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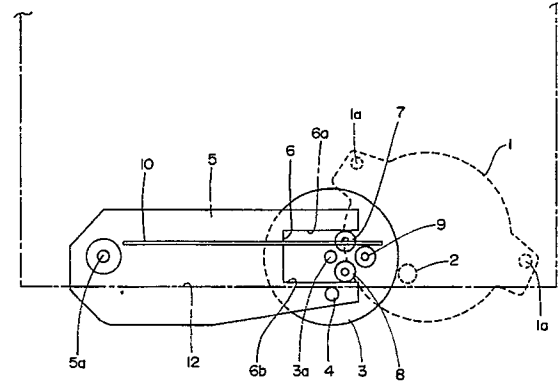
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54 **Display device.**

57 A display device comprises a reciprocating display panel, a drive motor, and a mechanism for converting the torque of the motor to a linear reciprocating operation of the panel. The conversion mechanism includes a disc (3) rotated at constant speed by the motor, first and second activating members (7,8) provided at equal radii on a surface of the disc, and a third actuating member (9) provided on the disc between the first and second members (7,8) and closer to the outer periphery of the rotational disc than the first and second members (7,8). An oscillating member (5) is attached at one end (5a) rotatably to a frame and has at its free end an opening defined by two edges (6a,6b) able to hold the first and second actuating members between them. A spring blade (10) is fixed at one end on the oscillating member (5) and bears at its free end on the third actuating member (9). A support (4) is provided on the oscillating member (5) for supporting the display panel.

FIG. 1



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The present invention relates to display devices with a reciprocating display panel and more particularly to a display device with a mechanism for converting the rotational movement of a motor to a linear reciprocating movement of a display panel.

Generally, display devices play a great roll as an advertising means in our modern life as consumers. Therefore, the display devices are required to exhibit their high distinctiveness.

Some of such known display devices use a phenomenon of moire involving generation of a movable design pattern using optical interference occurring between two overlapping reticulated design patterns by moving such patterns relative to each other. The applicant once proposed a display device using such phenomenon of moire, disclosed in Published Unexamined Japanese Patent Application Sho 62-95579.

This display device has a structure shown in FIGs. 10 and 11. This device includes a pair of front and back display panels 70 and 71. A pair of guides 72 is fixed one to each side of front display panel 70 such that back display panel 71 is slidable up and down through the guides. Front display panel 71 is made of a transparent plate with patterns and figures thereon. Displayed pattern and figure portions or transparent background portions have fine meshes 70a made of a lattice, parallel lines, radial lines and/or a combination of them drawn thereon. The back display panel 71 has meshes 71a which can coincide in position with meshes 70a. Each mesh 71a is the same as, or different from, mesh 70a. A light source (not shown) is provided behind display panels 70 and 71.

With the display device with such structure, the meshes 70a and 71a formed on the display panels 70, 71, respectively, are caused to deviate from each other by moving display panels 70 and 71 relative to each other and illuminating these panels with the light source from behind. Thus, interference (a phenomenon of moire) is caused to occur to create a small change in the quantity of light such as flickering or brightening in the meshes 70a of the front display panel 70.

In the display using such phenomenon of moire, the back display panel 71 is required to reciprocate up and down at constant speed relative to the front display panel 70. Therefore, as shown in FIG. 11, as means for driving the back display panel 71 up and down, a motor 74 supported by a bracket 73 and a mechanism for transmitting the drive force of motor 74 to the back display panel are provided. In the transmission mechanism, an arm 75 fixed to the drive shaft of the motor 74 and a roller 76 provided at an end of the arm 75 are used. The roller 76 abuts on a lower edge of the

back display panel 71.

However, in the conventional display device, the following problems are pointed out. In the transmission mechanism, the vertical movement per unit time of the arm 75 rotating at constant speed is small in the vicinity of an upper and a lower end of its locus, compared to the vertical movement of the arm when in its right and left horizontal positions. Therefore, the vertical speed of display panel 71 reciprocated up and down by the arm 75 is low at the upper and lower ends of the stroke compared to the other portions of the stroke. Thus, in the power transmission mechanism which converts a rotational motion to a vertical movement, its speed in the vicinity of the upper and lower ends of its movement is greatly low, so that it is difficult to cause the display panel to make a motion close to a linear movement at uniform speed.

Therefore, in the display device of FIG. 10 using such transmission mechanism, the generation of moire would stop at the upper and lower end of the moving stroke of the back display panel 71, so that it is difficult for moire to appear continuously.

Especially, if a slide on which waves on the water in a lake or sea are photographed is used at the front display panel 70 and the back display panel 71 is moved, a display of moving waves is made due to a phenomenon of moire. In this case, if transmission means shown in FIG. 11 is used, the move of the waves would stop when the back display panel 71 comes to the upper or lower end of the stroke, so that display itself would appear unnatural, disadvantageously.

In the conventional display device, the back display panel 71 is supported slidably by the pair of rail-like guides 72. Since in the conventional technique the back display panel 71 is greatly worn due to its sliding, the panel is low in durability. Therefore, backlash is very likely to occur in the linear motion of the back display panel 71 and a beautiful phenomenon of moire cannot be produced.

Such problems arise not only in display devices using a phenomenon of moire, but also common to all the devices which make a display by moving one or more display panels. Display effect would be impaired by reduced speed of the display panel at both ends of the stroke of the linear reciprocation converted by the rotating motor.

An object of the present invention is to provide a display device which while using a motor rotating at constant speed, the speed of the display panel is maintained substantially uniform through the overall reciprocating stroke of the display panel movement.

According to the invention in one aspect there

is provided a display device comprising a reciprocating display panel supported by a frame, a motor for driving the panel, a power transmission mechanism for converting the torque of the motor to a linear reciprocating operation of the panel, and a panel guide for guiding the panel, the power transmission mechanism comprising:

a rotational disc rotated at constant speed by the motor, a first and a second push member provided on the periphery of the same circle on a surface of the disc, the circle having the same center as the disc, and a third push member provided on the disc between the first and second push members and closer to the outer periphery of the rotational disc than the first and second push members;

a reciprocating member attached at one end rotatably to a frame, and having at another end an opening defined by two edges so as to hold the first and second push members therebetween;

a support provided on the reciprocating member for supporting the display panel;

a spring fixed at one end on the reciprocating member and abutting at another end on the third push member.

With such arrangement, when the first push member moves in the same direction as the display panel, it pushes an associated edge of the opening to move the reciprocating member. When the first push member moves orthogonal to the display panel, the second push member which has started to move in the same direction as the display panel in place of the first push member abuts on the other edge of the opening to restrict the moving speed of the reciprocating member. Therefore, only when the first and second push members move in the same direction as the reciprocating member, the reciprocating member is moved while when the first and second push members move horizontally, the reciprocating member is not pushed. Thus, the moving speed of the reciprocating member and the display panel is not reduced. The spring anchored at one end to the reciprocating member and abutting at the other end on the third push member causes the second push member to contact the opening such that the second push member limits the moving speed of the reciprocating member.

In the present invention, the transmission mechanism may comprise:

a rotational disk rotated at constant speed by the motor;

an elliptical member attached fixedly to the surface of the disc and having a pair of focal points at equal distances from the center of the disc;

a swingable arm attached rotatably to the frame and having at an end an opening defined by a pair of edges so as to hold the elliptical member

between the edges; and

a support member provided on the swingable arm for supporting the display panel.

The elliptical member has the shape of the integral combination of the first and second push members.

With such arrangement, when the rotational disc rotates, the elliptical member also rotates around the axis of the rotational disc as the center. This causes one end of the elliptical member to abut on the associated edge of the opening to push the reciprocating member when the associated outer peripheral portion of the elliptical member defining that end of its longer diameter moves in the same direction as the display panel. When the other peripheral portion of the elliptical member defining the associated other end of its longer diameter moves in the same direction as the display panel, the other end of the elliptical member abuts on the other edge of the opening to thereby limit the moving speed of the reciprocating member.

As a result, the moving speed of the reciprocating member is limited by only the ends of the elliptical member moving in the same direction as the display panel. Therefore, no reduction in the speed of the display panel occurs at the ends of the stroke of the reciprocating member.

The present invention also provides a display device comprising a reciprocating display panel, a motor having a rotatable drive shaft, a transmission mechanism for transmitting the torque of the motor through the drive shaft to the display panel, and a panel guide provided on the display panel for guiding the reciprocation of the display panel, the transmission mechanism comprising:

a drive elliptical cam provided on the drive shaft of the motor;

a follower elliptical cam meshing with the former elliptical cam such that both the cams have longer diameters orthogonal to each other; and

a support provided on the follower elliptical cam for supporting the display panel.

The drive force of the motor is transmitted from the drive elliptical cam to the follower elliptical cam to rotate same. If the drive elliptical cam rotates at constant speed, the moving stroke of the outer periphery of the drive cam is large at its outer periphery portions defining the ends of the longer diameter of the drive cam and smaller at its outer peripheral portions defining the ends of its shorter diameter. At this time, since the drive and follower elliptical cams engage each other such that their longer diameters are orthogonal to each other, the outer peripheral portion of one elliptical cam defining the end of its longer diameter engages the outer periphery portion of the other elliptical cam defining the end of its shorter diameter.

Therefore, the outer periphery portion of the drive elliptical cam which has a large moving stroke and defining one end of its shorter diameter engages the outer periphery portion of the follower elliptical cam defining the end of its longer diameter where the moving stroke of the display panel is small, so that the follower elliptical cam rotates at reduced speed.

The outer periphery portion of the drive elliptical cam which has a small moving stroke and defining one end of its longer diameter engages the outer periphery portion of the follower elliptical cam defining the associated end of its shorter diameter where the moving stroke of the display panel is large, so that the follower elliptical cam rotates at high speed.

As a result, the moving stroke of the follower elliptical cam per unit time becomes uniform throughout, and the display panel supported by a support provided on the follower elliptical cam makes a linear movement at uniform speed.

The drive force transmission mechanism for moving the display panel up and down may comprise:

a plate cam fixed to a lower edge of the display panel so as to protrude downwardly in the vicinity of the center of the lower edge of the display panel, the plate cam being defined by inclined taper edges; and

a rotational disc having a support sliding along a cam edge of the plate cam for pushing the cam edge.

With such arrangement, when the rotational disc is rotated by the motor and the push member provided on the rotational disc moves upward, the support member contacts the tapering edge of the plate cam. The support member which has moved upward moves in the direction perpendicular to the direction of movement of the display panel, so that a quantity of upward movement of the support member relative to the rotational angle of the rotational disc is small. However, since the plate cam has the central protrusion, even a small quantity of upward movement of the support member serves to move the display panel greatly upward and does not reduce the upward speed of the display panel.

The transmission mechanism may comprise:

a reciprocating member for supporting the display panel and having an opening with a pair of opposing edges:

a resilient member provided close to one of the edges of the opening and having a resiliency in a direction perpendicular to the direction of movement of the reciprocating member;

a rotational disc having a portion appearing in the opening, the disc being connected to the drive shaft of the motor;

a first push member attached to the above-

mentioned portion of the rotational disc so as to protrude outward from the opening and being engageable with the resilient member; and

a second push member attached on the above-mentioned portion of the rotational disc so as to protrude outward from the opening and being engageable with one of the edges of the opening.

With such arrangement, the second push member abuts on an associated edge of the opening to push and move the reciprocating member. When the second push member moves upward and its direction of movement becomes substantially perpendicular to the direction of movement of the reciprocating member, the moving speed of the second push member is reduced. At that time, in place of the second push member, the first push member during upward movement engages the resilient member to maintain the linear movement speed of the reciprocating member in the same direction as the first push member. When the first push member moves upward and its direction of movement approaches a direction perpendicular to the direction of movement of the reciprocating member, the moving speed of the first push member is reduced. At the time, the first push member is disengaged from the resilient member. This causes the second push member, which has started to move in the same direction as the reciprocating member due to the rotation of the rotational disc, to push the other edge of the opening to thereby directly move the reciprocating member downward. Thereafter, as in the upward movement of the display panel, the second and first push members moving in the same direction as the display panel move the reciprocating member alternately. Therefore, when the first and second portions move perpendicular to the display panel, the reciprocating member is neither moved nor reduced in speed.

The display device may have a panel guide with a leaf spring having a resiliency in the direction of movement of the display panel. Thus, backlash of the display panel in its transverse direction is suppressed.

The panel guide may have a link which is swingable only in the direction of movement of the display panel. Thus, backlash of the display panel in its transverse direction is suppressed.

The invention will now be described in more detail with reference to the following detailed description referring to the accompanying drawings in which like reference numerals designate like or corresponding parts throughout. In the drawings:

FIG. 1 is a front view of a first embodiment of the present invention;

FIGs. 2(A) - (I) each are an enlarged front view indicative of the move of the essential portion of the first embodiment;

FIGs. 3(A) and (B) each are a perspective view and a side view, respectively, of a display panel used in the first embodiment;

FIGs. 3(C) and (D) each are a perspective view of another example of a display panel used in the first embodiment;

FIG. 4 is a front view of the essential portion of a second embodiment of the present invention;

FIG. 5 is a front view of a third embodiment of the present invention;

FIG. 6 is a front view of a fourth embodiment of the present invention;

FIGs. 7(A) - (K) each are an enlarged front view indicative of move of the essential portion of the fourth embodiment;

FIGs. 8(A) and (B) are a front view and a side view, respectively, of a fifth embodiment of the present invention;

FIGs. 9(A) and (B) are a front view and a side view, respectively, of a sixth embodiment of the present invention;

FIG. 10 is a perspective view of a display device using a phenomenon of moire, as viewed from its front; and

FIG. 11 is a perspective view of the display of FIG. 10, as viewed from its back.

Preferred embodiments of the present invention will be described more specifically with reference to the drawings.

This embodiment of FIG. 1 is directed to a moire type display device similar to that shown in FIG. 10. In the present embodiment, the front display panel and the frames supporting the panel are omitted for clarifying purposes.

FIG. 1 is a front view of a power transmission mechanism used in the display device of the present embodiment. A motor 1 which moves the back display panel up and down is fixed to a frame (not shown) of the display device by screws 1a. An output gear 2 driven by the motor 1 meshes with a rotational disc 3, which rotates around a shaft 3a fixed to the frame.

Three roller-like push members 7-9 are provided rotatably on the disc 3. The first push member 7 is provided at a position in an upper right 45-degree direction from the central shaft 3a of the disc 3 as a reference point, as viewed in Fig. 1, and a second push member 8 is provided at a position in a lower right 45-degree direction from the central shaft 3a with of the first and second push members 7 and 8 being on the same circle having the center coinciding with the axis of the central shaft 3a. A third push member 9 is provided between the first and second push members 7 and 8 and closer to the disc 3 than both the push members 7 and 8.

A reciprocating member 5 is supported at one end rotatably on a shaft 5a provided on the frame.

The reciprocating member 5 extends horizontally and is positioned on this side from the disc 3 in FIG. 1. The reciprocating member 5 has a bifurcated end with an upper edge 6a and a lower edge 6b which define a square opening 6 therein to thereby permit slidable contact with the first and second push members 7 and 8.

A spring 10 is provided extending substantially parallel to the reciprocating member 5. The spring 10 includes a rod-like spring, for example, made of piano wire. An end of the spring 10 is fixed in the vicinity of the shaft 5a of the reciprocating member 5 and the other end of the spring is above the third push member 9.

A panel support 4 provided in the vicinity of an end of lower edge 6b of the opening 6. A lower edge of a back display panel 12 (shown by dot-dashed line) abuts on the panel support 4.

In the present embodiment, the back display panel 12 shown in FIGs. 3(A) and (B) is used. The upper and lower edges of the back display panel 12 each have a pair of panel guides 13, which each are made of a leaf spring one end of which is fixed to the frame (not shown) and the other end of which is fixed to the display panel 12. While the panel guides 13 are deflectable up and down due to the resiliency of the leaf spring, they cannot move in the direction transverse to the guides. Therefore, the display panel 12 moves only up and down to thereby restrict possible backlash. Since the leaf spring panel guides 13 support the display panel 12, the load of the display panel 12 exerted on the panel support 4 is controllable. The panel guides 13 are not worn and are durable because the display panel 12 does not slide. The panel guides 13 do not extrude from the right and left side edges of the display panel 12, so that appearance design is improved.

The operation of the power transmission mechanism in the present embodiment will be described next. FIGs. 2(A) - (I) illustrate the essential portions of the sequential operations of the transmission mechanism shown in FIG. 1.

In the state of FIG. 2(A), the first roller-like member 7 abuts on the upper edge 6a of the opening 6 while the second push member 8 abuts on the lower edge 6b such that the line passing through the centers of the members 7 and 8 is perpendicular to the upper and lower opening edges. The third push member 9 is very close to the spring 10. If the motor 1 is driven in this state and the output gear 2 is rotated clockwise, the rotational disc 3 is rotated counterclockwise. This causes the first push member 7 to push the upper edge 6a of the opening 6 upward to thereby lift the upper edge 6a. Therefore, the reciprocating member 5 rotates upward, so that the display panel 12 is also moved upward by the panel support of 4 of

the reciprocating member 5.

At this time the first push member 7 moves in the same vertical direction as the reciprocating member 5 so that the first push member moves at high speed.

As the rotational disc 3 further rotates, the third push member 9 abuts on the spring 10 as shown in FIG. 2(B) and the third push member 9 pushes the spring 10 upward in place of the first push member 7. This causes the first push member 7 to move away from the upper opening edge 6a to the lower opening edge 6b.

As the result of the upward movement of the spring 10 by the third push member 9, the reciprocating member 5 to which the spring 10 is fixed rotates upward around the shaft 5a. At that time, the second push member 8 abuts on the lower opening edge 6b, so that the rising speed of the reciprocating member 5 is limited by the moving speed of the second push member 8. As shown in FIGs. 2(A) and (C), the moving speed of the second push member 8 is substantially equal to that of the first push member 7 during the time when the second push member 8 moves to the horizontal position upward from the right lower 45-degree position with the shaft 3a as the reference point because the first and second push members 7 and 8 are positioned on the same circle of the rotational disc 3. The movement of the second push member 8 is along the direction of reciprocation of the reciprocating member 5, so that the second push member 8 moves at high speed. It is to be noted that the second push member 8 is different in moving speed from the third push member 9, and the difference in speed between both the members 8 and 9 is absorbed by deformation of the spring 10.

In this way, the reciprocating member 5 is pushed against the third push member 9 through the spring 10 and simultaneously, the second push member 8 abuts on the lower edge 6b of the opening to thereby restrict the moving speed of the reciprocating member 5. Thereafter, when the rotational disc 3 rotates and the first and second push members 7 and 8 abut on the lower opening edge 6b, the reciprocating member 5 arrives at its upper end.

As shown in FIG. 2(D), when the first push member 7 pushes the lower edge 6b downward, the reciprocating member 5 starts to lower. At this time, the first push member 7 moves the reciprocating member 5 to the lower left 45-degree position from the position on the same horizontal as the shaft 3a as the reference point in the figure, so that the first push member 7 is substantially equal in moving speed to the first push member 7 of FIG. 2(A) and the second push member 8 of FIG. 2(B). Since the movement of the first push member is

along the direction in which the reciprocating member 5 reciprocates, the first push member moves at high speed.

In the state of FIG. 2(D), the first push member 7 pushes the lower edge 6b downward, so that the second push member 8 moves away from the lower edge 6b. Even if the third push member 9 pushes the spring 10 upward, the first push member 7 pushes the reciprocating member 5 downward, so that the spring 10 deforms upward to thereby prevent the reciprocating member 5 from being moved by the force of the third push member 9.

As shown in FIG. 2(E), when the first push member 7 arrives at a lower left 45-degree position, the second push member 8 abuts on the upper opening edge 6a. In response, the reciprocating member 5 tries to move downward since the load of the display panel is exerted on the reciprocating member 5 through the support 4. However, downward movement of the reciprocating member 5 is limited because the reciprocating member is supported by the second push member 8. As the result of the reciprocating member 5 being supported by the second push member 8, the third push member 9 and first push member 7 are moved away from the spring 10 and the lower edge 6b, respectively.

This situation continues until the first push member 7 abuts on the upper edge 6a as shown in FIG. 2(G) through the situation of FIG. 2(F). The moving speed of the reciprocating member 5 during that time is determined by the speed of the movement of second push member 8 from the left upward 45-degree position to the left downward 45-degree position. The movement of the second push member 8 is along the direction in which the reciprocating member 5 reciprocates, so that it moves at high speed.

As shown in FIG. 2(G), when the first and second push members 7 and 8 abut on the upper opening edge 6a, the reciprocating member 5 is at the lowest position. Starting from this position, the first push member 7 pushes the upper opening edge 6a upward and the reciprocating member 5 moves upward, as shown in FIG. 2(H). As shown in FIG. 2(I), when the second push member 8 again abuts on the lower opening edge 6b, the rotational disc 3 makes its complete rotation. Since the movement of the first push member 7 during that time is along the direction of movement of the reciprocating member 5, the movement of the reciprocating member 5 by the first push member 7 is made at high speed. As the first push member 7b approaches its upper limit, the rising speed of the reciprocating member 5 decreases gradually. However, a decrease in the speed of the first push member 7 during the time when the first push

member 7 rises from the position where the first push member 7 is on the same horizontal line as the disc center 3a to a position in a direction which is at an angle of 45 degrees upward relative to the horizontal from the disc center 3a is negligible with respect to the influence on the function of the display.

As described above, the first and second push members 7 and 8 alternately push the reciprocating member 5 or restricts the moving speed of the reciprocating member 5 in the present embodiment. Therefore, in the present embodiment, the reciprocating member 5 is moved only when the first and second push members 7 and 8 move in the same direction as the reciprocating member 5. Therefore, when the first and second push members 7 and 8 move horizontally, the reciprocating member 5 is not pushed and hence the moving speed of the reciprocating member 5 and display panel 12 are not reduced whereas, conventionally, when one push member moves perpendicular to the direction of movement of the display panel, the moving speed of the display panel would decrease, disadvantageously.

In the present embodiment, the speed of the reciprocating member 5 is restricted by causing the second push member 8 to abut against the opening 6 edge. At that time, the push force of the second push member 8 against the opening 6 edges uses the action of the spring 10 and the weight of the reciprocating member 5, so that no complicated structure is required.

While in the present embodiment, the first and second push members 7 and 8 have been shown as being disposed in the respective 45-degree directions from the third push member 9 on one and the other side of the radial line passing through the centers of the third push member 9 and the disc 3, the present invention is not limited to the such angular relationship. In order to get the push force of the second push member 8 against the opening 6 edge, a pair of upper and lower springs may be used in place of the load of the display panel 12.

In place of the leaf spring of FIG. 3(A) as a panel guide, a sheet-like display panel 12 may be arranged so as to be pulled by a pair of helical springs 13a or a pull spring 13b for supporting purposes, as shown in FIGs. 3(C) and (D). At this time, an engaging portion may be provided on the sheet-like display panel 12 to be engaged with the panel support 4 of the reciprocating member 5.

In the second embodiment, as shown in FIG. 4, a transmission mechanism for moving the display panel 12 is used which includes rotational disc 3 meshing with output gear 2 of motor 1 and rotating at constant speed, and an elliptical member 14 fixed to the disc 3 and having focal points at equal distances from shaft 3a attached fixedly to the

center of rotational disc 3. Reciprocating member 5 attached rotatably to the frame (not shown), and having opening 6 defined by 6a and 6b so as to hold the elliptical member 14, and support 4 for the display panel provided in reciprocating member 5 are similar in structure to those corresponding members of the first embodiment. The elliptical member 14 includes an integral combination of first and second push members 7 and 8 of the first embodiment. One and the other periphery portions of the elliptical member 14 defining the corresponding ends of the larger diameter of the elliptical member are denoted by 14a and 14b, respectively.

When rotational disc 3 rotates in such embodiment, elliptical member 14 also rotates around the shaft 3a of the rotational disc 3. This causes one outer periphery portion 14a of the elliptical member 14 to move in the same direction as the display pane. At this time the peripheral portion 14a abuts on one opening edge 6a to push the reciprocating member 5. When the other outer peripheral portion 14b of the elliptical member 14 moves in the same direction as the display panel, it abuts on the other opening edge 6b to thereby restrict the moving speed of the reciprocating member. As a result, the moving speed of reciprocating member 5 is controlled only by the ends 14a and 14b of the elliptical member 14 moving in the same direction as the display panel 12. Therefore, no reductions in the speed occur at the stroke end of the reciprocating member 5.

In the embodiment of FIG. 5, the transmission mechanism to reciprocate the display panel 12 includes a drive elliptical cam 15 provided on output shaft 2 of motor 1 fixed to the frame (not shown), a follower elliptical cam 16 engaging the drive cam 15 such that the longer shafts of both the cams are orthogonal to each other and a support 4 provided on the follower elliptical cam 16 for support of the display panel 12.

In operation, the drive force of the drive shaft 2 of motor 1 is transmitted from the drive cam 15 to the follower elliptical cam 16 to rotate same. At this time, the cams 15 and 16 engage each other such that the longer diameters of the cams 15 and 16 are perpendicular to each other. Thus, the outer peripheral portion 15a of the drive cam 15 defining the associated end of its longer diameter engages the associated outer peripheral portion 16b of the follower cam 16 defining associated end of its shorter diameter, and the outer peripheral portion 15b of the drive cam 15 defining the associated end of its shorter diameter engages the associated outer peripheral portion 16a of the follower cam 16 defining the associated end of its longer diameter. Thus both the cams rotate.

First, when the outer peripheral portion of the

drive cam 15 defining the associated end of its longer diameter engages the outer peripheral portion of the follower cam 16 defining the associated end of its shorter diameter, it can be assumed that the drive cam 15 is a circular cam having its longer diameter and that the follower cam 16 is a circular cam having its shorter diameter. On the other hand, when the outer peripheral portion of the drive cam 15 defining the associated end of its shorter diameter engages the outer peripheral portion of the follower cam 16 defining the associated end of its longer diameter, it can be assumed that the drive cam 15 is a circular cam having its shorter diameter and that the follower cam 16 is a circular cam having its longer diameter.

According to such assumption, when the outer peripheral portion 16b of the follower cam 16 defining the associated end of its shorter diameter is driven by the outer peripheral portion 15a of the drive cam 15 which rotates at constant speed and which defines the associated end of its longer diameter, the diameter of the follower cam 16 is smaller than that of the drive cam 15. Thus the follower cam 16 rotates at higher speed than the drive cam 15.

In contrast, when the outer peripheral portion 16a of the follower cam 16 defining the associated end of its longer diameter is driven by the outer peripheral portion 15a of the drive cam 15 which rotates at constant speed and which defines the associated end of its shorter diameter, the diameter of the follower cam 16 is larger than that of the drive cam 15. Thus the follower cam 16 rotates at lower speed than the drive cam 15.

When the rotations of the cams 15, 16 are converted to linear movements, the strokes of the linear movements of the cams 15, 16 are small in the vicinity of the outer peripheral portions 15a, 16a of the drive cams 15, 16 which define the associated ends of their longer diameters, and larger in the vicinity of the outer peripheral portions 15b, 16b of the drive cams 15, 16 which define the associated ends of their shorter diameters.

Considering the above together, the follower cam 16 is rotated at high speed by the outer peripheral portion 15a of the drive cam 15 defining the associated end of its longer diameter at the outer peripheral portion 16b of the follower cam 16 defining the associated end of its shorter diameter and providing a large moving stroke. The follower cam 16 is rotated at lower speed by the outer peripheral portion 15b of the drive cam 15 defining the associated end of its shorter diameter at the outer peripheral portion 16a of the follower cam 16 defining the associated end of its longer diameter and providing a smaller moving stroke.

As a result, the overall moving stroke of the follower elliptical cam 16 per unit time is substan-

tially uniform and the display panel 12 supported by the support 4 provided on the follower cam 16 makes a linear movement at uniform speed.

In the embodiment, shown in FIG. 6, reciprocating member 30 which supports the display panel is provided reciprocatably on support plates 35a and 35b provided on the support base 34. At this time, the reciprocating member 30 has an upper and a lower guide slot 28 in which corresponding stud guides 27 fixed to support plates 35a, 35b are received. A motor 33 is disposed on support plate 35b. Rotational disc 29 is press fitted over the drive shaft 33a of the motor 33.

That portion of the reciprocating member 30 opposing the rotational disc 29 has an opening 25 defined by upper and lower horizontal inner edges 25a and 25b. The reciprocal member 30 has a pair of rod-like resilient members 23, 24 attached at one end by screws 32 to the reciprocating member 30. The resilient members 23 and 24 have resiliency in a direction perpendicular (horizontally, in FIG. 6) to the direction of movement of the reciprocating member 30 (vertically, in FIG. 6) and are deflectable. The resilient members 23, 24 each have a restrictive protrusion 31 thereon to restrict the movement thereof. The resilient member 23, 24 have free bent engaging ends 23a and 24a normally positioned close to the lower and upper opening edges 25b and 25a in the slot or opening 25.

A first and a second push members 21 and 22 are provided on rotational disc 29 so as to extend from the opening 25 outward. First push member 21 is engageable with the engaging ends 23a and 23b of the resilient members 23, 24, respectively. Second push member 22 is arranged to abut on the upper and lower edges 25a and 25b of opening 25.

The operation of the fourth embodiment is as follows. As shown FIGs. 7(A), (B), if rotational disc 29 rotates with first push member 21 engaged with engaging end 23a of resilient member 23, reciprocating member 30 is pulled upward in the figure. At this time, first push member 21 is moving in the same direction as reciprocating member 30, so that the moving speed of first push member 21 is high. As first push member 21 approaches its upper limit, the speed of first push member 21 in the rising direction gradually decreases.

Before the speed of first push member 21 greatly decreases, however, second push member 22 abuts on lower opening edge 25b in FIG. 7(C), and reciprocating member 30 is forced by second push member 22 to change its direction of movement instantaneously downward in the figure. Since second push member 22 is moving in the same direction as reciprocating member 30, its moving speed is maintained high even if its direction of

movement is reversed.

Thereafter, first push member 21 is disengaged from engaging end 23a of resilient member 23, as shown in FIG. 7(D). As shown in FIG. 7(E), reciprocating member 30 is pushed downward by

second push member 22. If reciprocating member 30 is further pushed downward by second push member 22, the direction in which the second push member 22 moves is substantially perpendicular to the direction of movement of reciprocating member 30, so that the lowering speed of second push member 22 gradually decreases. However, before the lowering speed of second push member 22 greatly decreases, engaging end 24a of resilient member 24 is engaged with first push member 21, as shown in FIG. 7(F) and reciprocating member 30 is further lowered by the force of first push member 21. Since the first push member 22 is in the same direction of movement as reciprocating member 30, the moving speed of reciprocating member 30 is not reduced.

As shown in FIGs. 7(G), (H), even if second push member 22 is disengaged from lower opening edge 25b, reciprocating member 30 is still pushed downward by resilient member 24 engaged with first push member 21.

When second push member 22 of FIG. 7(I) abuts on upper opening edge 25a, reciprocating member 30 moving downward in the figure is pushed by second push member 22 to instantaneously alter its direction of movement upward in the figure.

As shown in FIGs. 7(J), (K), engaging end 24a of resilient member 24 is then disengaged from first push member 21, and reciprocating member 30 is pushed downward by second push member 22 to thereby return to its state shown in FIG. 7A.

As described above, according to the present embodiment, first and second push members 21 and 22 alternately move reciprocating member 30. The movement of reciprocating member 30 by two push members 21, 22 occurs only when reciprocating member 30 and the push members have the same direction of movement. As a result, when push members 21, 22 are at their upper and lower limits and their vertical movements are small, reciprocating member 30 is not moved. Thus, the moving speed of reciprocating member 30 does not lower.

As shown in FIG. 8(A), (B), the fifth embodiment has a panel guide 17 on a lower edge of display panel 12 as shown in FIG. 8. Panel guide 17 has a downward extending taper at the center of the lower edge of panel guide 17 and defined by a pair of parabolas 17a. A support 11 which supports the display panel 12 is provided on disc 3 close to its outer periphery so as to be able to abut on the lower edge of panel guide 17.

In such embodiment, as rotational disc 3 rotates, support 11 slides along the lower parabolic edge 17a of panel guide 17. Even when the vertical stroke of support 11 is small, display panel moves vertically at substantially constant speed along taper side 17a due to its tapering edge. Therefore, display panel 12 makes a linear movement at uniform speed to thereby exhibit a phenomenon of moire effectively.

As shown in FIG. 9(A), (B), in the sixth embodiment, a guide ring 20 which is swingable only in the direction of movement of display panel 12 is disposed on a side of display panel 12. By this arrangement, right and left backlash of the display panel is suppressed to thereby improve the linear accuracy of the panel movement.

Claims

1. A display device comprising a display panel supported reciprocatably by a frame, a motor for driving the panel, a power transmission mechanism for converting the torque of the motor to a linear reciprocating operation of the panel, and a panel guide for guiding the panel, the power transmission mechanism comprising:

a rotational disc rotated at constant speed by the motor, a first and a second push member provided on the periphery of the same circle on a surface of the disc, the circle having the same center as the disc, and a third push member provided on the disc between the first and second push members and closer to the outer periphery of the rotational disc than the first and second push members;

a reciprocating member attached at one end rotatably to a frame, and having at another end an opening defined by two edges so as to be able to hold the first and second push members therebetween;

a support provided on the reciprocating member for supporting the display panel;

a spring fixed at one end on the reciprocating member and abutting at another end on the third push member.

2. A display device comprising a display panel supported reciprocatably by a frame, a motor for driving the panel, a power transmission mechanism for converting the torque of the motor to a linear reciprocating operation of the panel, and a panel guide for guiding the panel, the power transmission mechanism comprising:

a rotational disk rotated at contact speed by the motor;

an elliptical member attached to the sur-

face of the disc and having a pair of focal points at equal distances from the center of the disc;

a swingable arm attached rotatably to the frame and having at an end an opening defined by a pair of edges so as to hold the elliptical member between the edges; and

a support member provided on the swingable arm for supporting the display panel.

3. A display device comprising a reciprocating display panel, a motor having a rotatable drive shaft, a transmission mechanism for transmitting the torque of the motor through the drive shaft to the display panel to move the display panel up and down, and a panel guide provided on the display panel for guiding the reciprocation of the display panel, the transmission mechanism comprising:

a drive elliptical cam provided on the drive shaft of the motor;

a follower elliptical cam meshing with the former elliptical cam such that both the cams have longer diameters orthogonal to each other; and

a support provided on the follower elliptical cam for supporting the display panel.

4. A display device comprising a reciprocating display panel, a motor having a rotatable drive shaft, a transmission mechanism for transmitting the torque of the motor through the drive shaft to the display panel to move the display panel up and down, and a panel guide provided on the display panel for guiding the reciprocation of the display panel, the transmission mechanism comprising:

a plate cam fixed to a lower edge of the display panel so as to protrude downwardly in the vicinity of the center of the lower edge of the display panel, the plate cam being defined by taper edges; and

a rotational disc having a support sliding along a cam surface of the plate cam for pushing the cam surface of the plate cam.

5. A display device comprising a reciprocating display panel, a motor having a rotatable drive shaft, a transmission mechanism for transmitting the torque of the motor through the drive shaft to the display panel to move the display panel up and down, and a panel guide provided on the display panel for guiding the reciprocation of the display panel, the transmission mechanism comprising:

a reciprocating member for supporting the display panel and having an opening with a pair of opposing edges:

a resilient member provided close to one of the edges of the opening and having a resiliency in a direction perpendicular to the direction of movement of the reciprocating member;

a rotational disc provided so as to have a portion appearing in the opening, the disc being connected to the drive shaft of the motor;

a first push member attached to the above-mentioned portion of the rotational disc so as to protrude outward from the opening and being engageable with the resilient member; and

a second push member attached to the above-mentioned portion of the rotational disc so as to protrude outward from the opening and being engageable with one of the edges of the opening.

6. A display device comprising a reciprocating display panel, a motor having a rotatable drive shaft, a transmission mechanism for transmitting the torque of the motor through the drive shaft to the display panel to move the display panel up and down, and a panel guide provided on the display panel for guiding the reciprocation of the display panel, the panel guide comprising: a leaf spring having a resiliency exhibited only in the direction of movement of the display panel

7. A display device comprising a reciprocating display panel, a motor having a rotatable drive shaft, a transmission mechanism for transmitting the torque of the motor through the drive shaft to the display panel to move the display panel up and down, and a panel guide provided on the display panel for guiding the reciprocation of the display panel, the panel guide comprising:

a link swingable only in the direction of movement of the display panel.

FIG. 1

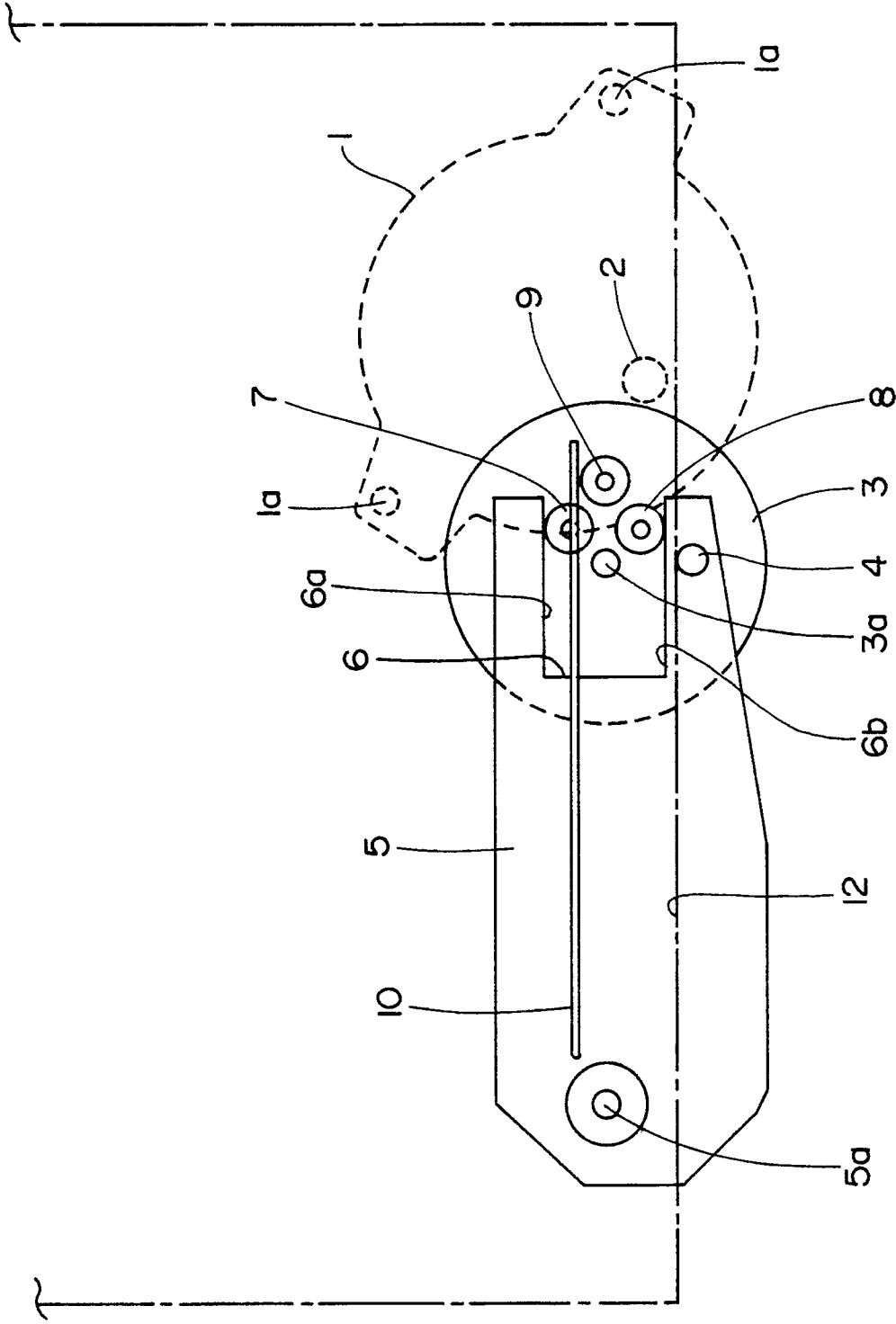


FIG. 2 (A)

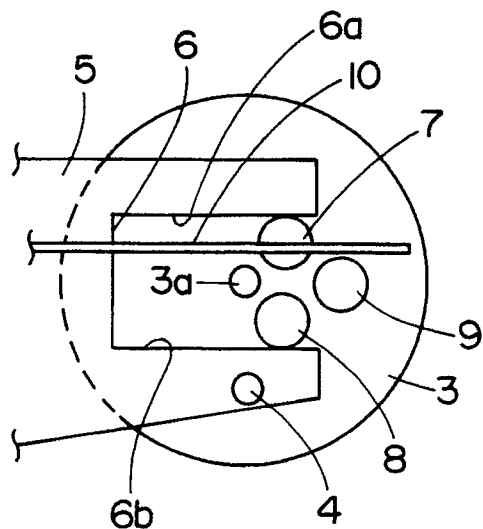


FIG. 2 (B)

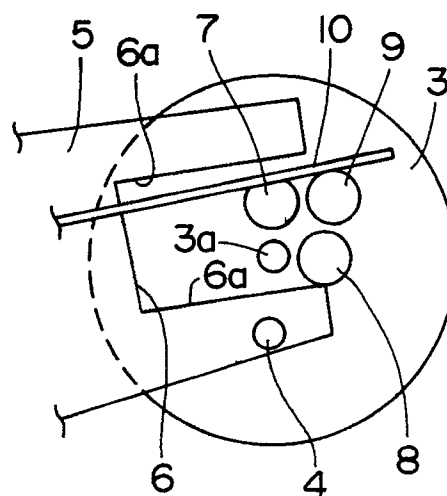


FIG. 2 (C)

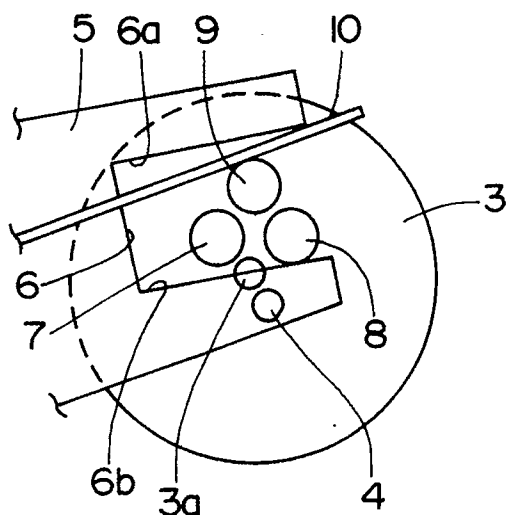


FIG. 2 (D)

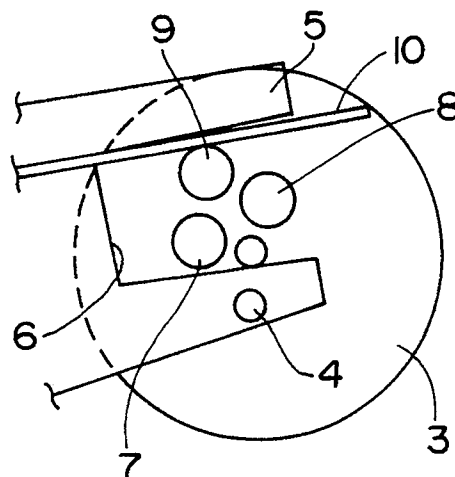


FIG. 2 (E)

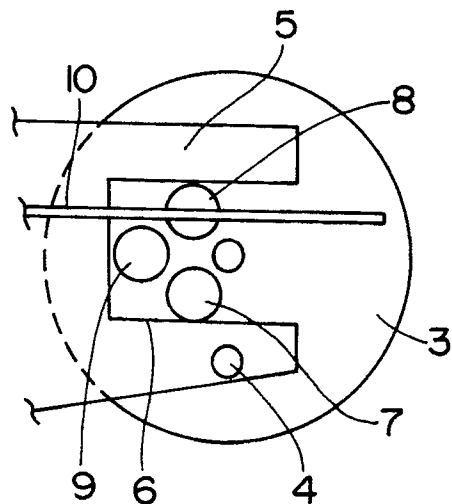


FIG. 2 (F)

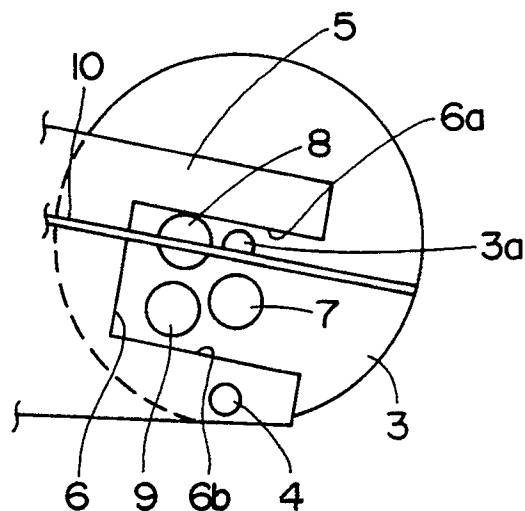


FIG. 2 (G)

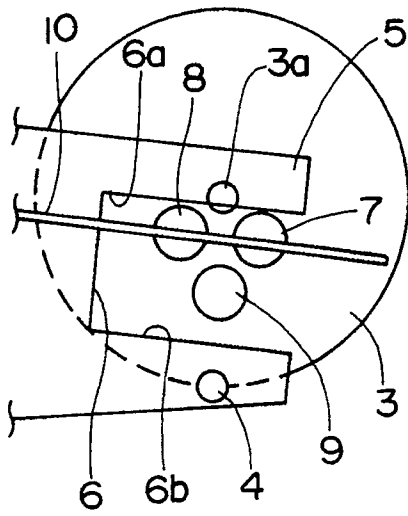


FIG. 2 (H)

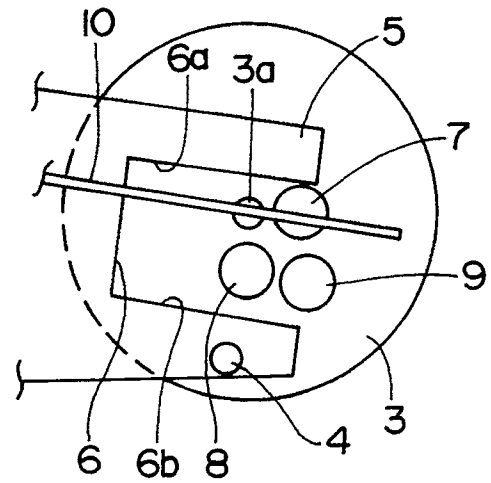


FIG. 2 (I)

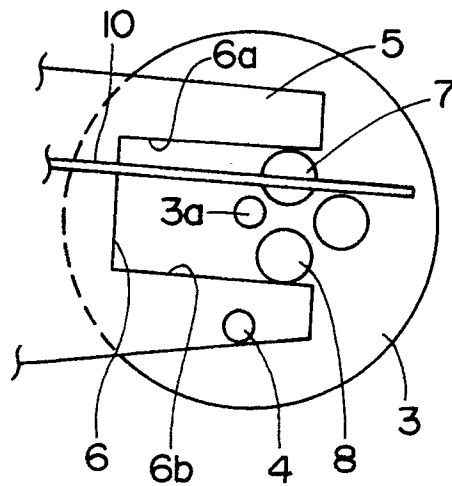


FIG. 3 (A)

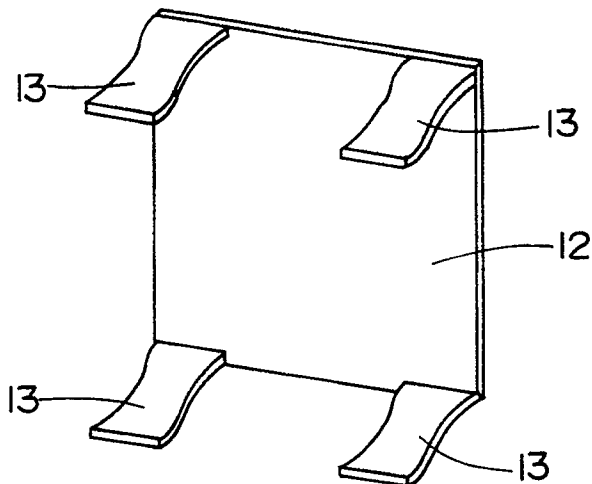


FIG. 3 (B)

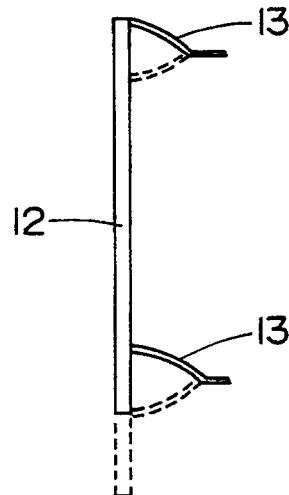


FIG. 3 (c)

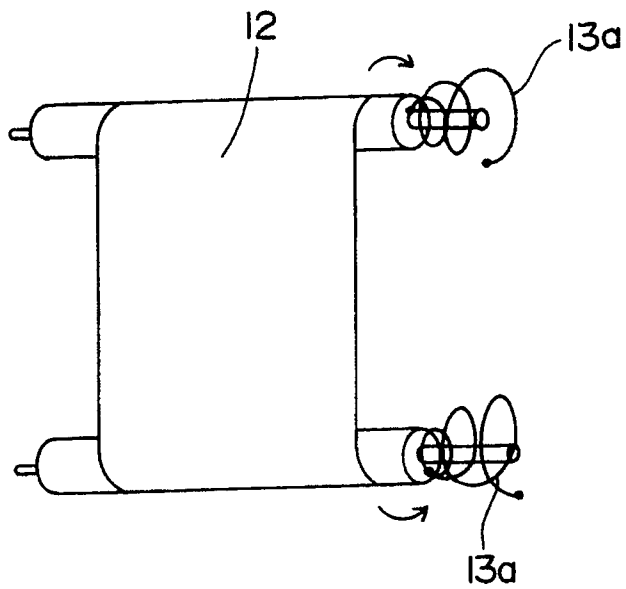


FIG. 3 (d)

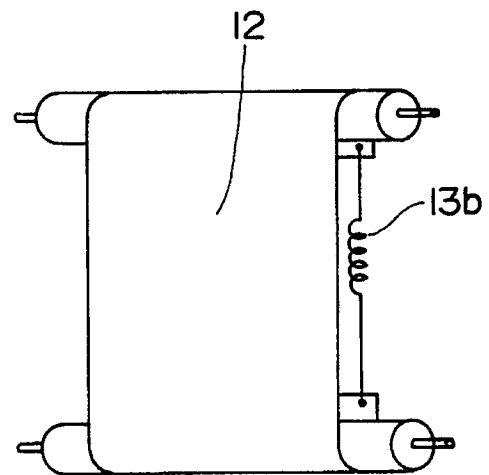
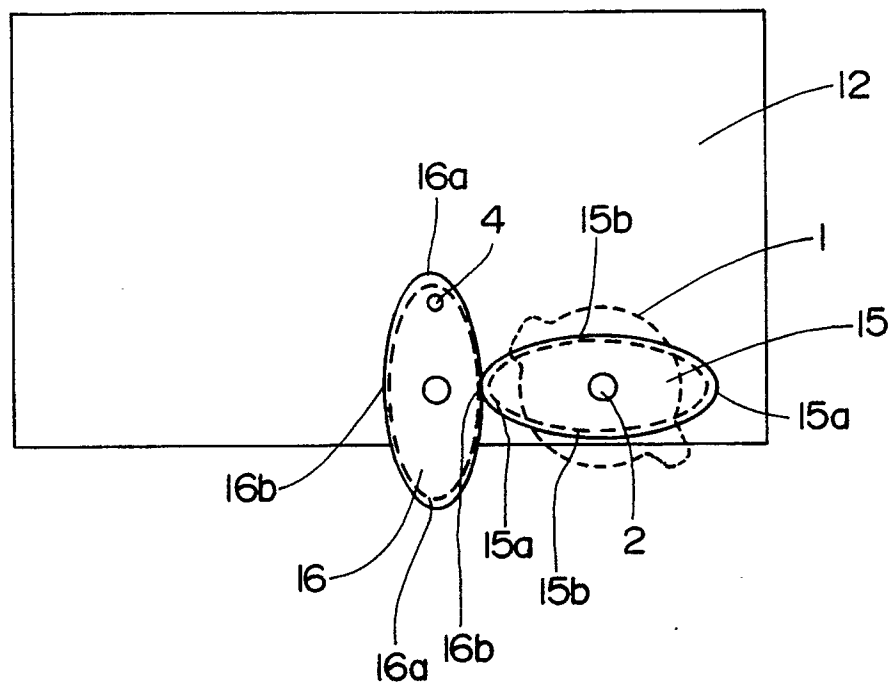


FIG. 5



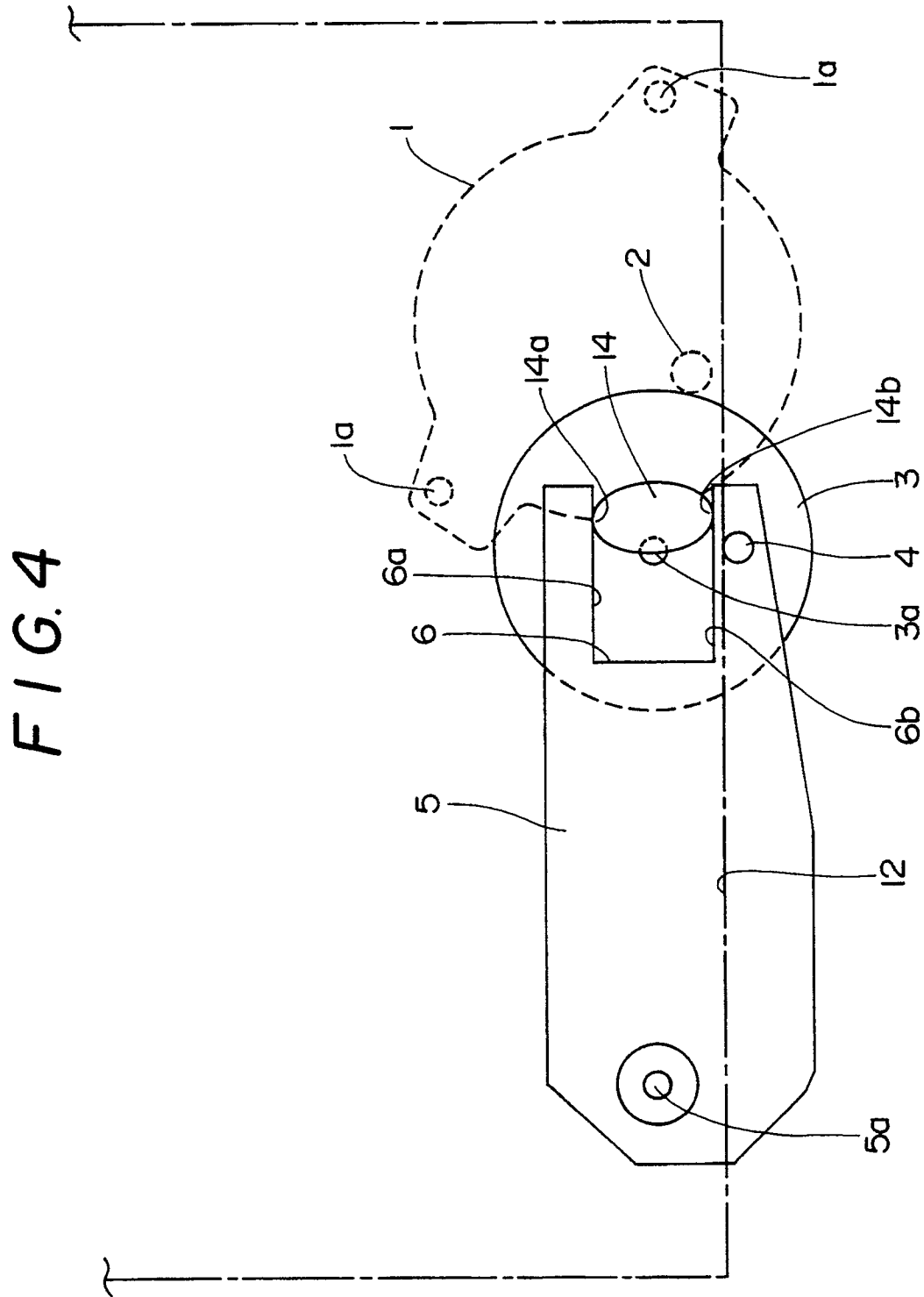


FIG. 6

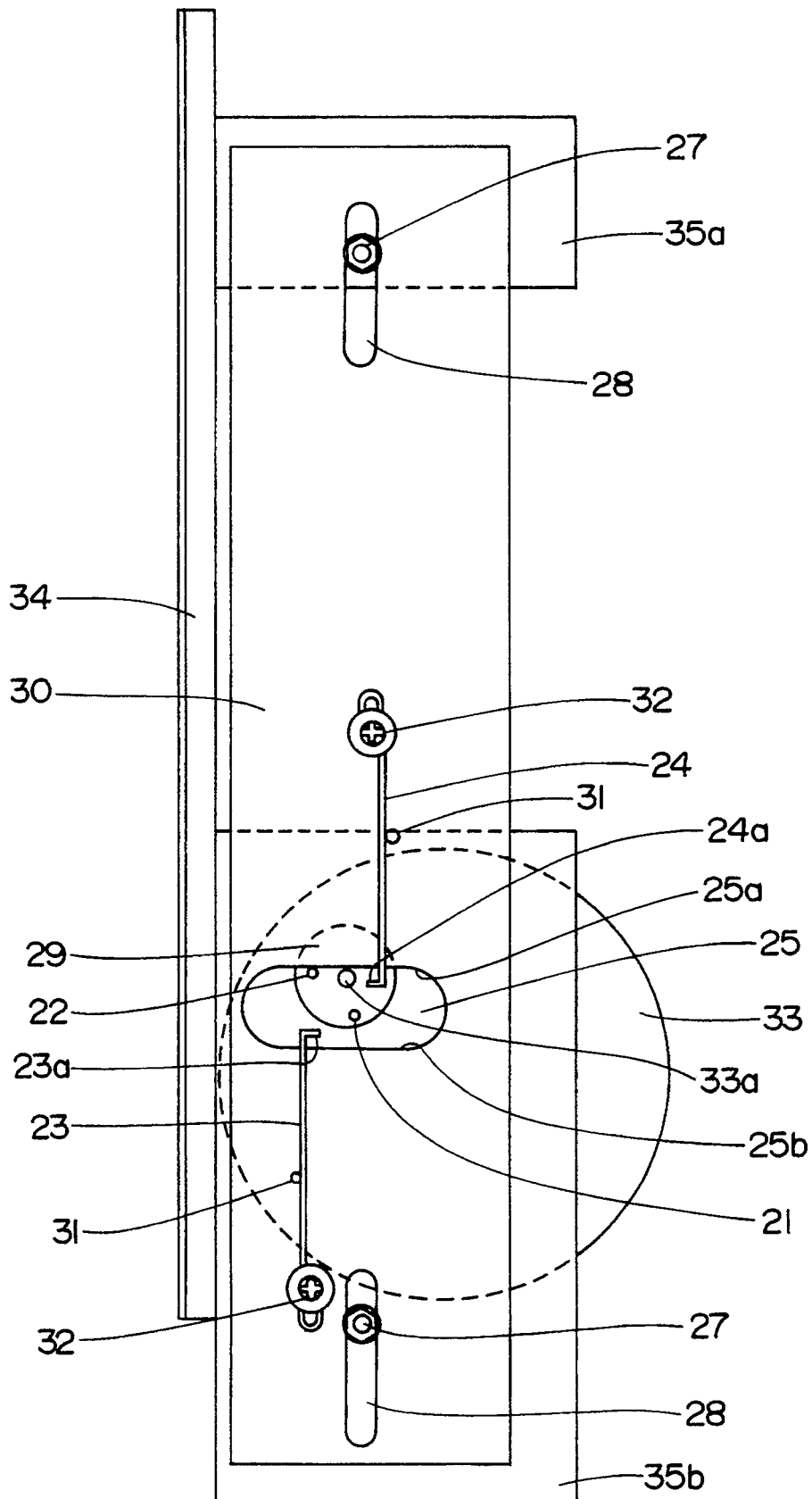


FIG. 7 (A)

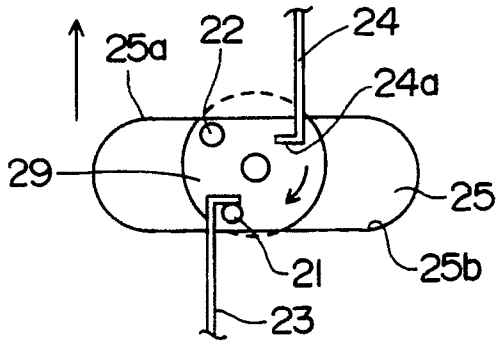


FIG. 7 (B)

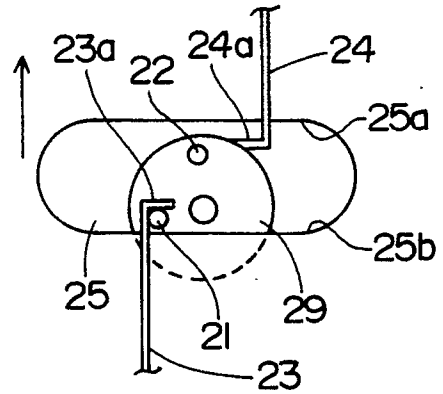


FIG. 7 (C)

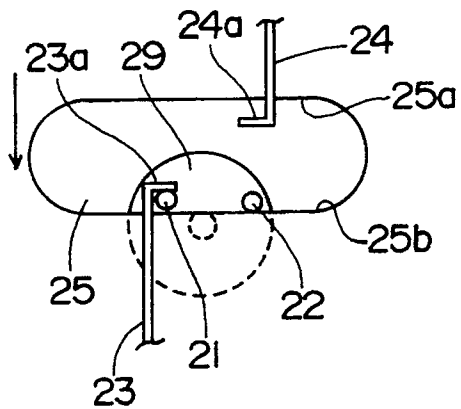


FIG. 7 (D)

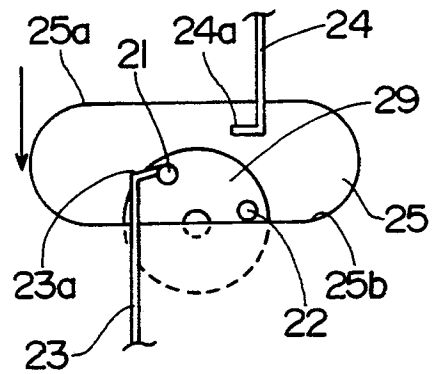


FIG. 7 (E)

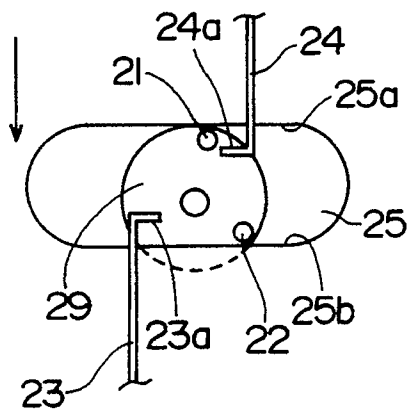


FIG. 7 (F)

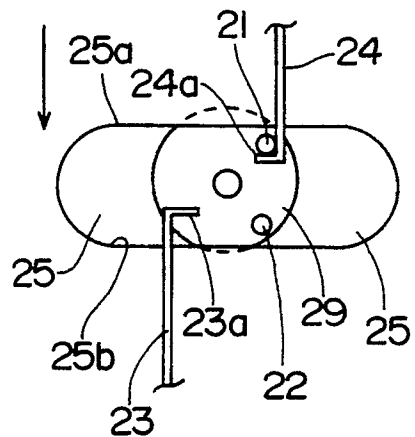


FIG. 7 (G)

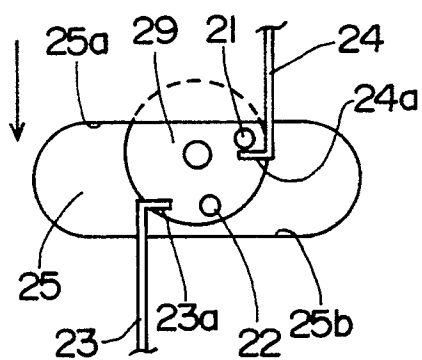


FIG. 7 (H)

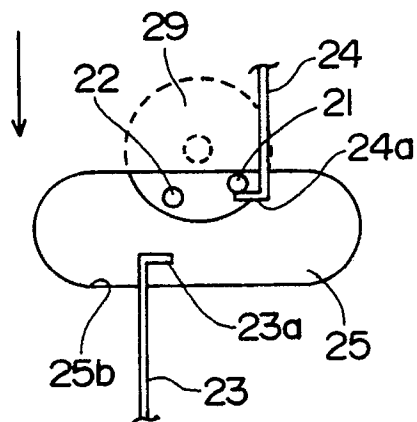


FIG. 7 (I)

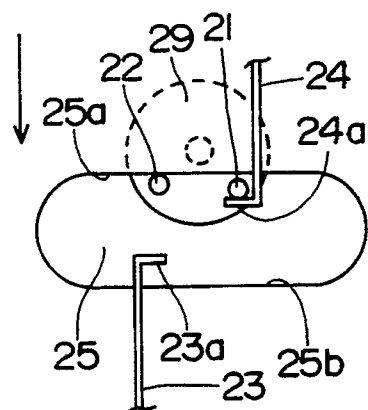


FIG. 7 (J)

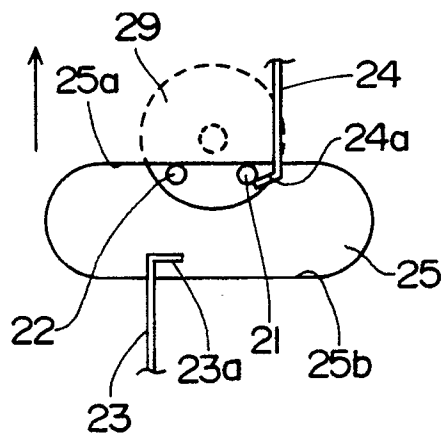


FIG. 7 (K)

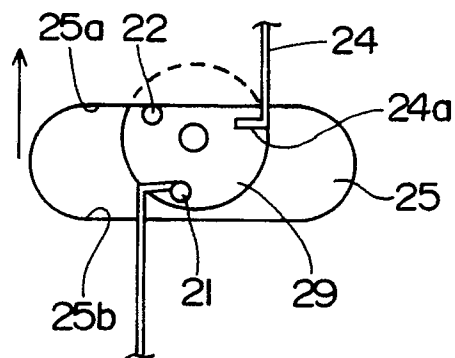


FIG. 8 (A)

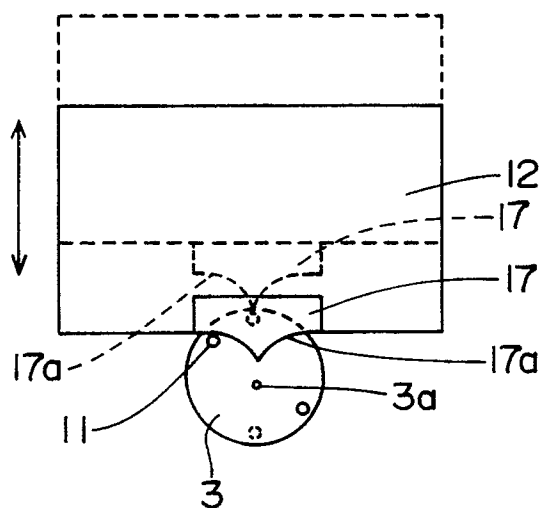


FIG. 8 (B)

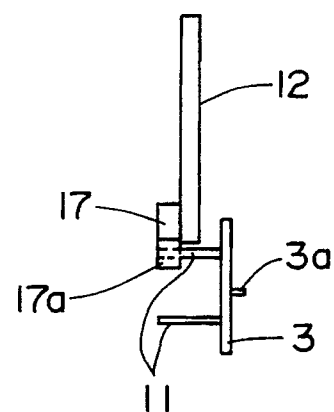


FIG. 9 (A)

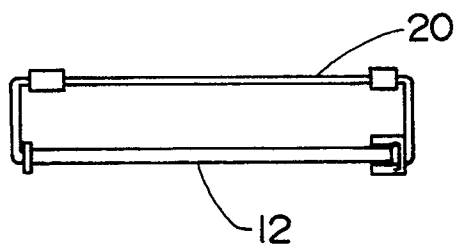


FIG. 9 (B)

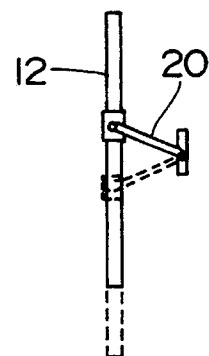


FIG. 10

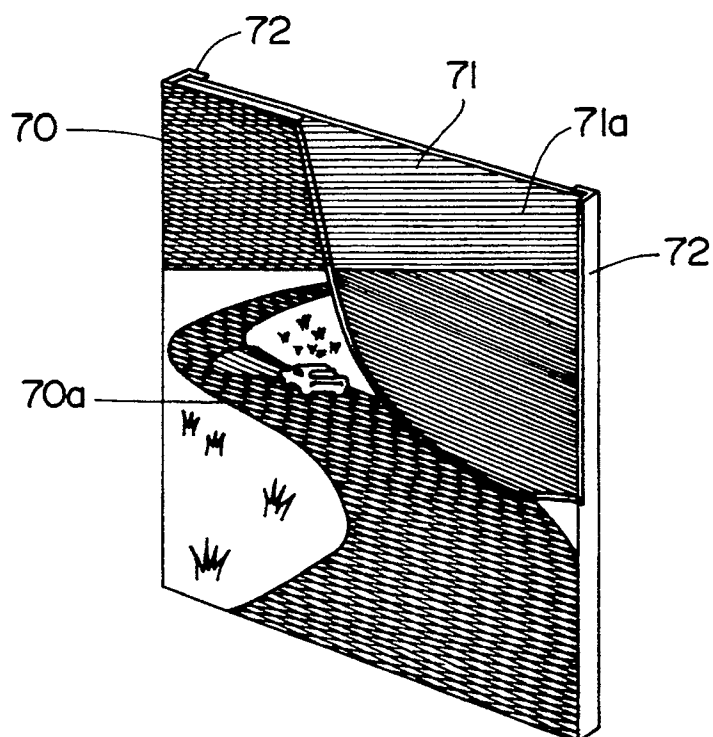
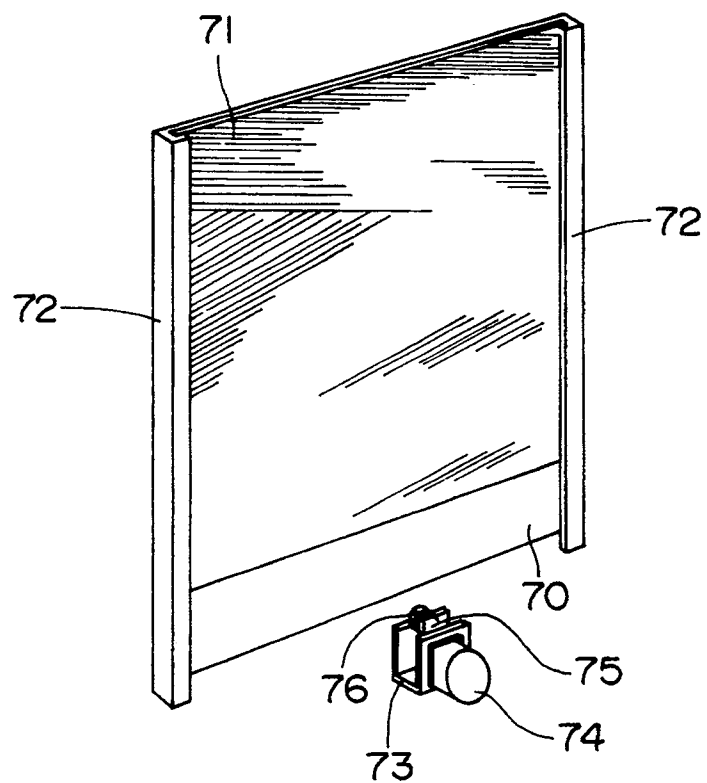


FIG. 11





Application Number

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.5)
A	GB-A-2 183 387 (BURON K.K.) * figures 2,3; abstract *	1-7	G 09 F 19/02
P,A	PATENT ABSTRACTS OF JAPAN vol. 14, no. 279 (P-1062), 5 June 1990; & JP - A - 281197 (FUJI ELECTRIC CO. LTD.) 22.03.1990 * whole document *	1-7	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			G 09 F
The present search report has been drawn up for all claims			
Place of search Berlin		Date of completion of search 29 July 91	Examiner TAYLOR P I
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention		E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	