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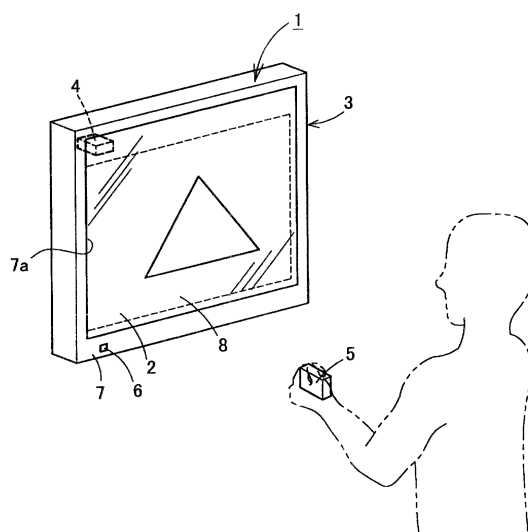
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(54) **Display device**

(57) A display device 1 is provided with an information electrode sheet 10 constructed of an information sheet bonded with an electrode sheet, a masking electrode sheet 11 constructed of a masking sheet bonded with an electrode sheet, an actuating frame 13 for relatively movably the sheets 10 and 12, a stepping motor 14 for driving the actuating frame 13, and a control unit 4. The masking sheet includes a plurality of slits. The

information sheet includes a plurality of image lines which configure plural items of screen information. The control unit 4 causes the stepping motor 14 to relatively move the sheets 10 and 11 to switch between displays of screen information, while controlling voltage application to the electrode sheets to selectively generate a repulsive force and an attractive force by an electrostatic action between the sheets 10 and 11.

FIG. 1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a display device for selectively displaying plural items of screen information provided on a sheet.

2. Description of Related Art

[0002] Conventionally, there has been proposed a display device for selectively displaying plural items of screen information provided on a sheet. One example is disclosed in Japanese patent application laid-open No. 7-302054. Fig. 27 is a schematic perspective view of the conventional display device. Fig. 28 is a cross-sectional view of the device of Fig. 27. Fig. 29 is a perspective view of a display sheet with transmissive portions to light.

[0003] As shown in Figs. 27 and 28, the display device includes a box-shaped housing 72 provided with an open window 71 on the front side. A light source chamber 74 is provided in the chamber 74 near the back so that light sources 73 such as an LED are disposed in correspondence with the open window 71. A transmissive light diffusing plate 75 is arranged in front of the light source chamber 74. This light diffusing plate 75 is formed with a plurality of slits (not shown) transmissive to light emitted from the light sources 73. A belt-like display sheet 76 with transmissive portions to light is movably disposed in front of the light diffusing plate 75. As shown in Fig. 29, this display sheet 76 is formed with a plurality of marks 77 such as different characters and patterns, which are drilled at predetermined intervals in a longitudinal direction. Both ends of the display sheet 76 are wound on a pair of rotary shafts 78 disposed in right and left ends in the housing 72. A driving belt (not shown) runs between the rotary shafts 78 with pulleys (not shown). One of the rotary shafts 78 is connected with a forward and reverse rotating motor 80. The motor 80, the rotary shafts 78, the unillustrated pulleys and driving belt, and others constitute a drive mechanism for moving the display sheet 76. A belt-like transparent protective sheet 81 is movably disposed in front of the display sheet 76. With such the structure, the motor 78 is rotated forward or reversely to selectively move the display sheet 76 in a forward or reverse direction between the rotary shafts 78, so that a desired one of the marks 77 can be freely selectively displayed.

[0004] However, the conventional display device has to be operated such that the display sheet 76 is moved by a length corresponding to at least the width of one mark 77 in order to selectively display a desired mark 77. Thus, it would take a long time for switching between the marks 77 to be displayed, impeding a prompt switching. When more than two marks 77 are needed skipping

to display a desired one, particularly, some viewers may feel a delay in the display switching, though it depends on a moving speed of the display sheet 76. Accordingly, the above display device is inappropriate for the method of displaying a desired mark 77 by instantaneously switching among the plural marks 77. This results in limited display variations.

[0005] In addition, the drive mechanism and others operated to move the display sheet 76 produce much noise, and the noise would continuously be produced for a time needed for switching the marks 77. This is disadvantage in quietness. Since the display sheet 76 is wound on the rotary shafts 78, the surface of the sheet 76 might be worn down due to sliding, causing a deterioration in quality for a short term.

[0006] Meanwhile, different from the above conventional display device which selectively displays the different marks 77 by winding the display sheet 76, there has been also known a display instrument and a display method of displaying a desired one from among different items of screen information by relatively moving two sheets. This display instrument is provided with a masking sheet having a plurality of slits arranged regularly at predetermined intervals and an information sheet disposed facing the masking sheet. The information sheet is provided with a plurality of image lines for configuring plural items of screen information, the image lines being arranged into alignment with the slits of the masking sheet. Relatively moving the sheets by hand operation allows a screen information drawn on the information sheet to be selectively displayed through the slits.

[0007] If such the silt-displaying instrument is adapted to a practical display device, the above mentioned disadvantages could be canceled. However, it is necessary for realization of a display device suitable for actual use to minimize each width of the slits and the image lines in order to prevent viewers from visually feeling strangeness or discomfort. As each width of the slits and the image lines is reduced, the relative movement between the masking sheet and the information sheet must be controlled with high precision and stability at a minute pitch. This causes difficulties in realizing a practicable display device.

SUMMARY OF THE INVENTION

[0008] The present invention has been made in view of the above circumstances and has an object to overcome the above problems and to provide a display device suitable for practical use, provided with a masking sheet and the information sheet which can be relatively moved with high precision and stability at a minor pitch.

[0009] Additional objects and advantages of the invention will be set forth in part in the description which follows and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instrumentalities and com-

binations particularly pointed out in the appended claims.

[0010] To achieve the purpose of the invention, there is provided a display device including: a masking sheet provided with a plurality of slits regularly arranged at predetermined intervals; an information sheet disposed facing the masking sheet and provided with a plurality of image lines which configure plural items of screen information, the image lines being arranged so as to come into alignment with the slits; an actuating frame for supporting the masking sheet and the information sheet disposed facing each other to allow relative movement between the sheets; and an actuator for driving the actuating frame to regularly relatively move the masking sheet and the information sheet.

[0011] According to the above configuration, to display a desired item of screen information, the actuator is driven to actuate the actuating frame, thereby relatively moving the masking sheet and the information sheet each supported by the actuating frame. When the specific image lines of the information sheet corresponding to the desired information are aligned with the slits of the masking sheet, selectively allowing the desired information to appear. In this manner, the simple relative movement between the masking sheet and the information sheet at a width level of each slit can switch between specific items of screen information. The masking sheet and the information sheet can be mechanically supported by the actuating frame which is actuated by the actuator. Accordingly, controlling the actuation quantity of the actuator can actuate the actuating frame with a fine pitch corresponding to the width level of each slit. The actuation quantity can be surely transmitted to at least one of the masking sheet and the information sheet.

[0012] In the display device, preferably, the actuating frame includes a fixed frame fixed for supporting one of the masking sheet and the information sheet and a movable frame for supporting the other sheet, the movable frame being movable with respect to the fixed frame by operation of the actuator.

[0013] Preferably, the display device further includes: a first electrode sheet including a transparent insulation sheet provided with transparent electrodes arranged in parallel with a sheet surface, the first electrode sheet being integrally configured with one of the masking sheet and the information sheet; a second electrode sheet including a transparent insulation sheet applied with positive and negative charges in alignment with the transparent electrodes of the first electrode sheet, the charges being in parallel with a sheet surface, and the second electrode sheet being integrally configured with the other of the sheets; and application voltage control means for controlling switching of voltage to be applied to the transparent electrodes in order to produce a repulsive force by an electrostatic action between the electrode sheets while the masking sheet and the information sheet are relatively moved, and produce an at-

tractive force by the electrostatic action between the electrode sheets while the relative movement between the sheets is stopped.

[0014] In the display device, preferably, the actuating frame is provided with a spacing control mechanism for adjusting a spacing between the first and second electrode sheets.

[0015] In the display device, preferably, the actuating frame is provided with an inclination control mechanism for adjusting a relative inclination between the masking sheet and the information sheet to align arrangement of the slits with that of the image lines.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The accompanying drawings, which are incorporated in and constitute a part of this specification illustrate an embodiment of the invention and, together with the description, serve to explain the objects, advantages and principles of the invention.

[0017] In the drawings,

Fig. 1 is a schematic perspective view of a display device in an embodiment according to the present invention;

Fig. 2 is a front view of a display unit of the display device in the embodiment;

Fig. 3 is a rear view of the display unit of Fig. 2;

Fig. 4 is a longitudinal sectional view of the display unit taken along the line A-A in Fig. 3;

Fig. 5 is a perspective exploded view of a sheet unit and an emitting plate of the display device;

Fig. 6 is a front view of a conceptual configuration of a masking sheet in the present embodiment;

Fig. 7 is an enlarged view of a part of the masking sheet shown in Fig. 6;

Fig. 8 is a front view of a conceptual configuration of an information sheet in the embodiment;

Fig. 9 is a front view of a conceptual configuration of a first and a second electrode sheets in the present embodiment;

Fig. 10A is a front view of each of the information sheet and the masking sheet, showing slits thereof;

Fig. 10B is a front view of each of the electrode sheets, showing slits thereof as compared with those of the information sheet and the masking sheet shown in Fig. 10A;

Fig. 11 is a partial enlarged view of linear electrodes in the present embodiment, showing an arrangement thereof;

Fig. 12 is a partial enlarged view of image lines in the present embodiment, showing an arrangement thereof;

Fig. 13 is an explanatory view of showing a conceptual sectional structure of the emitting plate and the display unit in the present embodiment;

Fig. 14 is a sectional view of a part of the display unit taken along the line B-B in Fig. 2;

Fig. 15 is a right side view of an actuating frame shown in Fig. 2;

Fig. 16 is a sectional view of a part of the display unit taken along the line C-C in Fig. 2;

Fig. 17 is a sectional view of a part of the display unit taken along the line D-D in Fig. 2;

Fig. 18 is a sectional view of a part of the display unit taken along the line E-E in Fig. 2, showing an attachment state of the information sheet and the masking sheet;

Fig. 19 is a circuit diagram of showing a conceptual electrical configuration of a control unit in the present embodiment;

Fig. 20 is a front view of an item of screen information in the present embodiment;

Fig. 21 is a front view of another item of screen information in the present embodiment;

Fig. 22 is a front view of another item of screen information in the present embodiment;

Fig. 23 is an explanatory view of an arrangement of the information sheet and the masking sheet before movement;

Fig. 24 is an explanatory view of an arrangement of the information sheet and the masking sheet after movement;

Fig. 25 is an explanatory view of showing operations of the display device in the present embodiment;

Fig. 26 is a partial enlarged view of showing an arrangement of image lines in another embodiment;

Fig. 27 is a perspective view of a display device in a prior art;

Fig. 28 is a cross sectional view of the display device of Fig. 27; and

Fig. 29 is a perspective view of a display sheet with transmissive portions to light, used in the display device of Fig. 27.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] A detailed description of a preferred embodiment of a display device embodying the present invention will now be given referring to the accompanying drawings.

[0019] Fig. 1 is a schematic perspective view of a display device 1 of a wall-hung type in the present embodiment.

[0020] The display device 1 includes a main unit 3 including a display screen 2 for displaying a plurality of display information; a control unit 4 incorporated in the main unit 3, the control unit being adopted to control operation of the main unit 3; and an infrared-ray remote controller 5 for controlling operation of the main unit 3. The infrared-ray remote controller 5 is arbitrarily operated by a user to select one from among plural items of screen information. An infrared-ray signal transmitted from the infrared-ray remote controller 5 is received by

a light receiving element 6 provided at the main unit 3. In Fig. 1, a graphic display of "Δ" is displayed as an example of screen information on the display screen 2 of the main unit 3. The main unit 3 is constructed of a box shaped casing 7 having an opening 7a on the front face and a transparent plate 8 fixed in the opening 7a to configure the display screen 2.

[0021] Fig. 2 is a front view of a display unit 9 incorporated in the main unit 3. Fig. 3 is a rear view of the display unit 9. Fig. 4 is a sectional view of the display unit 9 taken along line A-A in Fig. 3. The display unit 9 is provided with a sheet unit 12 consisting of an information electrode sheet 10 and a masking electrode sheet 11 disposed oppositely each other, an actuating frame 13 for supporting the information electrode sheet 10 and the masking electrode sheet 11 to be moved relatively, a stepping motor 14 serving as an actuator for driving the actuating frame 13, and a light emitting plate 15 arranged on the back of the sheet unit 12.

[0022] Fig. 5 is a perspective exploded view of the sheet unit 12 and the light emitting plate 15. The information electrode sheet 10 configuring the sheet unit 12 includes an information sheet 16 and a transparent first electrode sheet 17 integrally bonded with the back surface of the sheet 16. The masking electrode sheet 11 disposed opposite to the information electrode sheet 10 includes a masking sheet 18 and a transparent second electrode sheet 19 integrally bonded with the front surface of the sheet 18. A method for bonding the sheets 16 and 18 with the electrode sheets 17 and 19 respectively includes bonding them using transparent adhesive, for example.

[0023] The display device 1 in the present embodiment is, as basic principles, arranged to selectively display a desired one from among plural items of screen information by relatively moving the information sheet 16 and the masking sheet 18. In the embodiment, the masking electrode sheet 11 is fixed in a predetermined position, while the information electrode sheet 10 is moved, thereby relatively moving the information sheet 16 and the masking sheet 18.

[0024] In the present embodiment, the actuating frame 13 and the stepping motor 14 are actuated so as to move the information electrode sheet 10 with respect to the masking electrode sheet 11. The first electrode sheet 17 and the second electrode sheet 19 provided in the information electrode sheet 10 and the masking electrode sheet 11, respectively, are adopted to impart an electrostatic action between the sheets 16 and 18 when the information sheet 16 is moved and stopped.

[0025] The light emitting plate 15 is adopted to diffuse the light emitted from a predetermined light source, thereby illuminating the sheet unit 12 from the back thereof. As the predetermined light source, a fluorescent light can be used. Alternatively, natural light to be taken in can be used according to an installation site of the display device 1.

[0026] Next, each configuration of the masking sheet

18, information sheet 16, and the first and second electrode sheets 17 and 19 will be described in detail.

[0027] Fig. 6 shows a front view of a conceptual configuration of the masking sheet 18. The masking sheet 18 is constructed of a dark colored transparent sheet with a plurality of uncolored linear slits 21 regularly arranged at predetermined intervals d1, configuring a pattern of stripes. In the present embodiment, the masking sheet 18 is set to about 0.2 mm in thickness, and the interval d1 of the slits 21, i.e., the width of a colored part 22 is set to twice of the width w1 of the slit 21. For allowing the relative horizontal movement between the information sheet 16 and the masking sheet 18, the plurality of slits 21 are arranged in parallel to each other and obliquely at a predetermined slit angle θ with respect to the horizontal direction of the display device 1.

[0028] Fig. 7 is an enlarged view of a part of the masking sheet 18, showing a relationship between a movement pitch Pv needed for switching between screen information displays and each of the above slit angle θ and width w1 of the slit 21. The relationship between them can be expressed by the following formula (1).

$$Pv = w1 / \sin \theta \quad (1)$$

[0029] In the present embodiment, the slit angle θ is set to 4.78 degrees in order to set the movement pitch Pv (described later in detail) to 6 mm, for example. It is desirable that this slit angle θ is set in the range of 1 degree to 10 degrees, and more preferably in the range of 4 degrees to 6 degrees. The slit angle θ is set to the above ranged angle, whereby the movement pitch Pv which is sufficiently larger than the width w1 of the slit 21 can be ensured. At the same time, the oblique arrangement of the slits 21 makes it possible to prevent the feeling of strangeness from being imparted to a viewer. When the slit angle θ is relatively large, the movement pitch Pv is relatively short so that screen information displays can be switched comparatively speedily. If the slit angle θ is relatively small, the movement pitch Pv is relatively long so that screen information displays can be switched comparatively slowly. In the present embodiment, the width w1 of the slit 21 is set to 0.5 mm. It is to be noted that the width w1, interval d1, and number of slits 16 with respect to the size of the masking sheet 18 shown in Fig. 6 are merely determined conveniently in the embodiment, and they are not actually limited to the above.

[0030] Fig. 8 shows a conceptual configuration of the information sheet 16. This information sheet 16 is provided with a plurality of image lines 23 which can configure plural items of screen information. The image lines 23 are arranged so as to come into alignment with the slits 21 of the masking sheet 18, configuring the same pattern of stripes as that of the slits 21. In the present embodiment, the width w2 of the image line 23 is set to be equal to the width w1 of the slit 21. The image

lines 23 are arranged in parallel to each other and obliquely at the slit angle θ to the horizontal direction in accordance with the arrangement of the slits 21.

[0031] As shown in Fig. 8, the information sheet 16 is provided with different kinds of image lines 23 which can configure three types of screen information are arranged sequentially and repeatedly. In the present embodiment, three items of graphic displays " $\square$ ", " Δ ", and " $\circ$ " shown by double-dot lines in Fig. 8 are arranged on the information sheet 16. The width w2 and the number of image lines 23 with respect to the size of the information sheet 16 are determined conveniently in Fig. 8, and they are not actually limited thereto.

[0032] Fig. 9 is a front view of a conceptual configuration of the first and second electrode sheets 17 and 19. The electrode sheets 17 and 19 each are adopted to generate an attractive force and a repulsive force by an electrostatic action between the information sheet 16 and the masking sheet 18. The first electrode sheet 17 is constructed of a transparent insulation sheet provided with a plurality of linear electrodes 24 which are transparent electrodes arranged in parallel with the sheet surface and at predetermined intervals between the electrodes, whereby the electrodes are insulated from each other. In the present embodiment, the linear electrodes 24 arranged in a vertical position and in parallel to each other.

[0033] The second electrode sheet 19 is constructed of a transparent insulation sheet provided with a plurality of linear electrodes 25 which are transparent electrodes arranged in parallel with the sheet surface and at predetermined intervals between the electrodes, whereby the electrodes are insulated from each other and aligned with the linear electrodes 24 of the first electrode sheet 17. Thus, the electrode sheets 17 and 19 include the linear electrodes 24 and 25 respectively with the same arrangement. The thickness and the number of the linear electrodes 24 and 25 with respect to the size of the electrode sheets 17 and 19 in Fig. 9 are determined conveniently in the present embodiment, and they are not actually limited to the above.

[0034] Fig. 10A and Fig. 10B show the arrangements of the image lines 23 of the information sheet 16 and the slits 21 of the masking sheet 18 in comparison with the arrangements of the linear electrodes 24 and 25 of the electrode sheets 17 and 19. In the present embodiment, the linear electrodes 24 and 25 of the electrode sheets 17 and 19 are vertically arranged to be orthogonal to the movement direction corresponding to the relative movement between the information sheet 16 and the masking sheet 18 in the horizontal direction.

[0035] As shown in Fig. 11, the linear electrodes 24 and 25, each having a predetermined width w3, are arranged regularly with a predetermined electrode pitch p1. In the present embodiment, the electrode pitch p1 is set to 0.5 mm. As shown in Fig. 12, the width w2 of the image line 23 (which is equal to the width w1 of the slit 21) is set to be equal to the electrode pitch p1 of each

of the electrodes 24 and 25.

[0036] Fig. 13 shows an explanatory view of showing a conceptual sectional structure of the sheet unit 12 and the light emitting plate 15. In the embodiment, the light emitting plate 15 and the masking electrode sheet 11 are fixed in place, while the information electrode sheet 10 is arranged to be relatively movable with respect to the sheet 11. In Fig. 13, the image lines 23 represented by "A" of the information sheet 16 configure an image information on the aforementioned "□"; the image lines 23 represented by "B" configure an image information on "Δ"; and the image lines 23 represented by "C" configure an image information on "○".

[0037] Next, a configuration of the actuating frame 13 or the like will be described in detail. As shown in Figs. 2 to 4, the actuating frame 13 is configured to support the information electrode sheet 10 and the masking electrode sheet 11 relatively movably in the horizontal direction while these sheets are disposed oppositely. The stepping motor 14 is adopted to drive the actuating frame 13 in order to regularly relatively move the sheets 10 and 11. The actuating frame 13 is constructed of a base frame 31 laid in the horizontal direction, a fixed frame 32 fixed under the base frame 31 in parallel thereto, and a movable frame 33 supported movably in the horizontal direction under the base frame 31.

[0038] The base frame 31 is fixed to the casing 7 via brackets 31a fixed near both ends of the frame 31. A driving unit 34 including the stepping motor 14 is fixed on the upper side of the base frame 31. As shown in Fig. 2, both upper ends of the masking electrode sheet 11 are fixed to the fixed frame 32 with poster pins 26 so that the sheet 11 is hung from the fixed frame 32. Both upper ends of the information electrode sheet 10 disposed opposite to the masking electrode sheet 11 are fixed to the movable frame 33 with poster pins 26 so that the sheet 10 is hung from the movable frame 33. The driving unit 34 includes a unit bracket 35 fixed to the base frame 31, and the stepping motor 14 is fixed to this bracket 35.

[0039] As shown in Fig. 3, a bolt 37 having a trapezoidal external screw-thread is coaxially connected with an output shaft 14a of the stepping motor 14 via a coupling 36. The bolt 37 is engaged in a cylindrical nut 38 having a trapezoidal internal screw-thread. The nut 38 is fixed to an arm 39 extending downwardly, and the lower end of this arm 39 is connected with the movable frame 33.

[0040] As the stepping motor 14 in the present embodiment, a stepping motor capable of rotating at an angle of 1.8 degrees per step is used. In response to the characteristics of this stepping motor 14, the bolt 37 and the nut 38 each having a trapezoidal screw-thread of 30 degrees in angle and 2 mm in pitch are used. The movement pitch Pv of the information electrode sheet 10 can be changed arbitrarily by setting the number of steps for the stepping motor 14 used in the display device.

[0041] As shown in Fig. 2 to Fig. 4, the movable frame

33 is supported movably with respect to two slide shafts 40 supported horizontally in the base frame 31. That is, the movable frame 33 is supported slidably in the horizontal direction along the slide shafts 40 via slide holders 41 fixed to the right and left ends of the frame 33.

[0042] Fig. 14 is a sectional view of a part of the display unit 1 taken along line B-B in Fig. 2. The information electrode sheet 10 is fixed to the front side of this movable frame 33 and hung therefrom. Therefore, both of the slide holders 41 slide on the slide shafts 40, whereby the movable frame 33 slides together with the information electrode sheet 10 in the horizontal direction with respect to the base frame 31.

[0043] As shown in Figs. 2 to 4, the fixed frame 32 includes a first fixed frame 32A and a second fixed frame 32B. Fig. 15 is a right side view of the actuating frame 13 shown in Fig. 2. In the figures, the internal structure is partially omitted for facilitating the explanation. The sectional substantially U-shaped first fixed frame 32A is fixed onto the base frame 31 with both ends of the frame 32A supported on a pair of support shafts 42. A proximal end half of the support shaft 42 (the left half in Fig. 15) is formed into a bolt 42a.

[0044] The first fixed frame 32A is pushed against a nut 44 engaged with the bolt 42a by a spring 43 mounted on the bolt 42a of the support shaft 42. When the bolt 42a protruding from the front of the base frame 31 is turned, therefore, the first fixed frame 32A is moved longitudinally (transversely in Fig. 15) on the support shaft 42 together with the nut 44. In this way, a mechanism for longitudinally moving the first fixed frame 32A configures a spacing control mechanism 45 for finely adjusting a spacing (a distance) between the masking electrode sheet 11 and the information electrode sheet 10 as described later.

[0045] As shown in Figs. 2 and 3, the second fixed frame 32B formed in a planer shape is fixed, at both ends thereof, to the first fixed frame 32A via connecting pins 46. Fig. 16 is a sectional view of a part of the display unit 1 taken along line C-C in Fig. 2. The second fixed frame 32B is pushed against the first fixed frame 32A by the spring 47 mounted on the connecting pin 46. As shown in Figs. 2, 3, and 16, a pair of pin holes in which the connecting pins 46 are inserted are provided in both ends of the second fixed frame 32B, and one of the pin holes is an elongated hole 48 with a length in a vertical direction. Thus, when the right side (in Fig. 2) of the second frame 32B is vertically moved in a range corresponding to the length of the elongated hole 48, the frame 32B is inclined about the left connecting pin 46 in Fig. 2.

[0046] A mechanism for vertically inclining one side of the second fixed frame 32B in the above manner is adopted to finely adjust an inclination of the masking electrode sheet 11 as described later. In order to finely adjust this inclination, as shown in Figs. 2 and 3, an adjustment screw 49 is provided in the first fixed frame 32A. Fig. 17 is a sectional view of a part of the display

unit 1 taken along line D-D in Fig. 2. This adjustment screw 49 is mounted vertically through the first fixed frame 32A, and an adjustment nut 50 is engaged with the male screw of the screw 49. This adjustment nut 50 is connected with the second fixed frame 32B via a bracket 51.

[0047] A bracket 51 and the adjustment nut 50 are urged upwardly by means of a spring 52 mounted on the adjustment screw 49. By turning the adjustment screw 49, accordingly, the adjustment nut 50 is vertically moved on the male screw, thereby vertically moving one side of the second fixed frame 32B. Thus, the inclination of the masking electrode sheet 11 is finely adjusted. In the present embodiment, an inclination control mechanism 53 comprises the above connecting pin 46, spring 47, elongated hole 48, adjustment screw 49, adjustment nut 50, bracket 51, and spring 52.

[0048] Fig. 18 is a sectional view of a part of the display unit 1 taken along line E-E in Fig. 2, showing an attachment state of the information electrode sheet 10 and the masking electrode sheet 11. The upper end part of the information electrode sheet 10 is fixedly held on the movement frame 33 by a poster pin 26 and a retaining nut 27. Similarly, the masking electrode sheet 11 is fixedly held on the second fixed frame 32B by another poster pin 26 and another retaining nut 27.

[0049] Next, an electrical configuration of the display device 1 will be described below. Fig. 19 is a circuit diagram of a conceptual electrical configuration of a control unit 4 in the display device 1. The control unit 4 includes a controller 61, a light receiving element 6 connected to the controller 61, and two driving circuits 62 and 63 connected to the controller 61. The light receiving element 6 is adopted to receive an infrared-ray signal from the aforementioned infrared-ray remote controller 5. The controller 61 controls the display device 1 based on a predetermined program in response to the infrared-ray signal received by the light receiving element 6.

[0050] The driving circuit 62 is adopted to supply a predetermined drive current to the stepping motor 14 upon receipt of a control signal from the controller 61. The driving circuit 63 is adopted to apply a predetermined voltage to each of the linear electrodes 24 and 25 of the electrode sheets 17 and 19 upon receipt of the control signal from the controller 61. The linear electrodes 24 and 25 of the electrode sheets 17 and 19 each are wired to form three phases. The driving circuit 63 includes a high-voltage switching section, a high-voltage supply section, and a driving control section.

[0051] The driving control section performs switching with a low voltage to output a control signal in a pattern for repeating a charging operation and a moving operation. Based on this output signal, the high-voltage switching section turns on or off an output voltage of +600V from a direct high-voltage generator serving as the high-voltage supply section to apply the voltage to the linear electrodes 24 (25) of the three phases in turn.

[0052] As described above, the control unit 4 controls the stepping motor 14, and controls voltage application to the first and second electrode sheets 17 and 19.

[0053] In the present embodiment, the control unit 4 controls switching of the voltage to be applied to the linear electrodes 24 and 25 respectively so as to causes the generation of a repulsive force by an electrostatic action between both of the electrode sheets 17 and 19 while the masking sheet 18 and the information sheet 16 are relatively moved, or the generation of an attractive force by the electrostatic action between the electrode sheets 17 and 19 when the masking sheet 18 and the information sheet 16 are not relatively moved. In the present embodiment, the control unit 4 corresponds to applied voltage control means of the present invention.

[0054] As has been described above, in the display device 1 in the embodiment, in order to select and display a predetermined item of screen information, the control unit 4 controls the stepping motor 14 to relatively move the movable frame 33 configuring the actuating frame 13 in the horizontal direction with respect to the fixed frame 32. In this manner, the masking electrode sheet 11 and the information electrode sheet 10 supported by the frames 32 and 33 are relatively moved regularly, and the specific image lines 23 provided on the information sheet 16 of the information electrode sheet 10 is aligned with the slits 21 provided on the masking sheet 18 of the masking electrode sheet 11, and appears through the slit 21 upon alignment. Then, the specific screen information is selectively displayed.

[0055] For example, when the slit 21 of the masking sheet 18 is aligned with the image line 23 represented by "A" on the information sheet 16 as shown in Fig. 13, the image information on "□" is selectively displayed as shown in Fig. 20. From this state, the movable frame 33 is moved by means of the stepping motor 14, thereby moving the information electrode sheet 10 in the horizontal direction by a predetermined distance. Accordingly, the slit 21 is aligned with the image line 23 represented by "B" on the information sheet 16 in Fig. 13, the image information on "△" is selectively displayed as shown in Fig. 21. From this state, furthermore, the movable frame 33 is moved by means of the stepping motor 14, thereby moving the information electrode sheet 10 in the horizontal direction by a predetermined distance. In this manner, when the slit 21 is aligned with the image line 23 represented by "C" on the information sheet 16 in Fig. 13, the image information on "○" is selectively displayed as shown in Fig. 22.

[0056] According to the display device 1 of the embodiment, the masking sheet 18 and the information sheet 16 are merely moved relatively at the fine width level of each slit 21, whereby a specific item of screen information is switched to a different one to be displayed. The masking sheet 18 and the information sheet 16 are mechanically supported by the fixed frame 32 and the movable frame 33, respectively, and the movable frame 33 is driven by means of the stepping motor

14. Controlling the actuation quantity of the stepping motor 14 makes it possible to drive the movable frame 33 with a fine pitch of the width level of each slit 21. As a result, the driving quantity of the movable frame 33 is reliably transmitted to the information sheet 16. Thus, the masking sheet 18 and the information sheet 16 can be relatively moved precisely and stably with fine pitches, and the display device 1 of a slit display type suitable for practical use can be provided.

[0057] Here, the information sheet 16 and the masking sheet 18 are mounted on the movable frame 33 and the fixed frame 32, respectively, and are hung therefrom. Thus, there is a possibility that both of the sheets 16 and 18 hardly come into moderately close contact with each other, and a selected item of screen information does not clearly appear through the slits 21. On the other hand, since the sheets 16 and 18 are disposed adjacently facing each other though they do not come into contact with each other, there is also a possibility that the friction caused by the relative movement of the sheets impedes precise relative movement and causes facing surfaces of the sheets become dirty.

[0058] However, according to the display device 1 in the present embodiment, the first electrode sheet 17 is bonded integrally with the information sheet 16 to configure the information electrode sheet 10. The second electrode sheet 19 is similarly bonded integrally with the masking sheet 18 to configure the masking electrode sheet 11. While the information electrode sheet 10 and the masking electrode sheet 11 are relatively moved by actuation of the stepping motor 14, the control unit 4 controls the voltage switching to generate the repulsive force by an electrostatic action between the electrode sheets 17 and 19. As a result, the masking sheet 18 and the information sheet 16 are moderately apart from each other. Thus, the friction can be prevented from occurring between the sheets 16 and 18 during the relative movement, which makes it possible to precisely relatively move the sheets 16 and 18. Accordingly, the generation of dirt by the friction of the sheets 16 and 18 can be prevented, so that a deterioration of the display quality of the display device 1 can be avoided.

[0059] On the other hand, while the masking electrode sheet 11 and the information electrode sheet 10 are not relatively moved, the control unit 4 controls the voltage switching to generate the attractive force by the electrostatic action between the electrode sheets 17 and 19. Thus, the masking sheet 18 and the information sheet 16 come into moderately close contact with each other. Accordingly, a specific screen information appearing through the slits 21 can be displayed more clearly on the display screen 2.

[0060] As described above, the repulsive force and the attractive force caused by the electrostatic action generated between the first electrode sheet 17 and the second electrode sheet 19 finely vary depending on the distance between the electrode sheets 17 and 19. In order to generate optimal repulsive force or attractive

force between the sheets 17 and 19, it is required to set the distance between the sheets 17 and 19 to an optimal value. This optimal value may vary depending on how the information electrode sheet 10 and the masking electrode sheet 11 are mounted to the actuating frame 13 or a characteristic change of these sheets 10 and 11 with time.

[0061] However, according to the display device 1 of the embodiment, the spacing control mechanism 45 for adjusting the distance (the spacing) between the first and second electrode sheets 17 and 19 are provided in the actuating frame 13. Thus, operation of the spacing control mechanism 45 makes it possible to arbitrarily control the distance between the electrode sheets 17 and 19. That is, when the information electrode sheet 10 and the masking electrode sheet 11 are mounted to the actuating frame 13 or when a certain period has elapsed from the mounting, the support shaft 42 of the spacing control mechanism 45 is arbitrarily turned to move the fixed frame 32 with respect to the movable frame 33. This operation can arbitrarily control the distance (spacing) between the information electrode sheet 10 and the masking electrode sheet 11, namely, the distance (spacing) between the first and second electrode sheets 17 and 19. Accordingly, an optimal repulsive force or attractive force can be generated appropriately between the electrode sheets 17 and 19.

[0062] On the other hand, in the embodiment, the information electrode sheet 10 and the masking electrode sheet 11 are mounted to the actuating frame 13. During this mounting work, a fine difference in inclination may occur between the information sheet 16 and the masking sheet 18. If this fine difference in inclination occurs between these sheets 16 and 18, an inclination deviation will occur between the slit 21 and the image line 23. As a result, the arrangements of the slits 21 and the image lines 23 will not accurately be aligned with each other. This also may result in a deterioration of the display quality of screen information on the display screen 2.

[0063] However, the display device 1 according to the embodiment is arranged such that the inclination control mechanism 53 for controlling the relative inclination between the masking sheet 18 and the information sheet 16 is provided in the actuating frame 13. The inclination control mechanism 53 is actuated when the information electrode sheet 10 and the masking electrode sheet 11 are mounted, thereby making it possible to arbitrarily control the relative inclination between the information sheet 16 and the masking sheet 18. To be more specific, when the information electrode sheet 10 and the masking electrode sheet 11 are mounted to the actuating frame 13, the adjustment screw 49 of the inclination control mechanism 53 is arbitrarily turned so that the inclination of the second fixed frame 32B with respect to the first fixed frame 32A is finely adjusted. This operation can prevent the occurrence of a fine difference in inclination between the information sheet 16 and the masking sheet 18, thus avoiding an alignment error between

the arrangement of the slits 21 and the arrangement of the image lines 23. Consequently, the arrangements of the slits 21 and the image lines 23 can be accurately aligned with each other. Thus the display quality of screen information can always be assured.

[0064] Furthermore, according to the display device 1 in the embodiment, the slits 21 of the masking sheet 18 are designed in advance to be arranged obliquely with respect to the horizontal or vertical direction of the display device 1 as shown in Fig. 6. The image lines 23 of the information sheet 16 are similarly designed in advance with an oblique arrangement in alignment with the slits 21 as shown in Fig. 8. When the information sheet 16 is relatively moved with respect to the masking sheet 18 by means of the actuating frame 13 and the stepping motor 14 as shown in Figs. 23 and 24, the direction of the relative movement corresponds to a direction obliquely crossing a lengthwise direction of stripes of the slits 21 and the image lines 23 at an angle almost parallel and with a slight inclination. The movement pitch P_v needed for proper alignment between the slits 21 with the image lines 23 is thus larger than the predetermined interval between the slits 21 and that between the image lines 23.

[0065] That is, in order to relatively move the slit 21 (the masking sheet 18) with respect to the image line 23 from a position corresponding to the image line 23 represented by "B" as indicated by a solid line in Fig. 25 to another position corresponding to the image line 23 represented by "A" as indicated by a double-dot line in the figure, the masking sheet 18 and the information sheet 16 can be relatively moved with the movement pitch P_v larger than width w_2 of the image line 23. Therefore, even if the width w_2 of the image line 23 is set to a very small value for the purpose of enhancing the resolution of screen information, both of the sheets 16 and 18 can be relatively moved with the movement pitch P_v larger than the width w_2 .

[0066] Thus, the relative movement of the masking sheet 18 and the information sheet 16 and the alignment between the slit 21 and the image line 23 can be performed more precisely in comparison with a case in which slits and image lines are arranged to configure a vertical striped pattern. This can ensure the relative precise movement between the masking sheet 18 and the information sheet 16 even if the slit 21 and the image line 23 are further reduced in width to enhance the resolution of screen information. The size of the above movement pitch P_v can be determined depending on the aforementioned slit angle θ .

[0067] In the above display device 1, the masking sheet 18 and the information sheet 16 are individually supported by the actuating frame 13 with mechanical stability. Therefore, displacement between the sheets 16 and 18 due to external forces imparted to the display device 1 can mechanically be prevented.

[0068] The present invention may be embodied in other specific forms without departing from the spirit or es-

sential characteristics thereof. For instance, the following alternatives may be adopted.

(1) In the above embodiments, the information sheet 16 is moved with respect to the masking sheet 18 by means of the actuating frame 13 and the stepping motor 14 for allowing the relative movement between the sheets 16 and 18. Alternatively, both the masking sheet 18 and the information sheet 16 may be moved by the actuating frame and a predetermined actuator such as a stepping motor to relatively move both the sheets 16 and 18.

(2) In the above embodiment, the electrode sheets 17 and 19 are provided with the linear electrodes 24 and 25 respectively to be applied with voltages. An alternative design is to provide the linear electrodes 59 to either one of the electrode sheets 17 and 19 and apply in advance a positive and a negative charges to the other sheet, from which the linear electrodes are omitted, so as to come into alignment with those of the linear electrodes of the former sheet.

(3) In the above embodiment, the information sheet 16 and the masking sheet 18 are disposed directly facing each other with the opposite surfaces of the sheets integrally bonded with the first and second electrode sheets 17 and 19 respectively. An alternative design is to integrally bond electrode sheets to both the facing surfaces of the information sheet and the masking sheet. Another alternative design is to integrally bond a first electrode sheet to the facing surface of either one of the information sheet and the masking sheet, and a second electrode sheet to the opposite surface of the other one of the information sheet and the masking sheet to the first electrode sheet.

(4) In the above embodiment, the image lines 23 of the information sheet 16 and the slits 21 of the masking sheet 18 arranged at the predetermined slit angle θ , and the sheets 16 and 18 are relatively moved in the horizontal direction. An alternative design is to arrange the image lines and the slits in a vertical direction for allowing relative horizontal movement between the sheets, or to arrange the image lines and the slits in a horizontal direction for allowing relative vertical movement between the sheets.

(5) Although the display device 1 in the above embodiment is a wall-hung type, it may be a stand type of supporting the main unit on legs.

(6) In the above embodiment, a plurality of linear electrodes 24 and 25 are provided in a vertical direction in the electrode sheets 17 and 19, but the arrangement pattern is not limited thereto. Any pattern which can effectively cause close contact or separation between the information sheet and the masking sheet may be used. For example, the electrode sheets may be designed such that the entire

surface of each of the electrode sheets is applied with conductive material (such as ITO) and provided with wiring to be applied with positive and negative charges.

(7) The second embodiment uses the stepping motor 14 as an actuator for driving the actuating frame 13. Alternatively, instead of the stepping motor 14, a servomotor, a linear motor, or other electric motors may be used.

(8) In the above embodiments, the display device 1 is arranged such that a desired item of screen information is arbitrarily selected by operation of the infrared-ray remote controller 5 by a user. As an alternative design is to arrange the display device to automatically switch between the plural items of screen information based on a display program stored in the control unit. For example, the display device may be arranged in an automatic control type of repeating the actions of causing a sensor to detect that a certain item of screen information is on the display and, after a predetermined time of displaying the screen information, automatically switching the displayed screen information to another screen information.

(9) In the above embodiment, the information electrode sheet 10 and the masking electrode sheet 11 are directly attached to the fixed frame 32 and the movable frame 33 respectively to be hung therefrom. Alternatively, transparent acrylic boards may be fixed to the fixed frame and the movable frame respectively so that the information sheet and the masking sheet are bonded on the facing surfaces of the acrylic boards with the information sheet and the masking sheet facing each other.

(10) In the above embodiment, the device is arranged such that the information electrode sheet 10 and the masking electrode sheet 11 are directly fixed to and hung from the fixed frame 32 and the movable frame 33 constituting the actuating frame 13, and the movable frame 33 is moved by the driving power of the stepping motor 14. An alternative design is to the use of the actuating frame configured such that two transparent acrylic boards or transparent glass boards are disposed facing each other with upper and lower sides thereof slidably fit in guide frames disposed in parallel. The information sheet and the masking sheet are fixed to the facing surfaces of the acrylic or glass boards. In this case, at least one of the two acrylic or glass boards may be driven by an actuator.

(11) In the above embodiments, the plurality of image lines 23 which configure plural items of screen information are arranged so that the image lines of different kinds are directly adjacent as shown in Fig. 12.

Alternatively, colored boundary lines 23a each having a predetermined width w_g may be disposed between the adjacent image lines 23 as

shown in Fig. 26. The color of the boundary line 23a may be a dark color equal to that of the colored portion 22 in the masking sheet 18 or a white color. When the image lines 23 configuring a specific screen information appear through the slits 21 of the masking sheet, the adjacent image lines 23 of different kinds may possibly be viewed depending on the position of line of sight of viewers who view the screen information, resulting in inconvenience for the viewers. Provision of the boundary lines 23a can thus prevent such the inconvenience. In this case, the width of the boundary line 23a may be appropriately determined according to differences in the width w_2 of the image line 23 itself, a slit angle θ , and others.

(12) In the above embodiments, the information sheet 16 is provided with the image lines 23 of three different kinds ("A, B, C" in Figs. 12 and 13) to configure three items of information. The items of screen information and the corresponding image lines are not limited to the three types. They may be appropriately determined to configure plural types of screen information.

[0069] The foregoing description of the preferred embodiment of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and modifications and variations are possible in light of the above teachings or may be acquired from practice of the invention. The embodiment chosen and described in order to explain the principles of the invention and its practical application to enable one skilled in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended hereto, and their equivalents.

Claims

1. A display device (1) including:

- a masking sheet (18) provided with a plurality of slits (21) regularly arranged at predetermined intervals;
- an information sheet (16) disposed facing the masking sheet and provided with a plurality of image lines (23) which configure plural items of screen information, the image lines being arranged so as to come into alignment with the slits;
- an actuating frame (13) for supporting the masking sheet and the information sheet disposed facing each other to allow relative movement between the sheets; and
- an actuator (14) for driving the actuating frame

to regularly relatively move the masking sheet and the information sheet.

2. The display device according to claim 1, wherein the actuating frame includes a fixed frame (32) fixed for supporting one of the masking sheet and the information sheet and a movable frame (33) for supporting the other sheet, the movable frame being movable with respect to the fixed frame by operation of the actuator.
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 - 10
3. The display device according to claim 1 or 2, further including:
 - a first electrode sheet (17) including a transparent insulation sheet provided with transparent electrodes (24) arranged in parallel with a sheet surface, the first electrode sheet being integrally configured with one of the masking sheet and the information sheet;
 - 15
 - 20
 - a second electrode sheet (19) including a transparent insulation sheet applied with positive and negative charges in alignment with the transparent electrodes of the first electrode sheet, the charges being in parallel with a sheet surface, and the second electrode sheet being integrally configured with the other of the sheets; and
 - 25
 - application voltage control means (61, 63) for controlling switching of voltage to be applied to the transparent electrodes in order to produce a repulsive force by an electrostatic action between the electrode sheets while the masking sheet and the information sheet are relatively moved, and produce an attractive force by the electrostatic action between the electrode sheets while the relative movement between the sheets is stopped.
 - 30
 - 35
4. The display device according to claim 3, wherein the actuating frame is provided with a spacing control mechanism (45) for adjusting a spacing between the first and second electrode sheets.
 - 40
5. The display device according to any one of claims 1 through 4, wherein the actuating frame is provided with an inclination control mechanism (49) for adjusting a relative inclination between the masking sheet and the information sheet to align arrangement of the slits with that of the image lines.
 - 45
 - 50

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FIG. 1

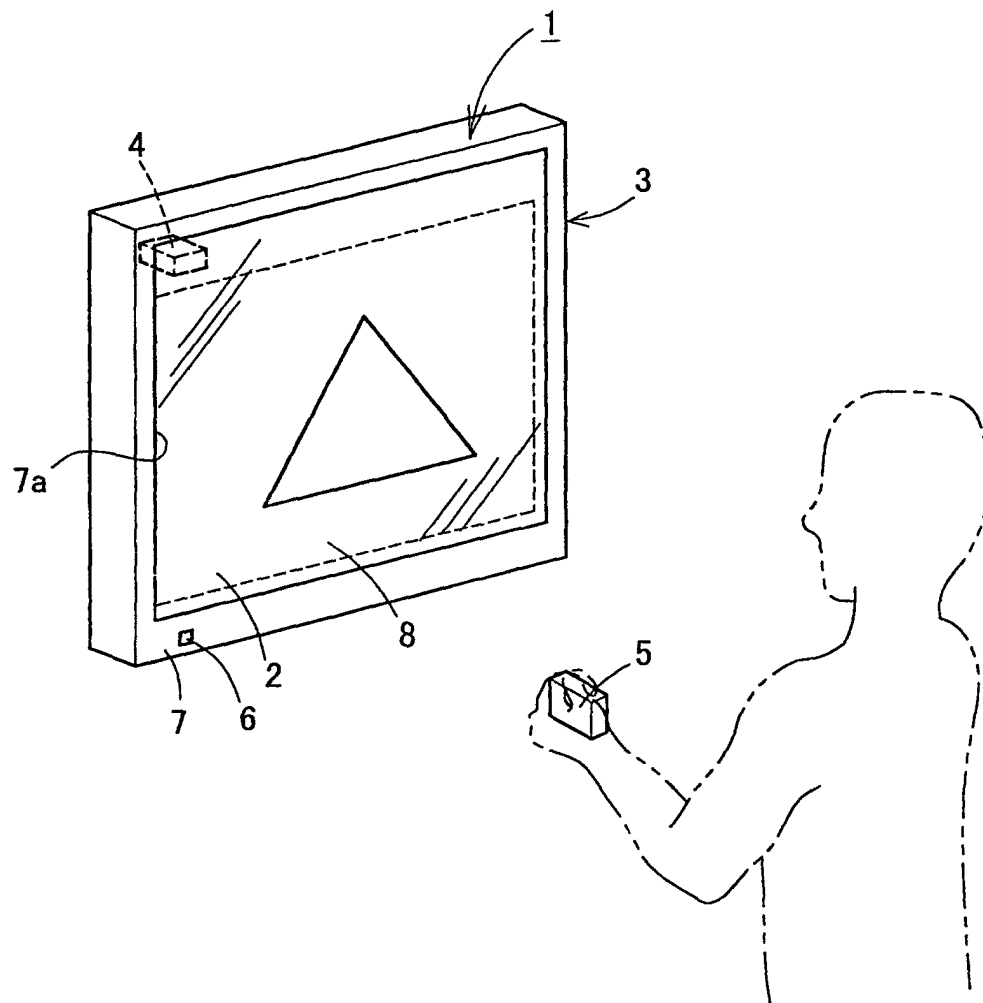


FIG. 2

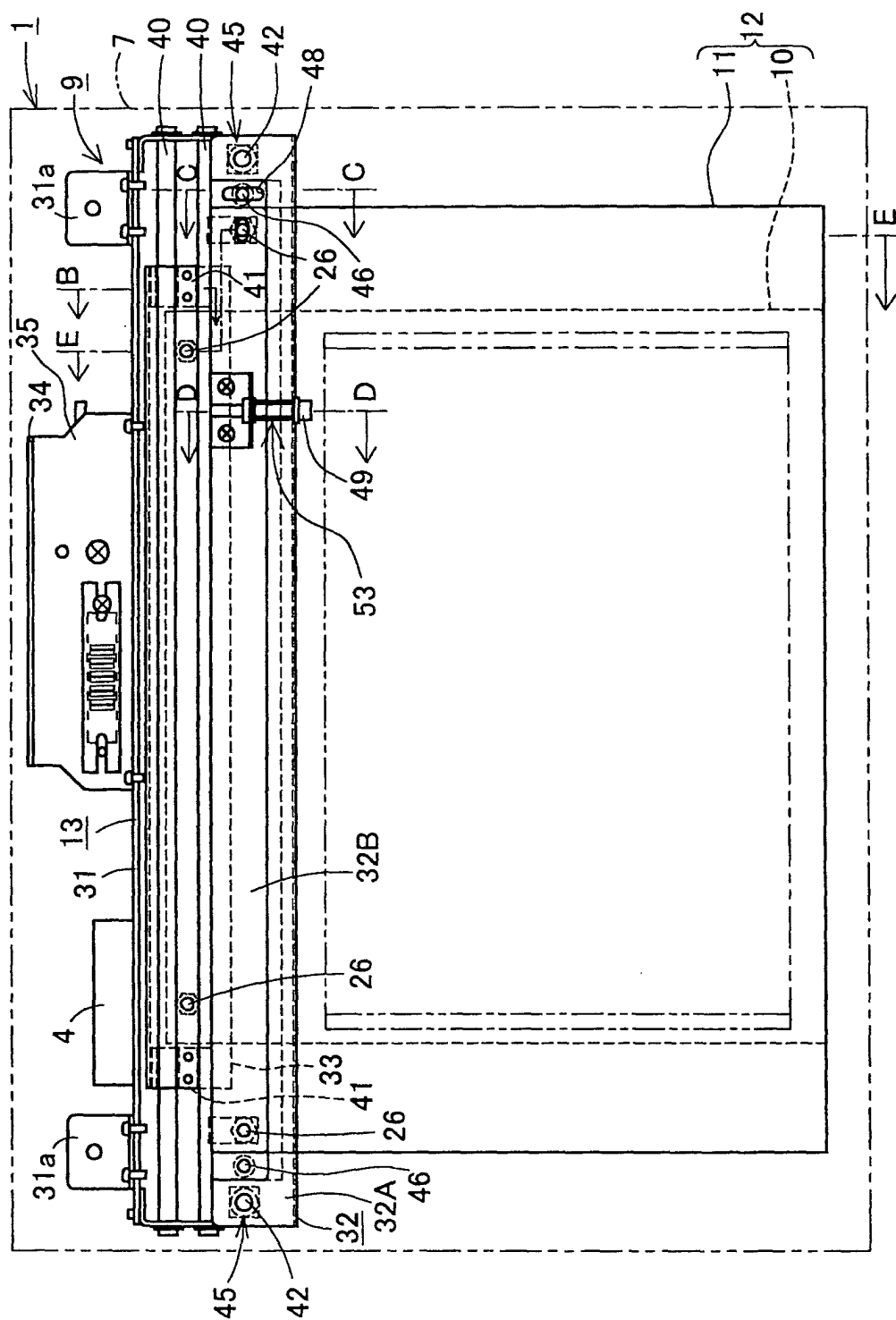


FIG. 3

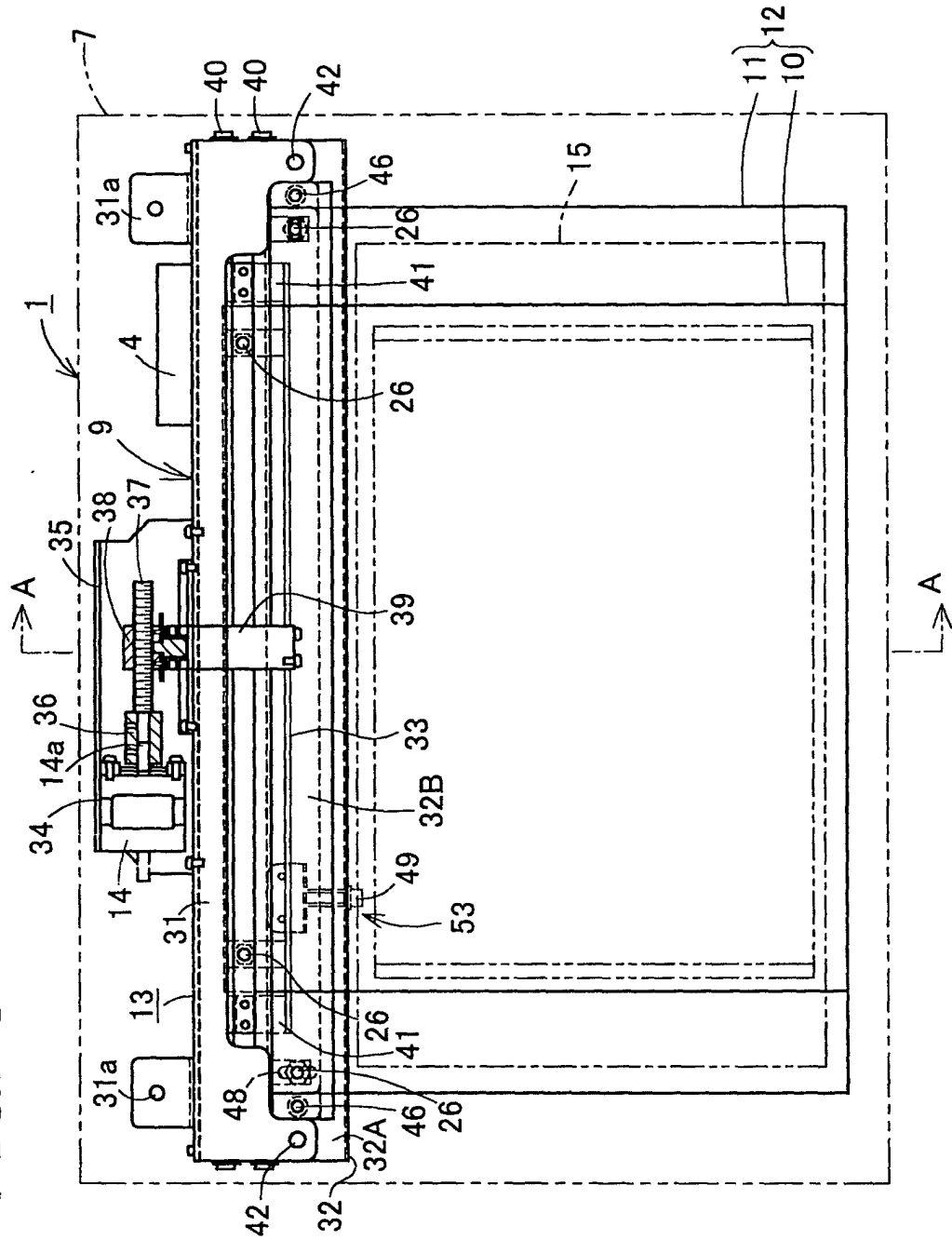


FIG. 4

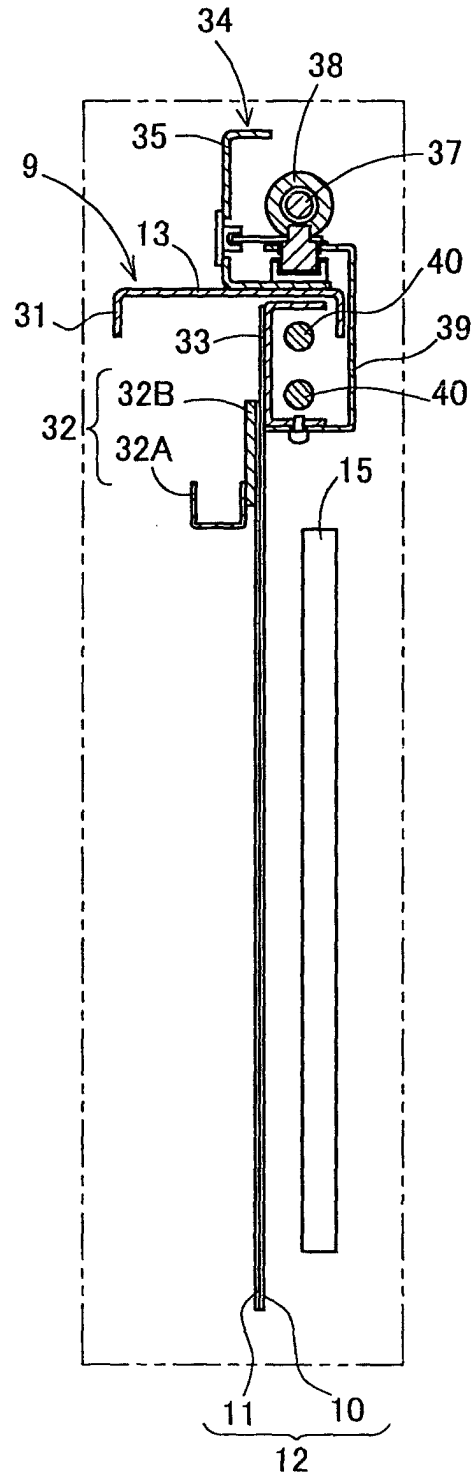


FIG. 5

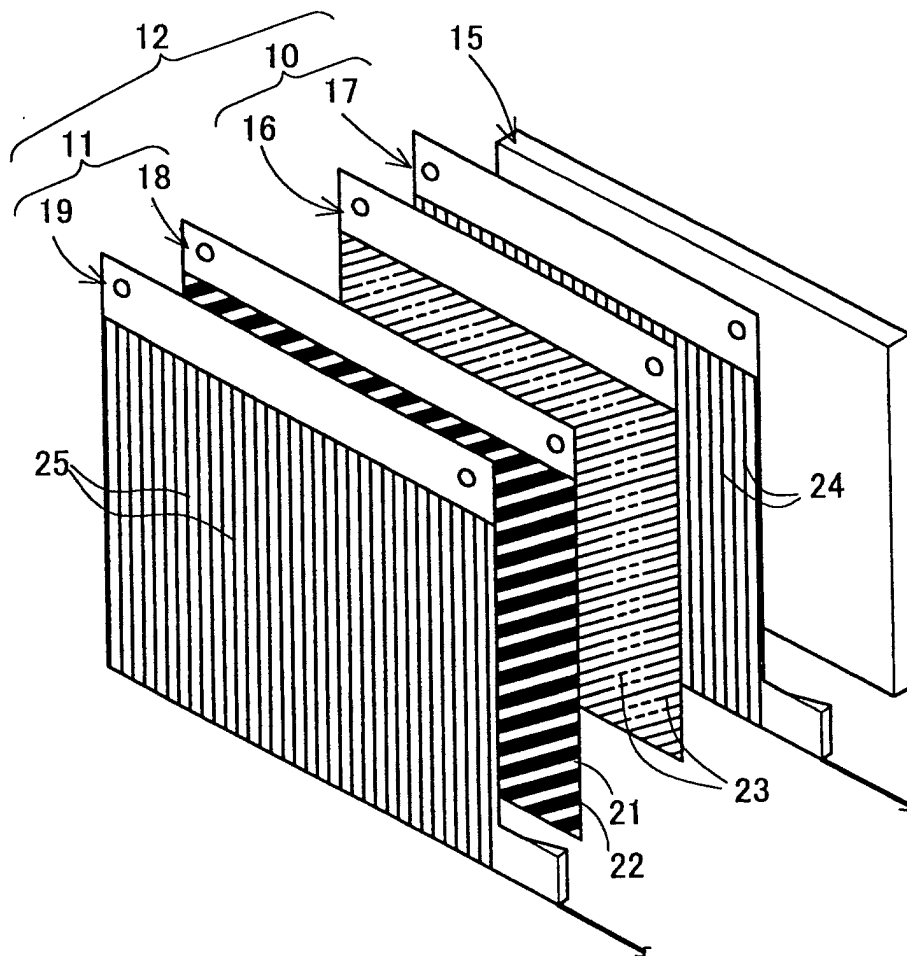


FIG. 6

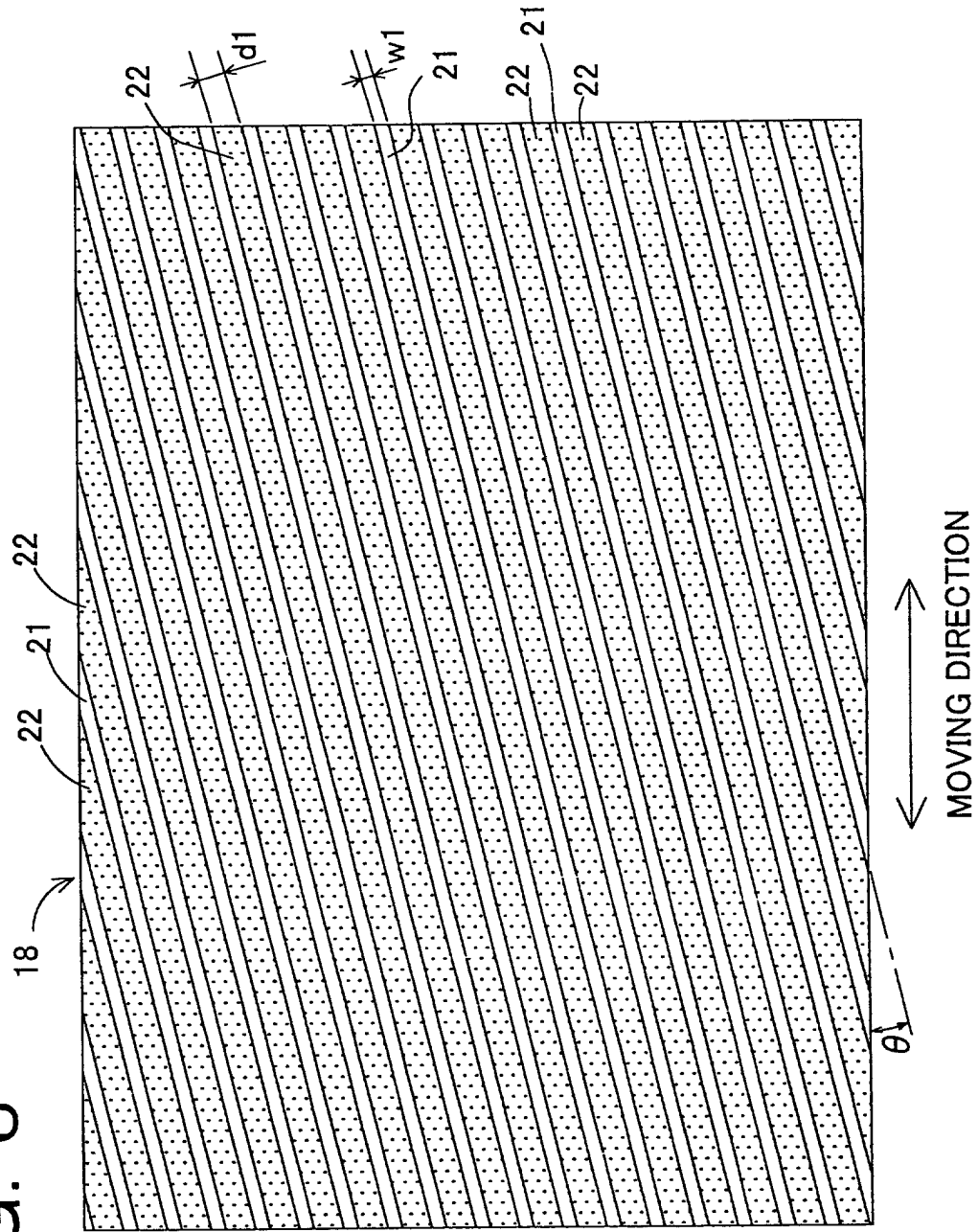


FIG. 7

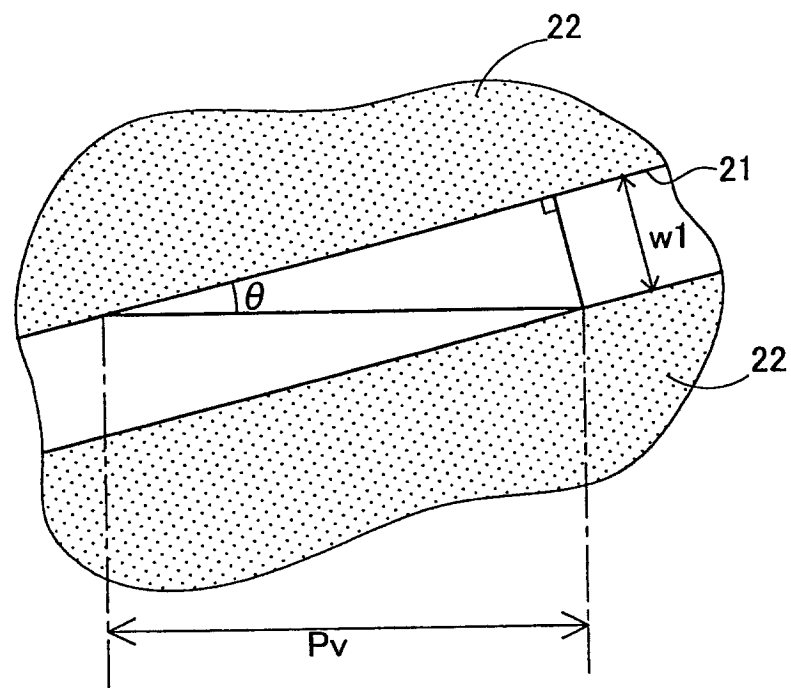
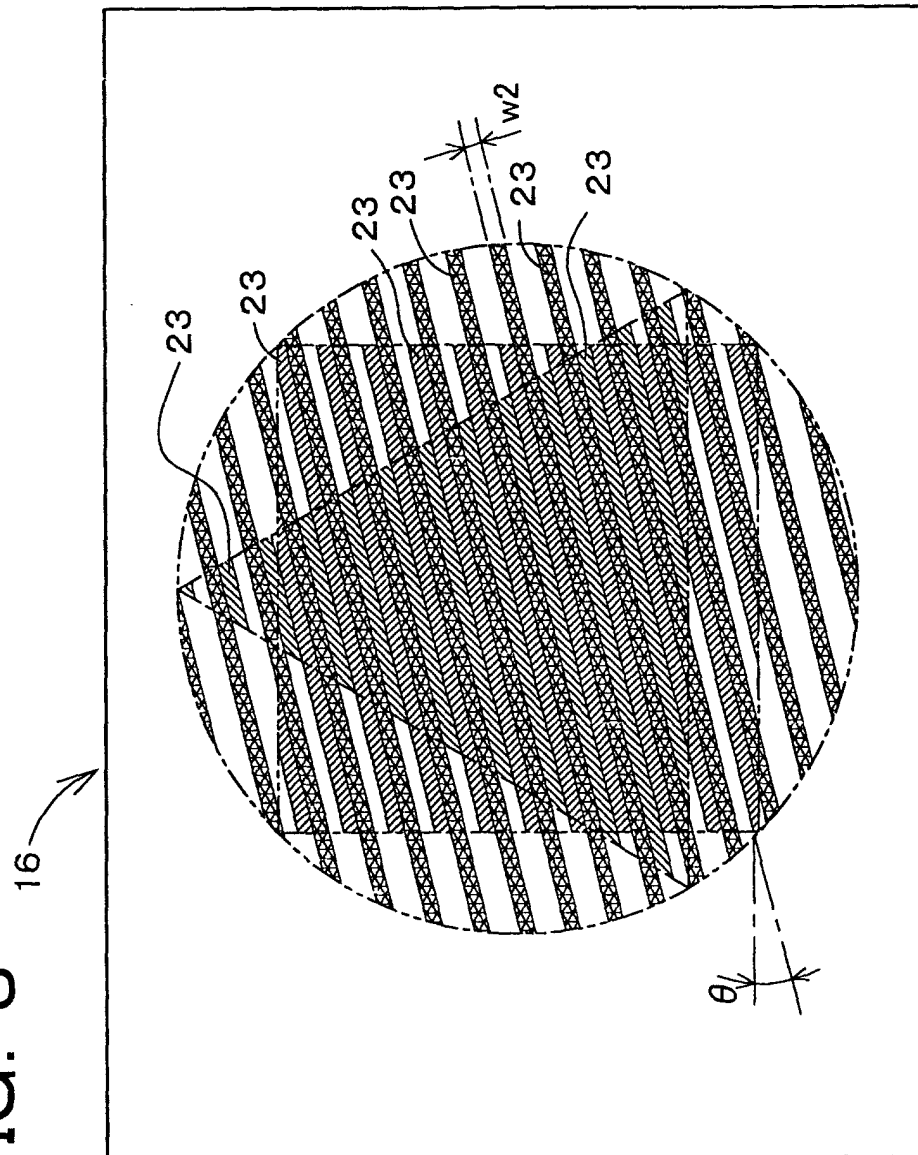


FIG. 8



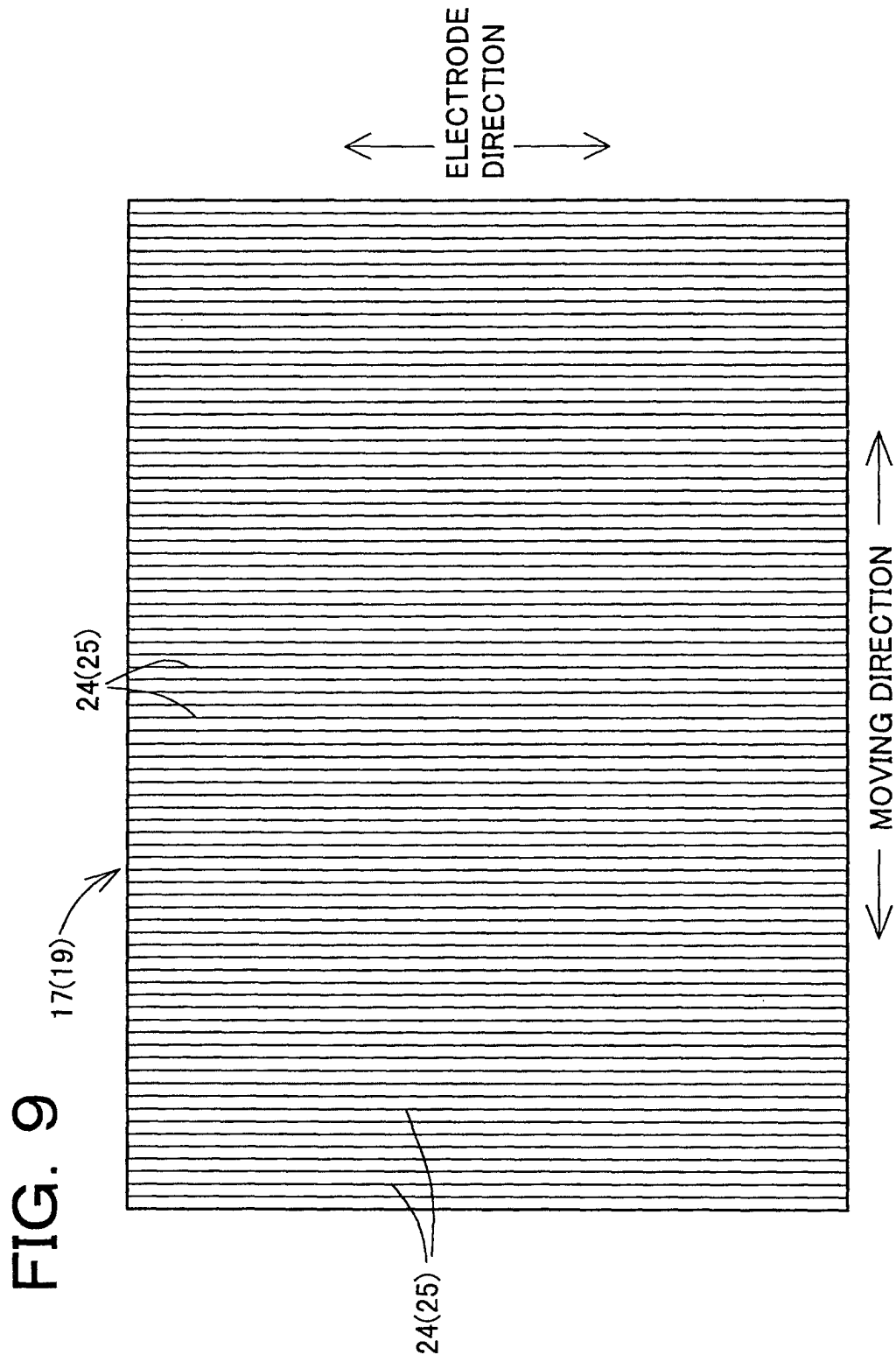


FIG. 10A

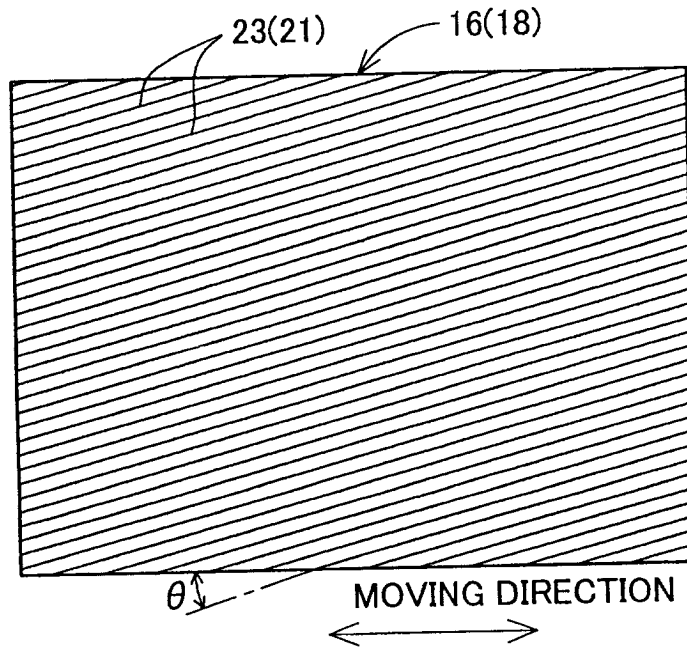


FIG. 10B

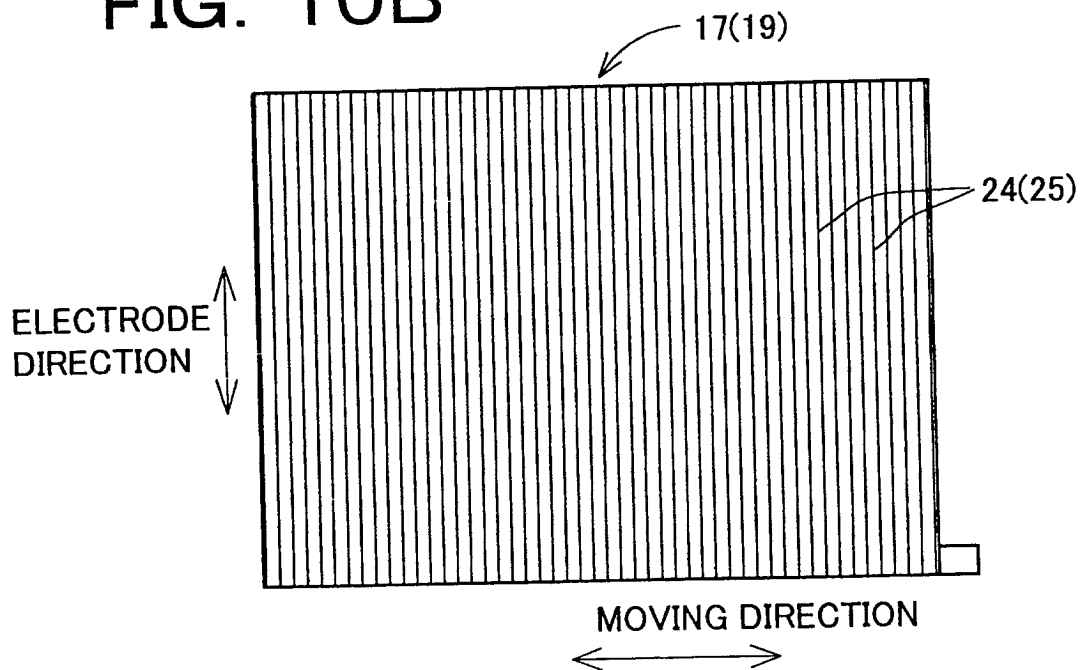


FIG. 11

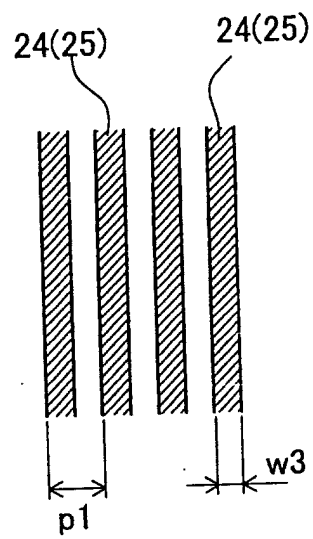


FIG. 12

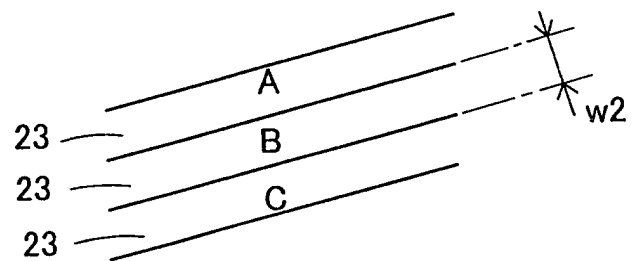


FIG. 13

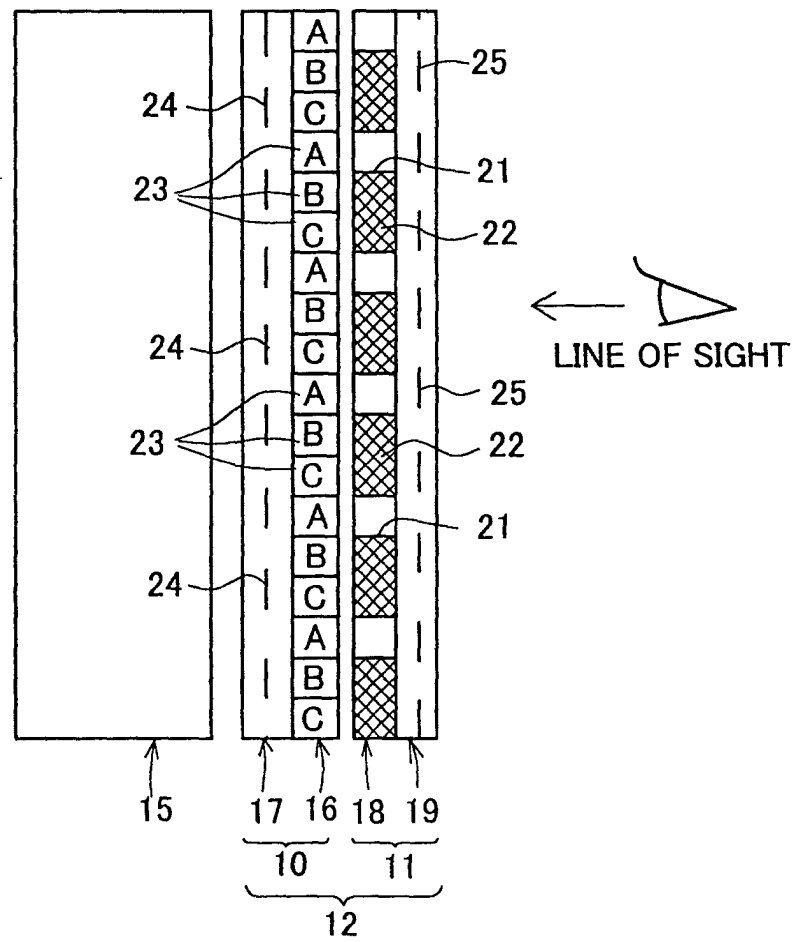


FIG. 14

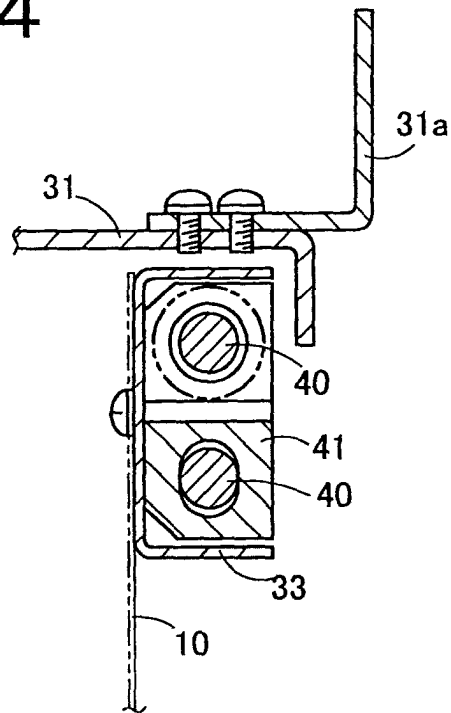


FIG. 15

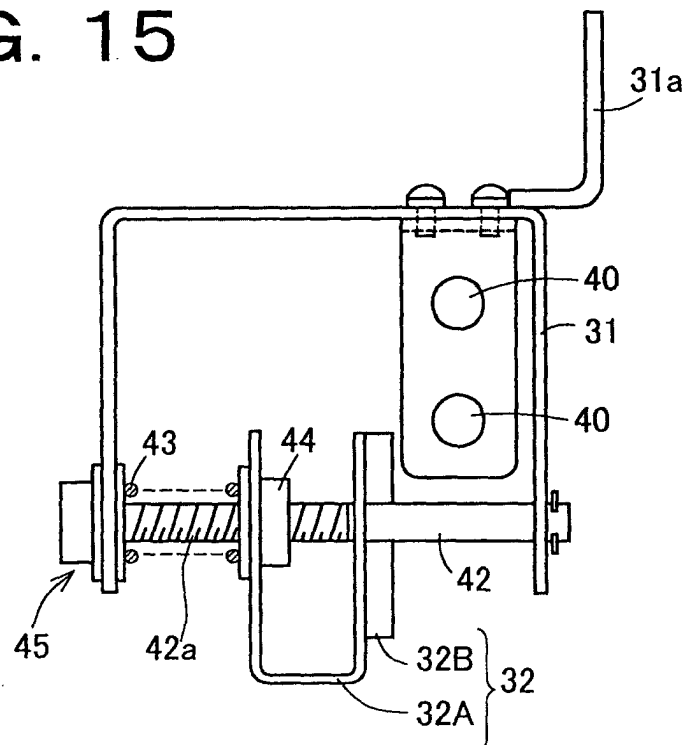


FIG. 16

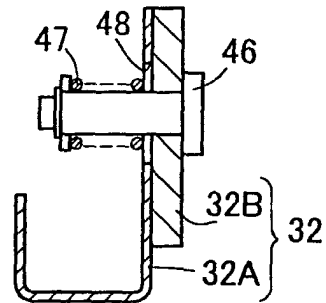


FIG. 17

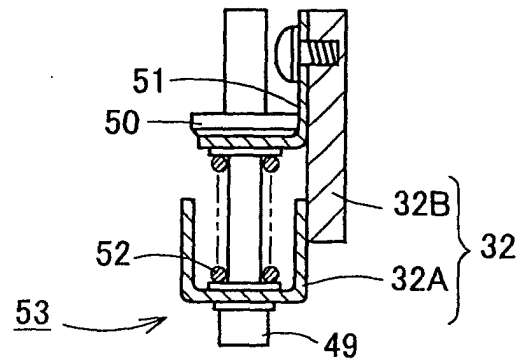
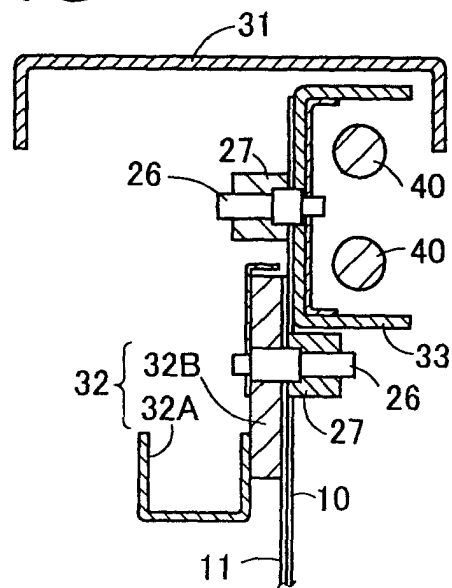


FIG. 18



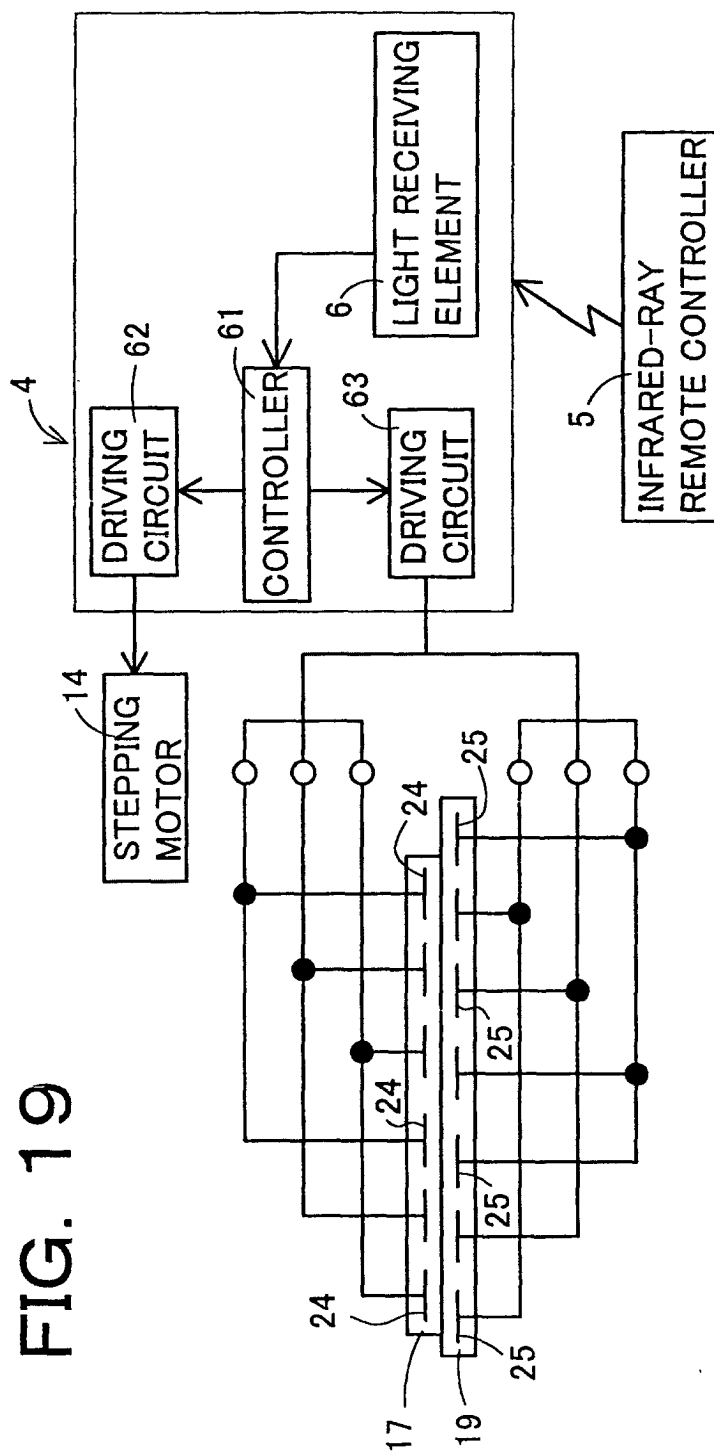


FIG. 20

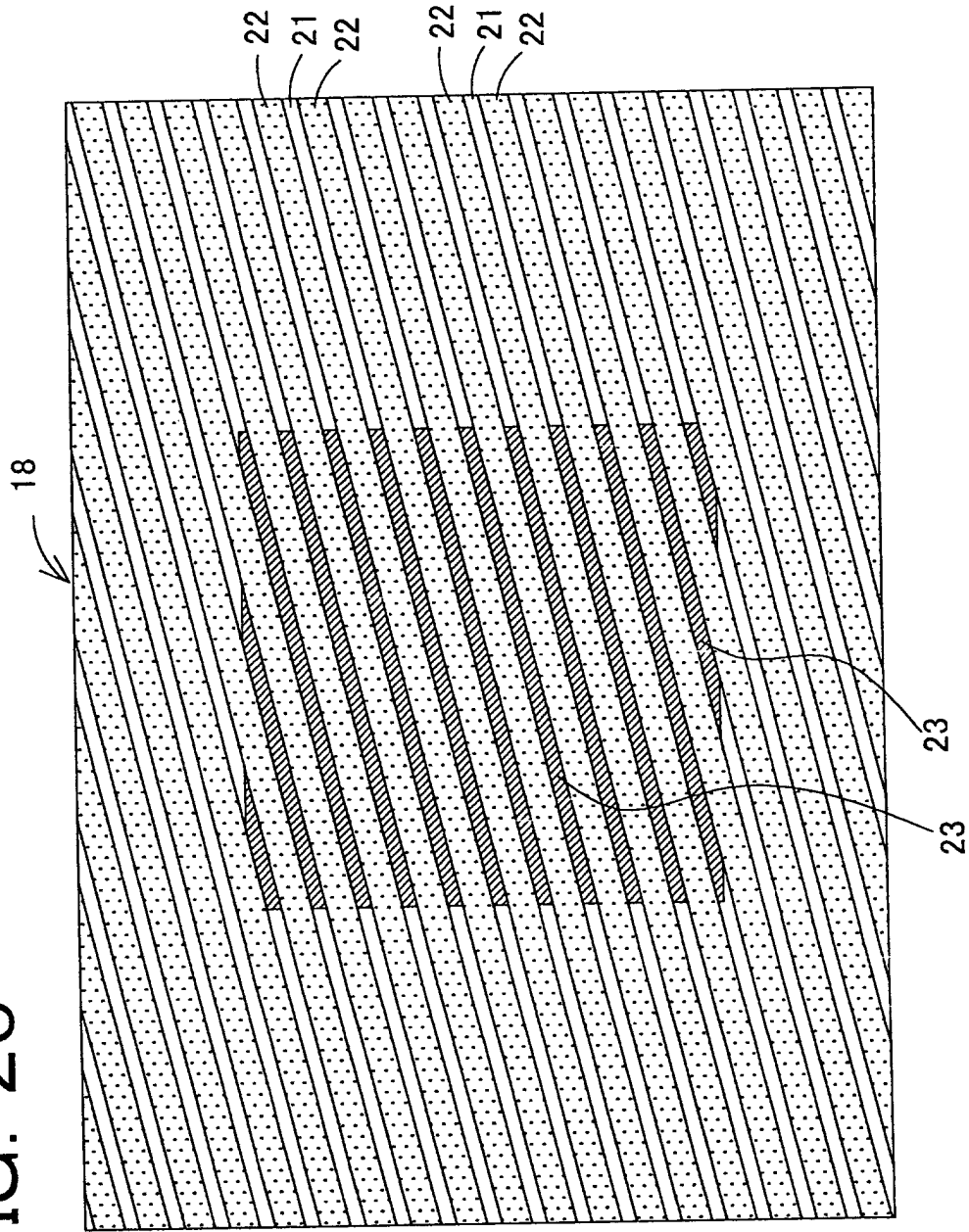


FIG. 21

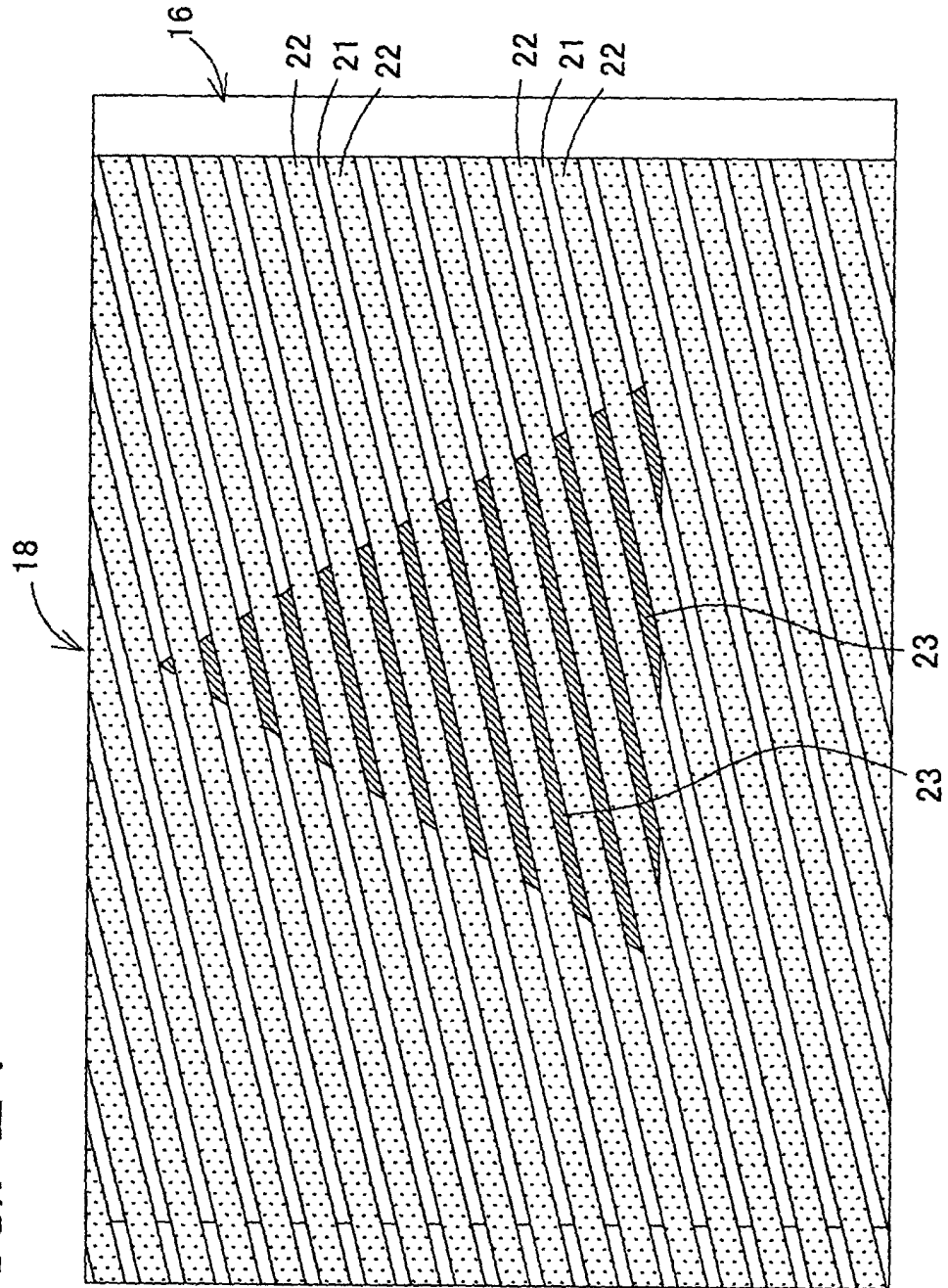


FIG. 22

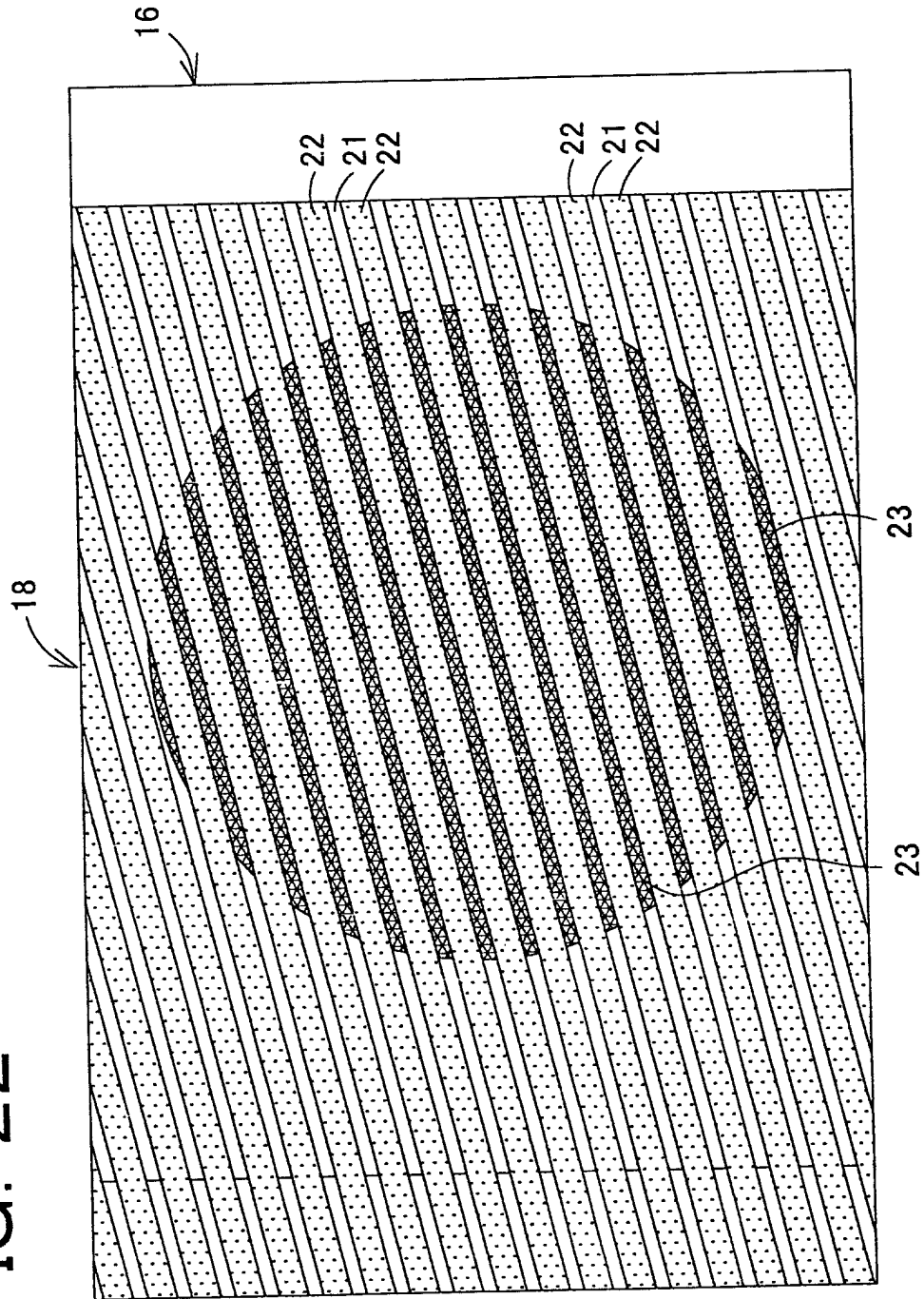


FIG. 23

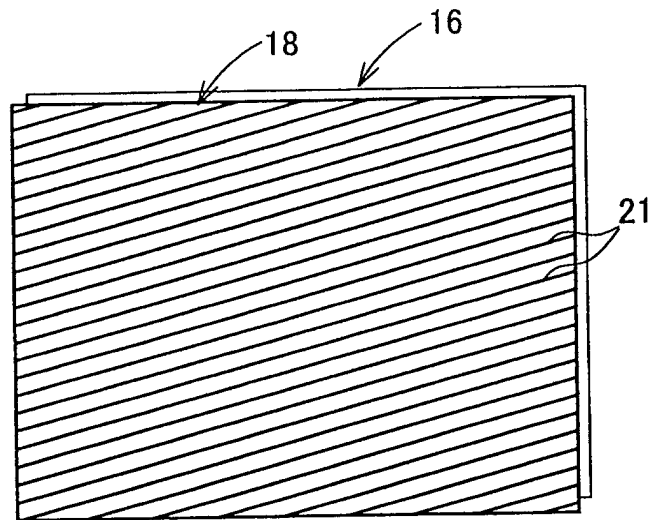
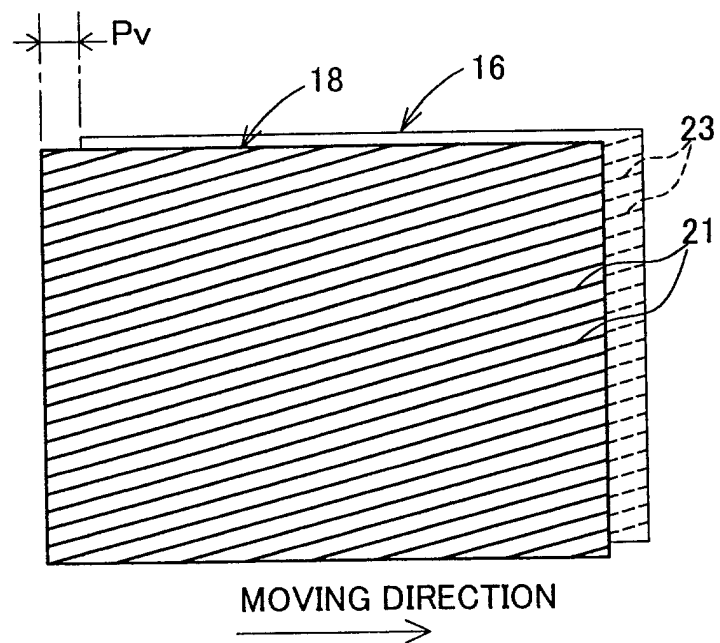


FIG. 24



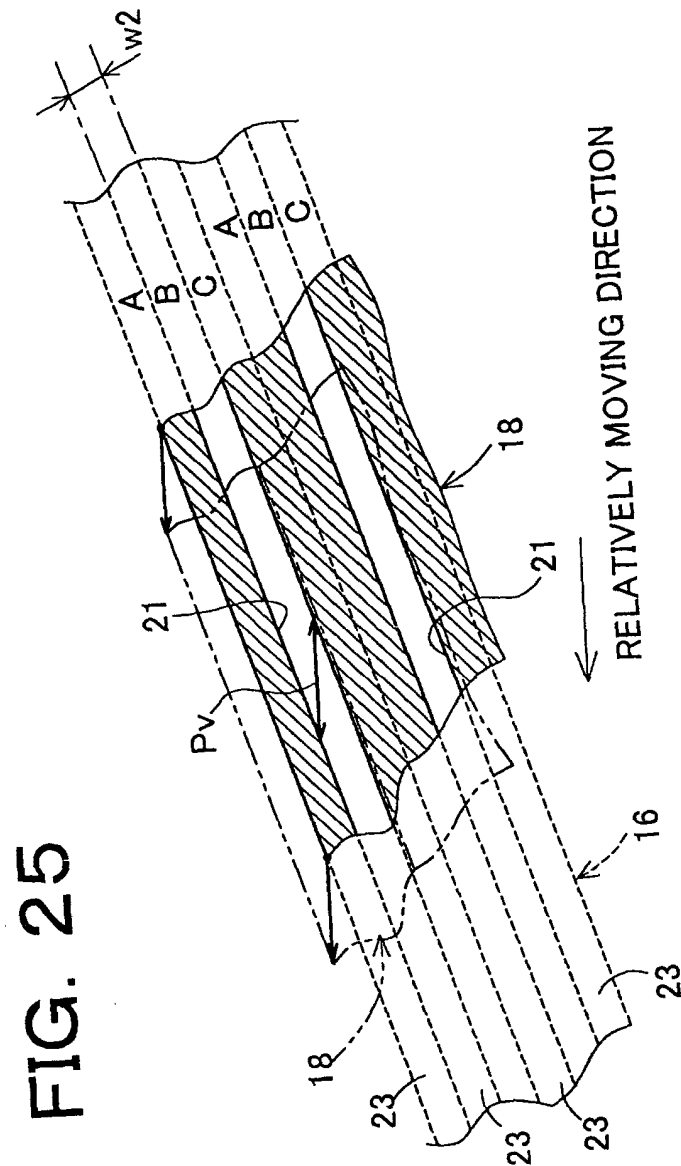


FIG. 26

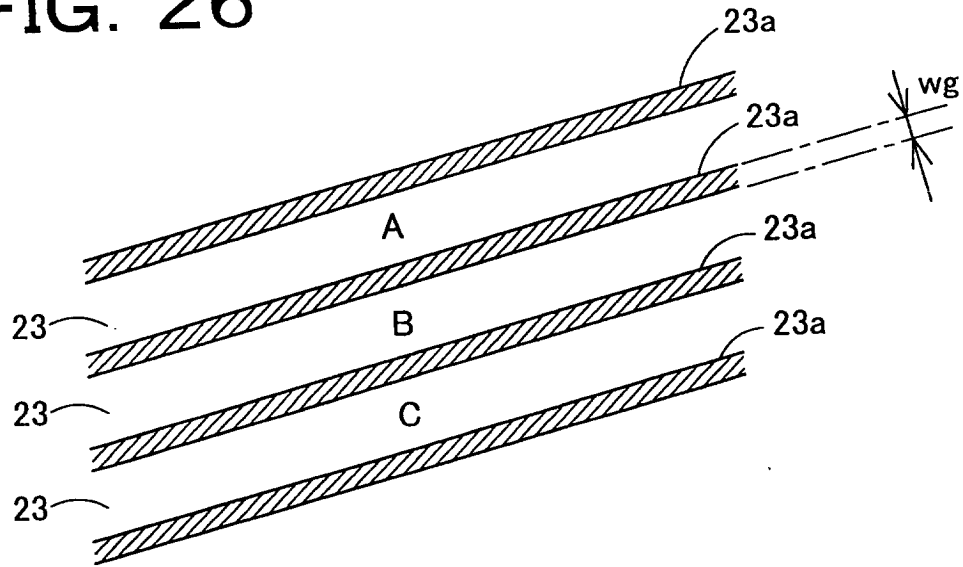


FIG. 27

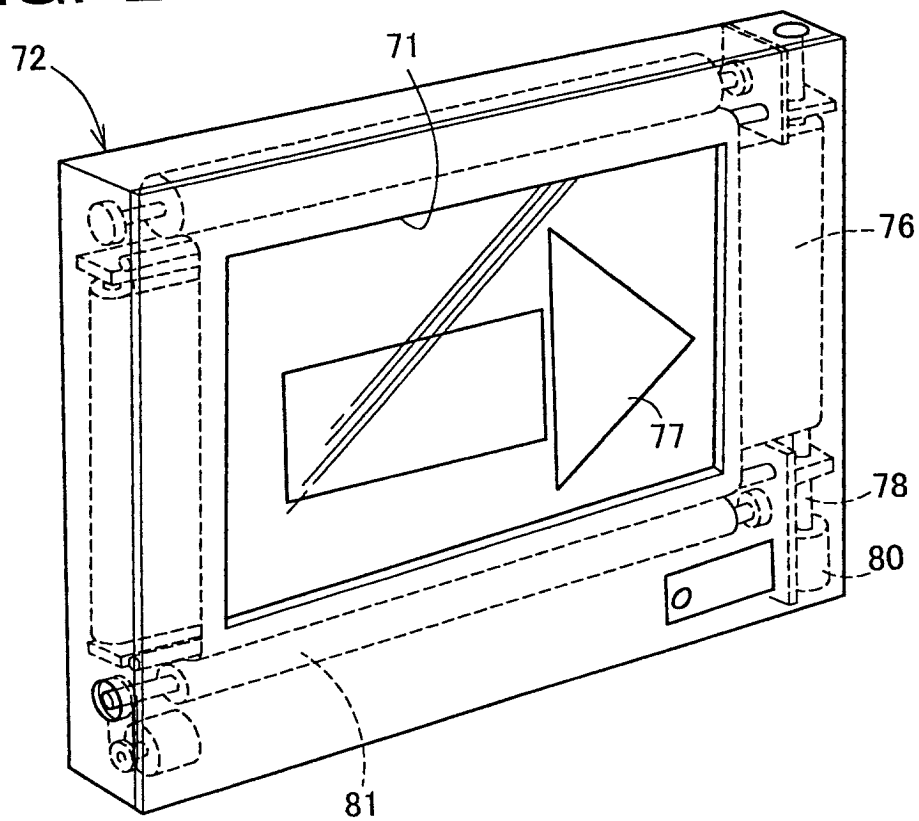


FIG. 28

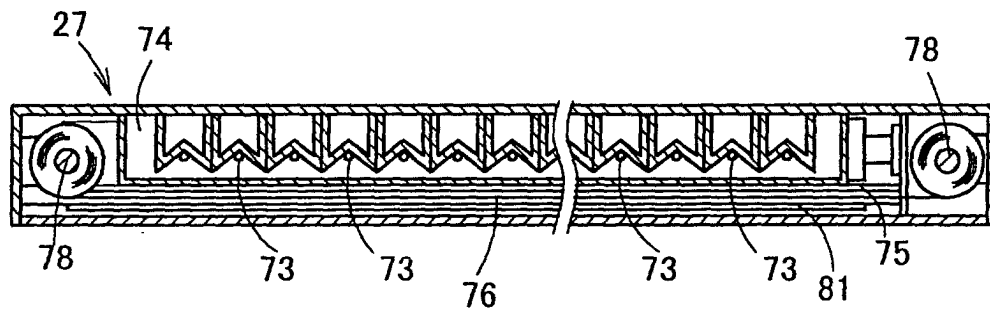
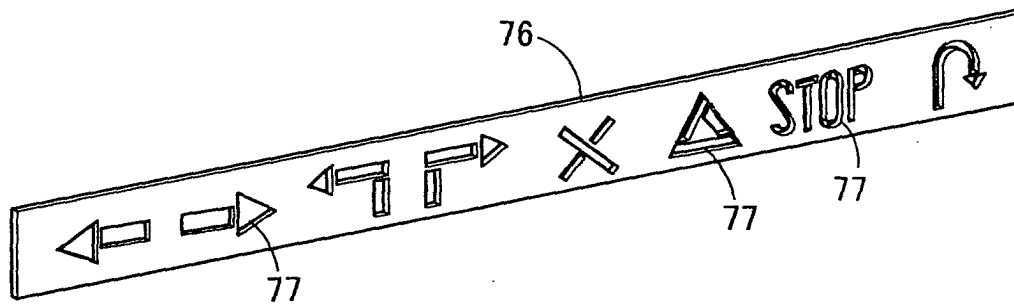


FIG. 29





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 11 9637

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.7)
X	WO 97 26642 A (J.GREENLEES LTD.) 24 July 1997 (1997-07-24) * page 12 - page 24; figures 1-7 *	1-3	G09F11/00
X	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 11, 28 November 1997 (1997-11-28) & JP 09 179509 A (MITSUBISHI CHEM CORP;KASEI OPTONIX CO LTD), 11 July 1997 (1997-07-11) * abstract *	1-3	
X	US 3 883 966 A (V.E.LUDWIG) 20 May 1975 (1975-05-20) * column 2 - column 5; figures 1-9 *	1,2	
X	US 3 484 969 A (H.A.NEWLAND) 23 December 1969 (1969-12-23) * column 2 - column 3; figures 1-5 *	1,2	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			G09F
Place of search THE HAGUE		Date of completion of the search 12 October 2000	Examiner Boeykens, J
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ON EUROPEAN PATENT APPLICATION NO.**

EP 00 11 9637

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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12-10-2000

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 9726642	A	24-07-1997	AU 1393997 A	11-08-1997
JP 09179509	A	11-07-1997	NONE	
US 3883966	A	20-05-1975	NONE	
US 3484969	A	23-12-1969	NONE	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82