a longitudinal direction of the slits is set in the conveying direction of the photosensitive film 10. The mask plate 37 is directly confronted with the photosensitive film as depicted in Fig. 2. Printing light emitted from the light source 23 is passed through the base plate 35, the auxiliary filters 45-47 and the light-transmitting slit groups 40-43 in the mask plate 37, to expose the photosensitive film 10.

The operation of the present embodiment is described now. In Fig. 1, the photosensitive film 10 being unexposed is set at the supply shaft 12. A front end of the photosensitive film 10 is passed through the exposure stage 14, and retained on the core 11 of the winder shaft 16. Before the passage of the front end, the pressure plate 21 of the exposure unit 20 is moved down by the nip guide mechanism 24 and is set in the retracted position. After passing the front end, the nip guide mechanism 24 is moved upwards to keep the photosensitive film 10 in tight contact with the exposure mask 22. The halogen lamps 25 of the light source 23 is turned on before the photosensitive film 10 is conveyed by the conveyor roller sets 13 and 15. Thus latent images of stripe pixel patterns and a black matrix are recorded on the photosensitive film 10 in a manner of stripes extending in the conveying direction. Subsequently the photosensitive film 10 being exposed is developed by a photo film processor known in the art of optical instruments.

In Fig. 4, developed photosensitive film 49 as color filter is illustrated. The developed photosensitive film 49 includes a blue stripe pixel pattern 50, a green stripe pixel pattern 51, a red stripe pixel pattern 52 and a black matrix pattern 53 by way of visible images. The black matrix pattern 53 is located between the stripe pixel patterns 50, 51 and 52. In the present embodiment, the stripe pixel patterns of the three colors respectively have the width W1 = 0.37 mm. Each slit of the light-transmitting slit group 43 has the width W2 = 0.05 mm. The stripe pixel patterns of the three colors are arranged at the pitch (S1) of 0.40 mm. Edge portions of the stripe pixel patterns are subjected to double exposure respectively at a width of 0.01 mm in connection with the black matrix pattern. As a result, the stripe pixel patterns of the three colors respectively have a width 0.35 mm. The black matrix pattern 43 has a width 0.05 mm. Subsequently the developed photosensitive film 49 is cut as one piece of the color filter having a size suitable for a liquid crystal display panel, and secured to it.

In the above embodiment, the photosensitive film 10 is conveyed consecutively as depicted in Fig. 1. The stripe pixel patterns 50-52 and the black matrix pattern 53 are formed to extend in the conveying direction of the developed photosensitive film 49 in Fig. 4. Furthermore an apparatus of Figs. 5 and 6 may be used for exposing the photosensitive film 10 to obtain the developed photosensitive film 49. In Figs. 5 and 6 in contrast, the photosensitive film 10 can be shifted in its width direction crosswise to the conveying direction. In Fig. 7, developed photosensitive film 55, as color filter, comes to have blue, green and red stripe pixel patterns 56, 57 and 58 and a black matrix pattern 59 all extending in the width direction of the developed photosensitive film 55.

In Fig. 5, the exposure apparatus for producing a color filter is constituted of a framework or chassis 60, a photosensitive film conveyor 61, a shifter 62, an exposure unit 63 and a controller 64. See Fig. 6. The chassis 60 has a box shape, and contains the various components.

In Fig. 6, the conveyor 61 includes a supply shaft 65, conveyor rollers 66, 67 and 68 and a winder shaft 69, all of which are supported on lateral plates 70 in respectively rotatable manner. The lateral plates 70 are fixed by stays 71. Guide rollers 72 and 73 guide the photosensitive film 10. The core 11 is fitted on each of the supply shaft 65 and the winder shaft 69. The conveyor rollers 66-68 are rotated by a motor (not shown), intermittently convey the photosensitive film 10 as much as a length to be exposed at one time with an exposure mask 83, and set an unexposed region of the photosensitive film 10 in the exposure stage. The winder shaft 69 is rotated by the winder motor to wind the exposed portion of the photosensitive film 10 about the core 11. A recess 74 is formed in the bottom edge of the lateral plates 70, and allows the bottom edge of the lateral plates 70 to move despite the disposition of the exposure unit 63 when the lateral plates 70 is shifted by the shifter 62.

The shifter 62 is constituted of a guide mechanism 75 and a shifter mechanism 76. The guide mechanism 75 includes a pair of guide rails 77 and guide rollers 78 rotatable in contact with the guide rails 77. The guide rollers 78 support the conveyor 61 in a movable manner on the guide rails 77. The guide rails 77 are disposed in a width direction of the photosensitive film 10.

In Fig. 5, the shifter mechanism 76 includes a motor 80 and endless belts 81 rotated by the motor 80. One portion of the endless belts 81 is fixedly retained on the lateral plates 70. The endless belts 81 are rotated in both forward and backward directions, to shift the conveyor 61 in the width direction of the photosensitive film.

In Fig. 5, the exposure unit 63 is disposed in a path of shift of an unexposed region of the photosensitive film 10 shifted by the shifter 62. In Fig. 6, the exposure unit 63 is constituted by the exposure mask 83, a light source 84, a shutter 85 and a push roller 86. In Fig. 5, the exposure mask 83 includes a group of light-transmitting regions or slits 90 for blue pixels, a group of light-transmitting regions or slits 91 for green pixels, a group of light-transmitting regions or slits 92 for red pixels, and a group of light-transmitting regions or slits 93 for a black matrix. Each of the light-transmitting slit groups 90-93 consists of a group of openings or slits in the same manner as the light-transmitting slit groups 40-43 in the mask plate 37 of Fig. 3. The exposure mask 83 is oriented in such a manner that a longitudinal direction of the slits is set in the shifting direction of the shifter 62.

In Fig. 6, the shutter 85 is disposed between the exposure mask 83 and the light source 84, and shiftable between the light-shielding position and the light-applying position by a shutter drive unit (not shown). The push roller 86, when the photosensitive film 10 is shifted, keeps the photosensitive film 10 in tight contact with the exposure mask 83, and is secured to the chassis 60 by U-shaped brackets 87. The brackets 87 have a U-gap 87a disposed in a conveying path of the photosensitive film 10, so that the photosensitive film 10 being shifted is kept from contacting the brackets 87.

The controller 64 is constituted by a microcomputer known in the art. An unexposed region of the photosensitive film 10 conveyed intermittently by the conveyor 61 is shifted to the exposure unit 63 by the shifter 62 in a crosswise shifting manner. In the crosswise shifting, the exposure unit 63 expose the photosensitive film 10 to create mask patterns. Accordingly the mask patterns are recorded in a form of latent images with the stripe pixel patterns and the black matrix by way of stripes extended in the width direction of the photosensitive film 10.

The operation of the present embodiment is described now. The front end of the photosensitive film 10 is passed through the position of the exposure stage. Then a start command for exposure is entered. A cooler fan and halogen lamps of the light source 84 are turned on. The photosensitive film is advanced to set an unexposed region of the photosensitive film 10 on the exposure stage. The motor 80 of the shifter 62 is rotated in the forward direction, to shift the conveyor 61 crosswise to the conveying direction. The conveyor 61 stops being shifted when the conveyor 61 comes to its terminal position. The shutter 85 is set in the open position, before the motor 80 of the shifter 62 is rotated in reverse. The conveyor 61 is now shifted in reverse to its initial shifting direction. The unexposed region of the photosensitive film 10 is moved past the exposure unit 63, to expose the photosensitive film 10 to record the mask pattern of the exposure mask 83. After the exposure, the shutter 85 is closed. Then the conveyor 61 is driven to convey the exposed region until a next unexposed region is set in the exposure stage. Similar operation is repeated. Each time after the mask pattern is recorded on one unexposed region of the photosensitive film 10, the photosensitive film 10 is conveyed intermittently. When the exposing operation to the photosensitive film 10 is finished, the photosensitive film 10 is developed, to form the developed photosensitive film 55 with the stripe pixel patterns 56, 57 and 58 and the black matrix pattern 59 extending in the width direction crosswise to the conveying direction as illustrated in Fig. 7.

In the above embodiment, the conveyor 61 is shifted by the shifter 62 to take an exposure. In addition, an exposure unit 96 may be shifted by a shifter 97 in the width direction of the photosensitive film 10 without shifting a photosensitive film conveyor 95, as illustrated in Fig. 8. The exposure pattern can be created in a manner similar to Fig. 7. The photosensitive film 10 is intermittently moved to set an unexposed region at the exposure stage, in a manner similar to Fig. 6. In the embodiment of Figs. 5 and 6, the photosensitive film 10 is exposed by the exposure unit 63 in the course of the backward shift of the shifter 62. But the photosensitive film 10 may be exposed in the course of forward shift of the shifter 62. Furthermore the photosensitive film 10 may be exposed both during the backward shift and during the forward shift of the shifter 62. It is possible in the apparatus of Fig. 1 that the photosensitive film 10 is intermittently conveyed, that the exposure mask 22 is shifted in the conveying direction while the photosensitive film 10 is stopped, so as to obtain the stripe pixel patterns and the black matrix pattern depicted in Fig. 4.

In the above embodiment, each color stripe is recorded by use of a single array of light-transmitting slits. But each color stripe or stripe pixel pattern can be recorded by use of two or more arrays of light-transmitting slits. Such two or more arrays should be constituted by slits classified in a regularly arranged manner among the slits which would derive from a single array like the above embodiment. The light-transmitting slits for the black matrix, as they are typically narrower than, and arranged at a smaller pitch than, the other three groups of the slits. It is advantageous to use plural arrays to which light-transmitting slits for the black matrix are arranged. Consequently an interval between adjacent two of the slits in the same array can be greater than that according to the above embodiment. This has an advantage in that the light-transmitting slits for the black matrix become easier to manufacture.

In the above embodiments, the light-transmitting slit groups 40-43 are formed in the chromium plate. Alternatively a transparent base plate can be electroplated with a chromium layer, which can be partially eliminated by etching or any suitable method to create the mask patterns constituted of slits or light-transmitting regions. Moreover, other methods may be used for forming a layer of light-shielding material, which can be partially eliminated to create mask patterns. It is possible to dispose an auxiliary filter in the light-transmitting regions.

In the present embodiment, the length L1 of the light-transmitting slit groups 40-42 are equal between the colors associated therewith. Of course the length L1 of the light-transmitting slit groups 40-42 may be varied between the colors. The exposing amount is changed due to the length L1. Density of the color filter can be set different between the colors by increasing or decreasing the length L1. Moreover relative speed between the photosensitive film 10 and the exposure mask 22 may be changed to change the exposing amount. Thus it is also possible to change the entire density of the color filter.

The light source in the above is the halogen lamps 25. Also it is possible in the present invention to use a tungsten lamp, a fluorescent lamp, a mercury-vapor lamp and a light-emitting diode. Among them, the halogen lamp and the fluorescent lamp are desirable. Uniform emission of rays can be obtained from fluorescent lamps being arranged in series with the light-transmitting slit groups.

The auxiliary filters used in the present invention are interference filters, but may be color glass filters and color film filters being general-purpose in the photographic field. But interference filters are the most preferable in view of keeping illuminance without being lowered.

The photosensitive film used in the present invention may be selected from various examples. Preferred examples of the photosensitive film are color reversal photo film of a coupler-in-developer type, color reversal photo film of a coupler-in-emulsion type, color negative photo film adapted to color negative process, color photo film for display, auto positive color film, and the like. Those are disclosed in such books as Kagaku Shashin Binran, Jo (Handbook of Scientific Photography, volume one), Maruzen Publishing Co., pages 559-564 and 569, and The Theory of the Photographic Process, the Fourth Edition, T.H. James, Macmillan Publishing Co., 1977. In addition, the following examples are preferable:

A) a coupler-in-emulsion type of color photosensitive film disclosed in JP-A 63-261361 in which two or more couplers are included in a common layer of photosensitive silver halide emulsion and different in hue obtained by the color development;

B) a coupler-in-developer type of photosensitive film disclosed in JP-A 64-79701 which is developed by processing solution including developing agent and two or more couplers which are different in color development in association with a common silver halide;

C) a color filter photosensitive material disclosed in JP-A 6-303977 and Japanese Patent Applications Nos. 6-84315, 6-155726, 7-122733 and 7-18157 in which a support layer is used as a base plate of the color filter, or which includes a peelable layer for the purpose of transferring color photosensitive layers to a base plate.

A support plate of the photosensitive film used in the present invention should be transparent and have transmittance of light. However it is possible to use a filter producing material disclosed in Japanese Patent Application No. 6-1363, in which a silver halide emulsion layer is initially formed as a coating on a different support, and then is transferred to the main light-transmitting support to obtain the filter producing material. The light-transmitting characteristic is not necessary. For example, the support may have a back surface coated with carbon black. A plastic support plate may be used as a part of the color photosensitive material. It is preferable to attach protective film to the back of the support plate in reverse to the photosensitive surface, for the purpose of keeping resistance to being scratched. Preferred examples of the protective film are polyethylene and polyethylene terephthalate. Of course this protective film is eliminated before the photosensitive film is fitted on the LCD panel.

It is desirable for the material for the light-transmitting base plate to be optically isotropic and have high resistance to heat. Examples of the material are polyethylene terephthalate, polybutylene terephthalate, polyethylene naphthalate, polystyrene, polycarbonate, polyether sulfone, cellulose acetate, polyarylate, soda-lime glass, borosilicate glass, quartz, and the like. Surfaces of the base plate can be coated with an undercoat as desired. Moreover the surfaces may be finished by a process of glow discharge, corona discharge, application of ultraviolet rays, and the like. The base plate may have any form of a plate, sheet or film. Its thickness may be determined suitably for the purpose and kinds of the material, and can be in a preferable range of 0.01-10 mm.

The photosensitive film of the present invention is processed by such ordinary methods as disclosed in Research Disclosures (R.D.) No. 17,643, pages 28-29 and No. 18,716, page 651, left and right columns, to obtain a micro color filter. The photosensitive film may be further subjected to the prehardening process or the post-hardening process. For example, the photosensitive film is subjected to the color developing process, the desilvering process and the washing process. In the desilvering process, the bleach-fixing process by means of bleach-fixing agent can be used, instead of a combination of the bleaching process by means of bleaching agent and the fixing process by means of fixing agent. The bleaching process, the fixing process and the bleach-fixing process may be combined and arranged in any order of the three. The stabilizing process may be used instead of the washing process. Or the stabilizing process may be effected after the washing process. It is also possible to use monobath process by means of monobath developing bleach-fixing processing solution with which the color development, bleaching and fixation are effected in the single bath. In combination with those, it is possible to use the prehardening process, the neutralizing process associated with the prehardening process, the stop-fixing process, the posthardening process, the compensating process, the intensifying process and the like. Among those, the activator developing process may be used instead of the color developing process.

Although the present invention has been fully described by way of the preferred embodiments thereof with reference to the accompanying drawings, various changes and modifications will be apparent to those having skill in this field. Therefore, unless otherwise these changes and modifications depart from the scope of the present invention, they should be construed as included therein.

Claims

1. An exposure mask for producing a color filter (49, 55) from silver halide photosensitive material (10), said color filter having blue, green and red pixel patterns (50-52, 56-58) and a black matrix (53, 59), characterized by:

   a first group (40, 90) of light-transmitting regions for exposing said blue pixel pattern;
   a second group (41, 91) of light-transmitting regions for exposing said green pixel pattern;
   a third group (42, 92) of light-transmitting regions for exposing said red pixel pattern;
   a fourth group (43, 93) of light-transmitting regions for exposing said black matrix; and
   first to third auxiliary filters (36, 45-47) respectively disposed to cover said first to third groups of said light-transmitting regions.

2. An exposure mask as defined in claim 1, characterized in that said light-transmitting regions are respectively extended in one longitudinal direction, and said first to fourth groups are region arrays in each of which said light-transmitting regions are arranged in a direction crosswise to said one longitudinal direction.

3. An exposure mask as defined in claim 1 or 2, characterized by a light-transmitting protective film laminated thereon, said protective film having a small coefficient of friction.

4. A method of producing a color filter (49, 55) from silver halide photosensitive material (10), said color filter having blue, green and red pixel patterns (50-52, 56-58) and a black matrix (53, 59), characterized by comprising steps of:

   moving an exposure mask (22, 83) and silver halide photosensitive material in a manner relative to each other, said exposure mask including a first group (40, 90) of light-transmitting regions for exposing said blue pixel pattern, a second group (41, 91) of light-transmitting regions for exposing said green pixel pattern, a third group (42, 92) of light-transmitting regions for exposing said red pixel pattern, a fourth group (43, 93) of light-transmitting regions for exposing said black matrix, and first to third auxiliary filters (36, 45-47) respectively disposed to cover said first to third groups of said light-transmitting regions, said relative moving being crosswise to a serial direction in which said light-transmitting regions are arranged in each of said first to third groups; and
   illuminating said photosensitive material through said exposure mask to form said blue, green and red pixel patterns and said black matrix.

5. A color filter producing method as defined in claim 4, characterized in that said exposure mask (22, 83) is stationary, and said photosensitive material (10) is conveyed continuously.

6. A color filter producing method as defined in claim 4, characterized in that said photosensitive material (10) is conveyed intermittently and set in an exposure station, and said exposure mask (22, 83) or said photosensitive material is shifted relatively in a width direction of said photosensitive material.

7. An apparatus for producing a color filter (49, 55) from silver halide photosensitive material (10), said color filter having blue, green and red pixel patterns (50-52, 56-58) and a black matrix (53, 59), characterized by:

   an exposure mask (22, 83), including:

      (A) a first group (40, 90) of light-transmitting regions for exposing said blue pixel pattern, said light-transmitting regions being respectively extended in one longitudinal direction, and arranged in at least one array oriented crosswise to said longitudinal direction;
      (B) a second group (41, 91) of light-transmitting regions for exposing said green pixel pattern, said light-transmitting regions being respectively extended in said longitudinal direction, and arranged in at least one array oriented crosswise to said longitudinal direction;
      (C) a third group (42, 92) of light-transmitting regions for exposing said red pixel pat-

tern, said light-transmitting regions being respectively extended in said longitudinal direction, and arranged in at least one array oriented crosswise to said longitudinal direction;

(D) a fourth group (43, 93) of light-transmitting regions for exposing said black matrix, said light-transmitting regions being respectively extended in said longitudinal direction, and arranged in at least one array oriented crosswise to said longitudinal direction;

(E) first to third auxiliary filters (36, 45-47) respectively disposed to cover said first to third groups of said light-transmitting regions;

an exposure unit (20, 63, 96) for forming said blue, green and red pixel patterns and said black matrix on said photosensitive material by illumination through said exposure mask; and a conveyor (13, 15, 61, 95) for continuously conveying said photosensitive material to said exposure unit in said longitudinal direction of said light-transmitting regions.

8. An apparatus for producing a color filter (49, 55) from silver halide photosensitive material (10), said color filter having blue, green and red pixel patterns (50-52, 56-58) and a black matrix (53, 59), characterized by:

an exposure mask (22, 83), including:

(A) a first group (40, 90) of light-transmitting regions for exposing said blue pixel pattern, said light-transmitting regions being respectively extended in one longitudinal direction, and arranged in at least one array oriented crosswise to said longitudinal direction;

(B) a second group (41, 91) of light-transmitting regions for exposing said green pixel pattern, said light-transmitting regions being respectively extended in said longitudinal direction, and arranged in at least one array oriented crosswise to said longitudinal direction;

(C) a third group (42, 92) of light-transmitting regions for exposing said red pixel pattern, said light-transmitting regions being respectively extended in said longitudinal direction, and arranged in at least one array oriented crosswise to said longitudinal direction;

(D) a fourth group (43, 93) of light-transmitting regions for exposing said black matrix, said light-transmitting regions being respectively extended in said longitudinal direction, and arranged in at least one array oriented crosswise to said longitudinal direction;

(E) first to third auxiliary filters (36, 45-47) respectively disposed to cover said first to third groups of said light-transmitting regions;

a conveyor (61, 95) for intermittently conveying said photosensitive material;
an exposure unit (63, 96) for forming said blue, green and red pixel patterns and said black matrix on said photosensitive material by illumination through said exposure mask;
a shifter (62, 97) for shifting said exposure unit and said conveyor in a manner relative to each other; and
a controller (64) for causing said shifter to shift said exposure unit and said conveyor in a manner relative to each other after said conveyor intermittently conveys said photosensitive material, said controller causing said exposure unit to form said blue, green and red pixel patterns and said black matrix on an unexposed region of said photosensitive material during said relative shifting, said controller causing said conveyor to convey said photosensitive material intermittently to supply said shifter with an unexposed region thereof.

9. A color filter producing apparatus as defined in claim 8, characterized in that said shifter (62) shifts said conveyor (61).

10. A color filter producing apparatus as defined in claim 8, characterized in that said shifter (97) shifts said exposure unit (96).

FIG. 1

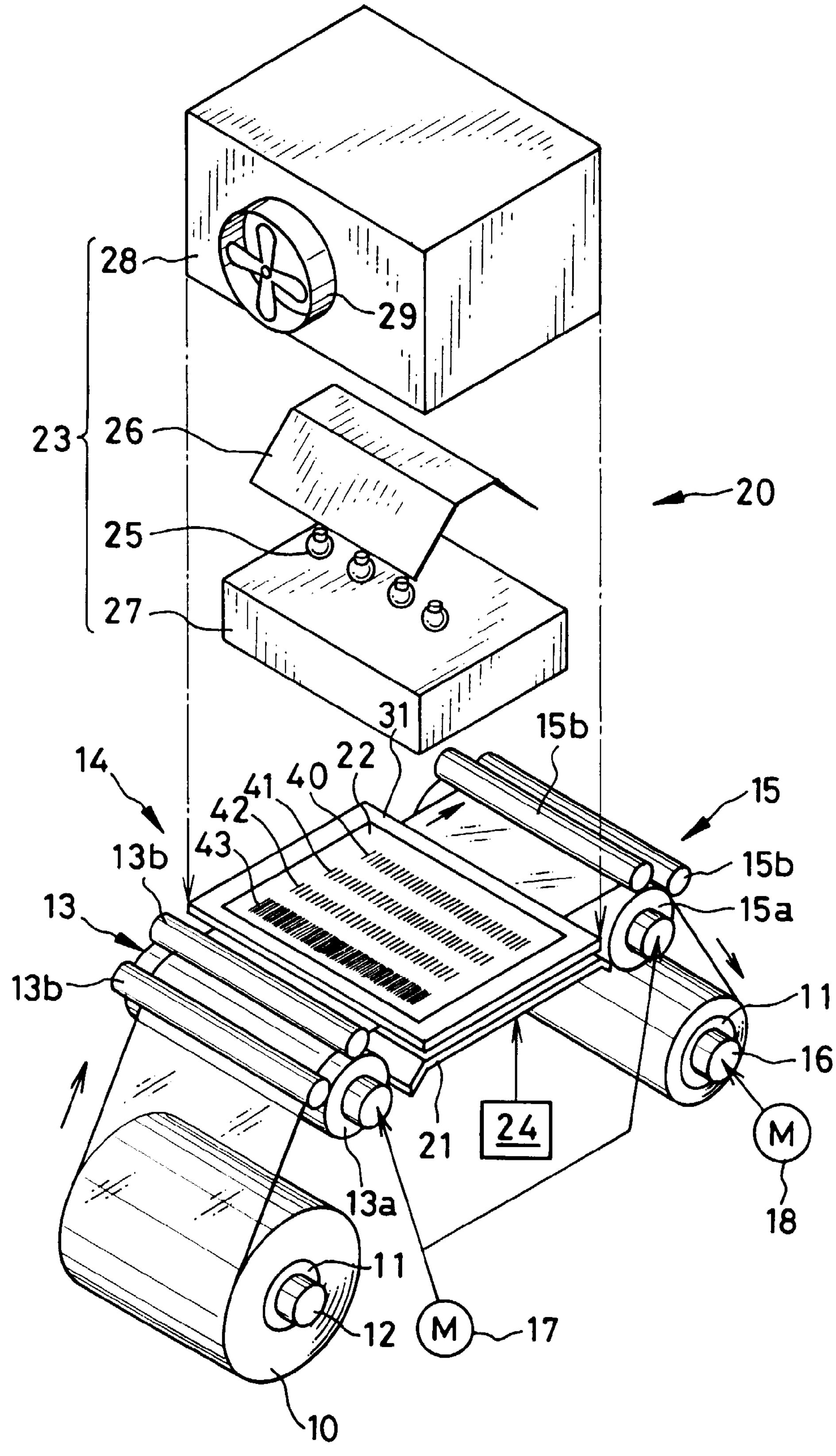

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FIG. 2

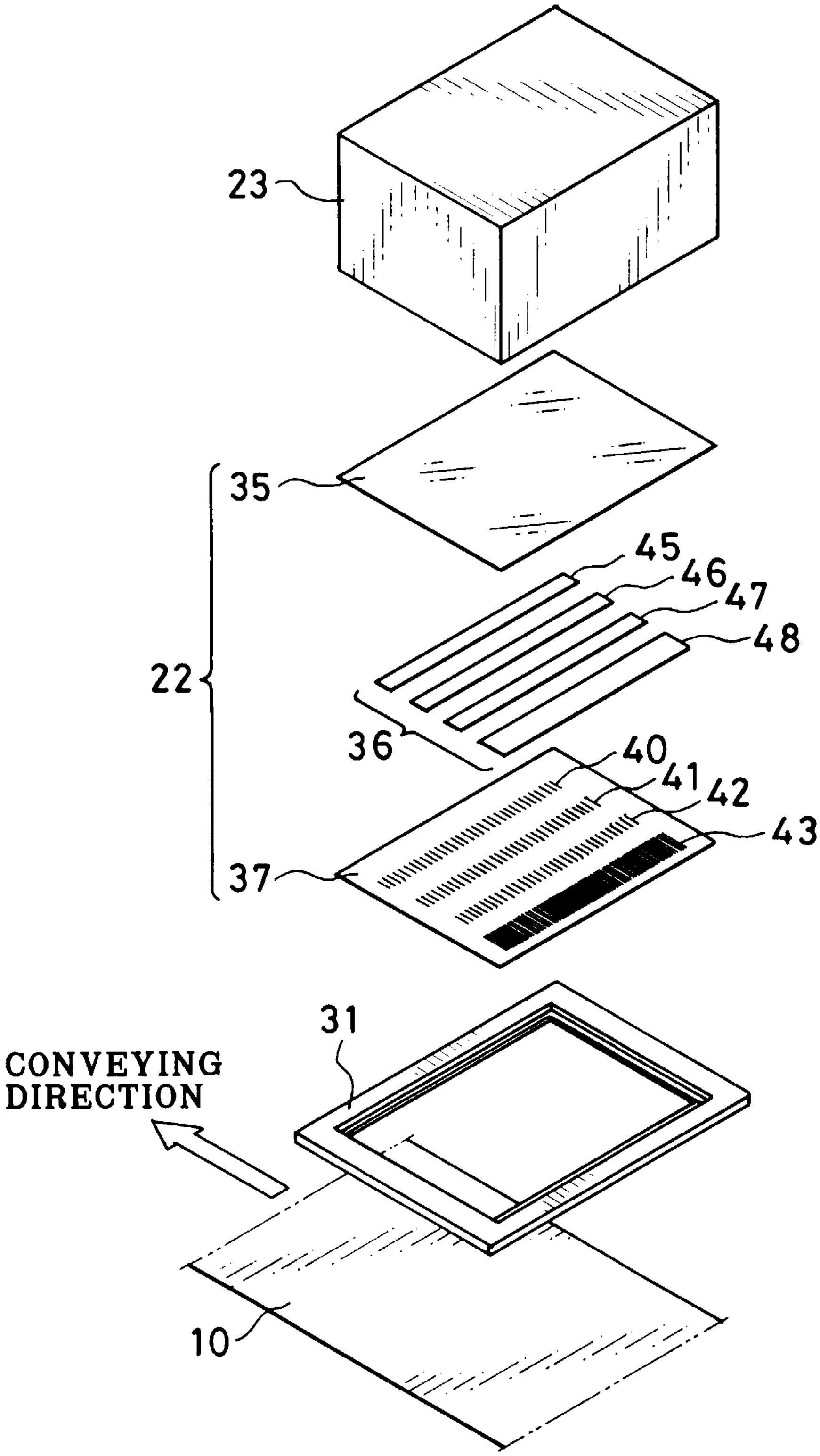

FIG. 3

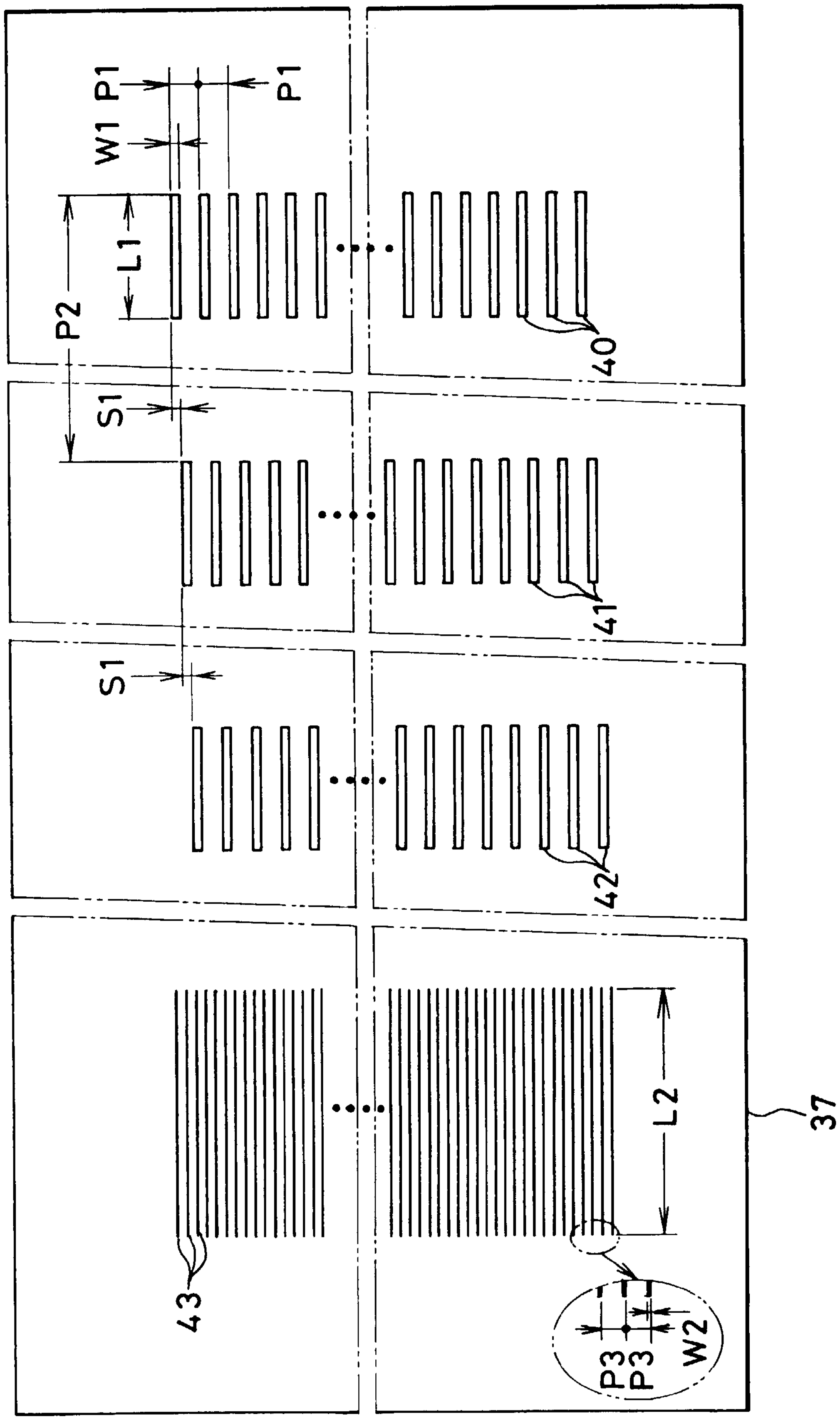

FIG. 4

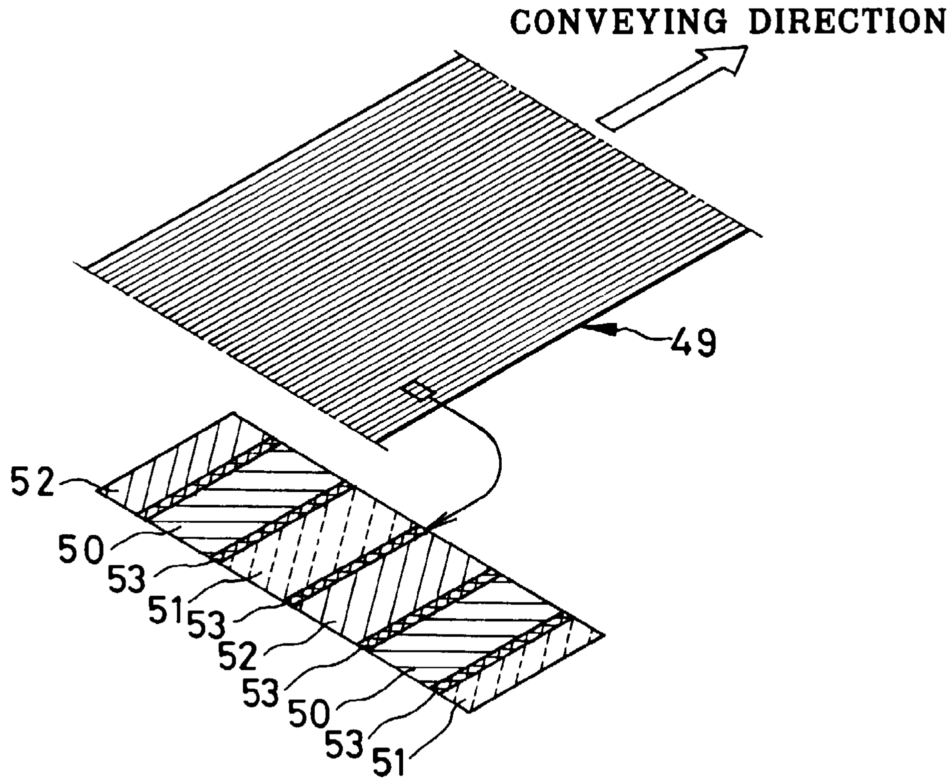
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FIG. 7

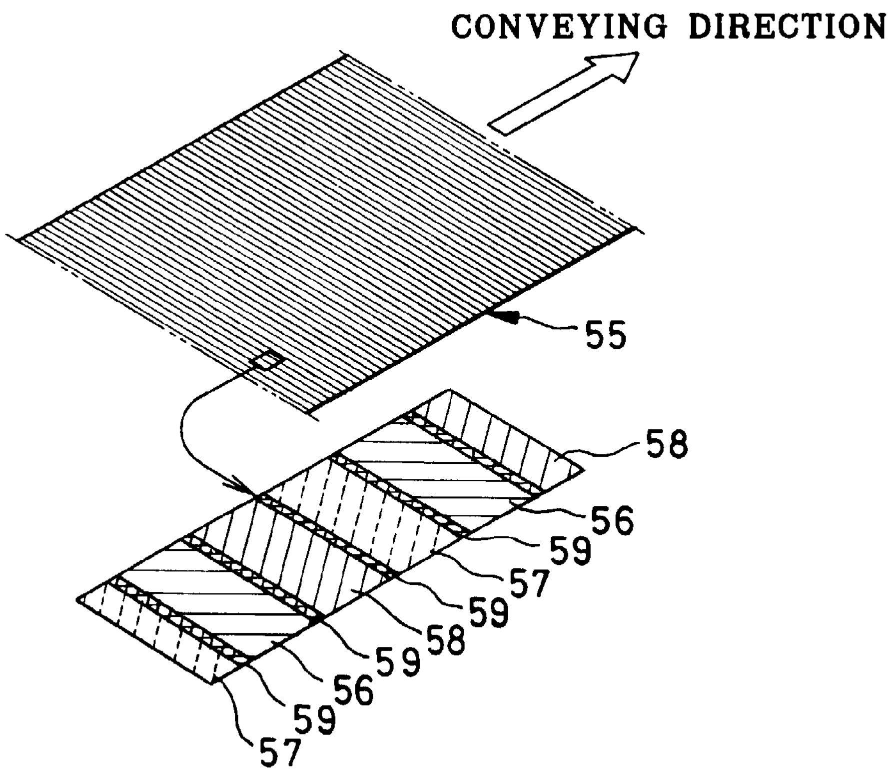
CONVEYING DIRECTION
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FIG. 5

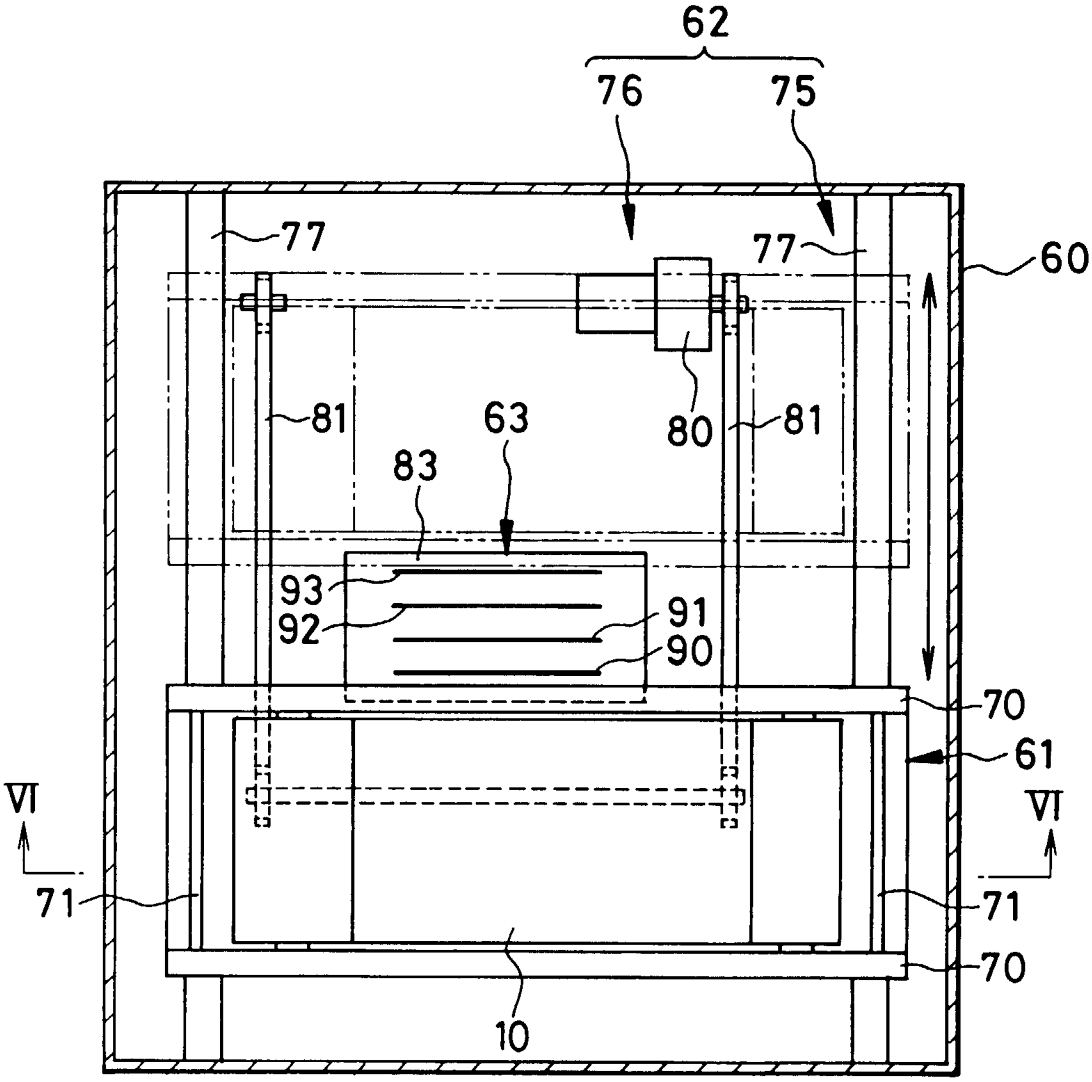

FIG. 6

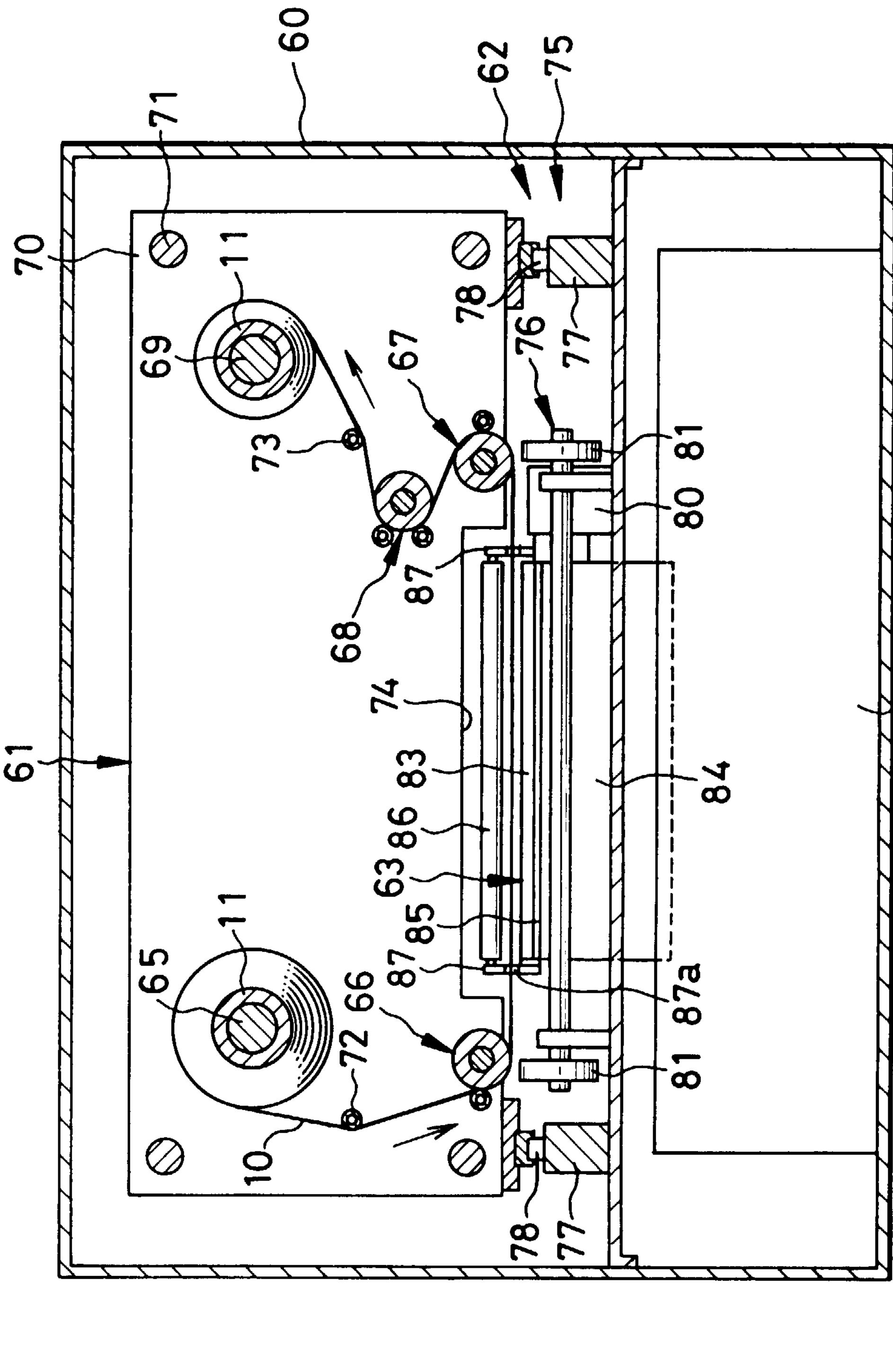
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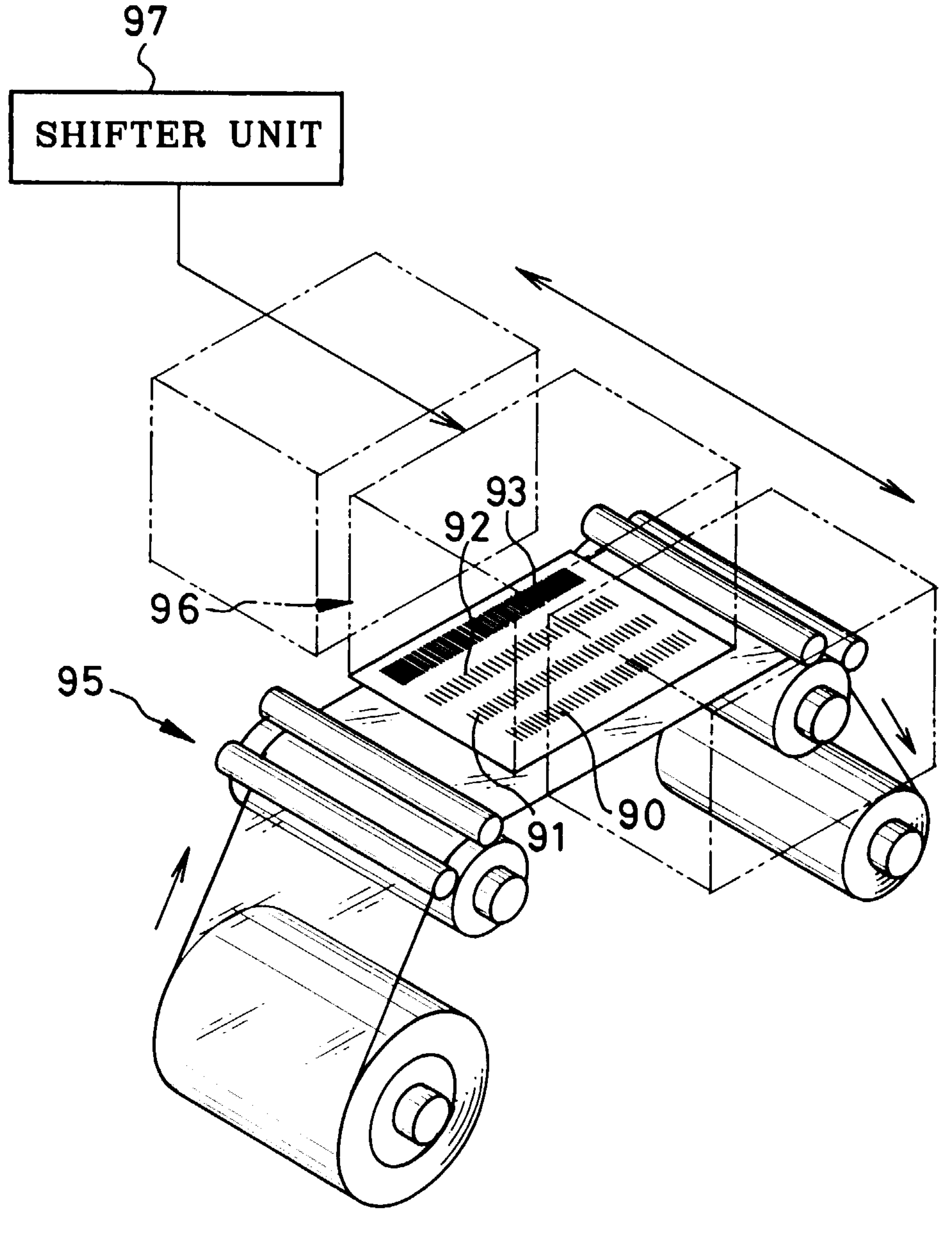
FIG. 8



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97310230.4

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 6)
A,D	EP 0744654 A2/A3 (FUJI PHOTO FILM CO., LTD.) 27 November 1996 (27.11.96), claims, page 12, lines 56,57. --	1-10	G 03 C 7/12
A	EP 0615161 A1 (AGFA-GEVAERT) 14 September 1994 (14.09.94), claims, page 8, lines 6-40. ----	1-10	

TECHNICAL FIELDS SEARCHED (Int. Cl. 6)

G 03 C
G 03 F
G 02 B
G 02 F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	16-02-1998	SCHÄFER

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