June 2, 1970 W. R. AIKEN 3,516,086

ELECTROSTATICALLY CONTROLLED HINGED PIVOT DISPLAY DEVICE

Filed March 24, 1969

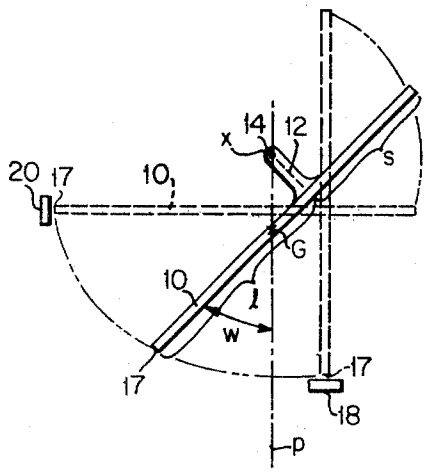


FIG. 1

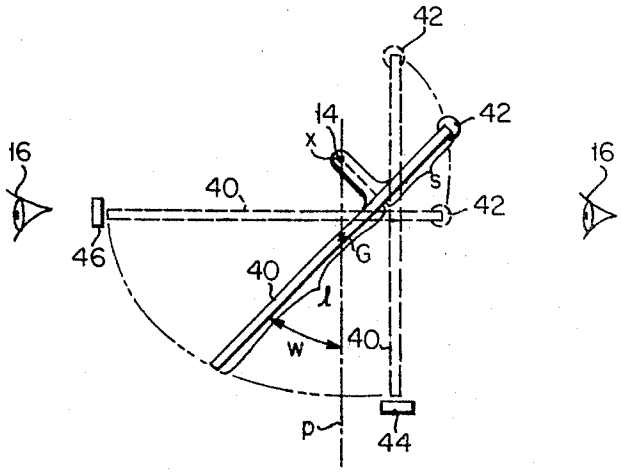


FIG. 2

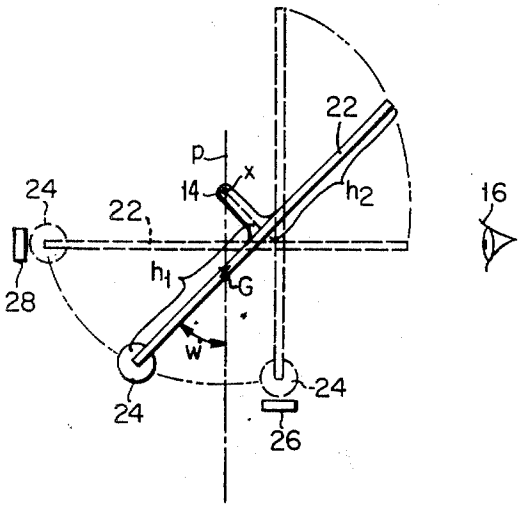


FIG. 3

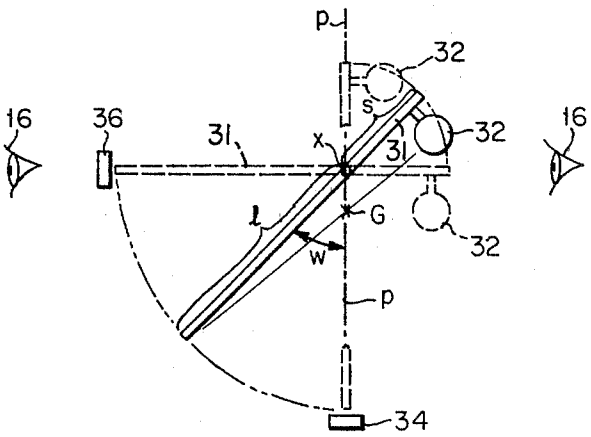


FIG. 4

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3,516,086
Patented June 2, 1970

3,516,086

ELECTROSTATICALLY CONTROLLED HINGED PIVOT DISPLAY DEVICE

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Continuation-in-part of application Ser. No. 553,195, May 26, 1966. This application Mar. 24, 1969, Ser. No. 809,880

Int. Cl. G08b 5/14

U.S. Cl. 340—378 7 Claims

ABSTRACT OF THE DISCLOSURE

A display device wherein a vane is mounted for rotation about a horizontal axis between a vertically disposed display position and a horizontally disposed erase position in such a manner that it assumes, under the force of gravity, an inclined intermediate position of balance. Electrode means are located adjacent an outer edge of said vane in said two operational positions thereof to pull the vane, upon energization, selectively into one or the other of the defined operational positions thereof. Thus, when the vane is to be moved from one to the opposite operational position, de-energization of the electrode means adjacent the vane in its last position permits the vane to swing under the force of gravity toward its intermediate position and closer to the effective range of the newly energized opposite electrode means. Hence, the force of gravity is employed to initiate movement of the vane toward its new position no matter in which direction the vane is to be moved, where formerly the force of gravity opposed setting of the vane into a new position in at least one direction.

This is a continuation-in-part of my pending U.S. patent application Ser. No. 553,195 filed May 26, 1966 for a Signalling Device now abandoned.

The present invention relates to display devices of the type employing relatively movable components to display, expose or conceal an identifying mark or sign such as a brightly painted surface, a number, a warning inscription, and the like. More particularly, the invention relates to display devices of the type referred to, wherein the relative movement of the sign displaying and concealing components is accomplished by the repelling and/or attracting effect of electrostatic charges. Display devices of the type to which the present invention relates are described in my U.S. Pat. No. 3,089,120 issued May 7, 1963 for a Signalling Device.

In devices of this type, a thin sheet or vane is hingedly supported for swinging movement from a substantially horizontal position of rest to a raised position about an axis located close to one of its edges, and this movement is effected by the repelling and/or attracting effect of electrostatic charges that are applied to the vane and/or electrodes which are located at suitable points adjacent the intended path of movement of the vane. In the performance of devices of this type, the electrostatic charges applied must, therefore, overcome the force of gravity acting upon the vane. As a result thereof these devices require the application of substantial voltages for dependable operation, especially in cases where it is desirable that the vane be raised from a horizontal to a vertical or near vertical position.

It is an object of the invention to minimize the voltage requirements in display devices of the type referred to.

Another object of the invention is to provide a display device of the type referred to, wherein the effect of gravity upon the control vane is employed to aid in the intended movement of the vane.

More particularly it is an object of the invention to provide a display device, of the type referred to, wherein the vane is to be moved between a substantially horizontal and a substantially vertical position, and which is so arranged that the effect of gravity on the vane is employed to initiate the intended movement of the vane in either direction, i.e., irrespective of whether the device is operated to move the vane from a vertical to a horizontal position, or vice versa from a horizontal to a vertical position.

In accordance with the invention the vane of a display device, of the type referred to, is mounted in such a manner that the plane determined by its axis of rotation and its center of gravity forms at all times an angle with the plane of the vane itself. This may be accomplished by mounting the vane for rotation about a horizontal axis above and removed from the plane of the vane, which is so located relative to the vane that its normal projection upon the vane divides the vane into unequal halves; or by providing one-half of the vane with a counterweight in cases wherein the normal projection of the axis of rotation of the vane divides the vane into equal halves; and in cases wherein the axis of the vane lies in the plane of the vane, this may be accomplished by locating the axis of rotation of the vane closer to one of the end edges of the vane than to the other and by attaching to the smaller one of the portions into which the vane is divided by said axis, a counterweight that is removed from the plane of the vane. In all these instances, the vane assumes a slanting position of rest intermediately of its vertical and horizontal positions when not acted upon by an electrostatic field or fields. Hence, whenever the vane is held in a vertical or horizontal position by energization of a suitably placed electrode, and is to be moved into the opposite position, de-energization of the active electrode permits the vane to swing automatically through its position of balance toward its opposite position, and this movement is then easily completed by energization of another suitably placed electrode. The described arrangement provides a high degree of dependability in the operation of the display devices, of the type referred to, and reduces the power requirements for the actuating electrodes because whenever the vane is to be moved into an opposite position, it depends for initiation of its movement into said opposite position no longer upon the action of an electrostatic field generated by a remotely located actuating electrode. Upon de-energization of the electrode that held it in its last position, the vane moves automatically towards, and into the range of, said actuating electrode which then pulls it into its new position.

The invention will best be understood by reference to the accompanying drawing which illustrates certain preferred embodiments thereof and wherein FIGS. 1, 2, 3 and 4 are schematic side elevations of four different display devices embodying the principles of my invention.

In FIG. 1, the reference numeral **10** identifies a planar vane which may be formed by a sheet of metal, stiff paper or plastic material. Said vane is mounted for rotation about an axis X which is located above and a distance withdrawn from the plane of the vane **10**. This may be accomplished by providing the vane along opposite edges with upwardly directed ears **12** whose perforated upper ends are engaged over a spindle **14**. The location of the axis of rotation X relative to the vane is such that its normal projection upon the vane divides the vane into a small portion *s* and a larger portion *l*. As a result thereof the vane will assume an inclined or slanted position wherein its center of gravity indicated at G is located directly below the hinge axis *x*, with its larger portion *l* located below its smaller portion *s* as shown in solid lines in FIG. 1. When moved from this position, and in the

absence of other forces acting upon the vane, the vane will always endeavor to return to this position of balance. To set the vane to a vertical position wherein it presents one of its surfaces to a viewer symbolically represented by the eye **16**, an electrode **18** is placed adjacent to the bottom edge **17** of the vane in its intended vertical position. When said electrode **18** is energized to generate a vane-attracting electrostatic field, it pulls the vane against the force of gravity from its balanced position into the vertical position shown in phantom lines, and will maintain the vane in said vertical position as long as said electrode is so energized. To effectively remove the front surface of the vane **10** from view by the onlooker **16**, it is necessary that it be placed into a horizontal position which is likewise indicated in phantom lines in FIG. 1. This is accomplished by de-energization of the electrode **18** and by energizing another electrode **20** located adjacent to the bottom edge **17** of the vane in its intended horizontal position to generate a vane-attracting electrostatic field. As soon as electrode **18** is de-energized, the vane commences to move under the force of gravity toward its opposite position even if the vane-attracting field generated by electrode **20** were not strong enough to reach the vane in its vertical position and lift it out of its vertical position against the force of gravity. In fact, in the described arrangement, it is the force of gravity that lifts the vane out of its vertical position towards its intermediately located position of balance where it is much closer to the opposite electrode **20** and where the vane-attracting electrostatic field generated by said opposite electrode is strong enough to complete the intended movement of the vane and lift it against the force of gravity into its horizontal position. Similarly, when it is desired to return the vane **10** to its display position, electrode **20** is de-energized and electrode **18** is energized, and immediately upon de-energization of electrode **20** the vane swings under the force of gravity toward its balanced position and closer to the effective range of the attracting field set up by energization of electrode **18** even if this field is initially not strong enough to act effectively upon a vane that is as remote from it as the vane **10** in its horizontal position. Once the vane has reached its balanced position, however, the intensity of the vane-attracting field generated by electrode **18** is strong enough to complete the intended movement of the vane into its display position and to hold it dependably in this position.

The display device of the invention illustrated in FIG. 2 differs from the display device illustrated in FIG. 1 in that its axis of rotation x is located closer to the upper edge of the vane **40** than in the embodiment of the invention illustrated in FIG. 1. To achieve under these conditions a position of balance of the vane that is located approximately midway between the intended vertical and horizontal operational positions of the vane, it is necessary that the counterweight **42** be supported from the smaller one s of the portions s and l into which the vane is divided by the normal projection of axis x upon the vane. In fact, the size and/or location of the counterweight **42** in relation to the relative size of the portions l and s provides means for adjusting the position of balance of the vane to predetermined angles relative to its vertical and horizontal operational positions. As in the embodiment of the invention illustrated in FIG. 1, selectively operable electrodes **44** and **46** are effective, upon energization, to pull the vane **40** into either of its operational positions.

In the embodiment of the invention illustrated in FIG. 3, the vane **22** is mounted for movement about an axis x that is located above and a distance withdrawn from the plane of the vane, and is so positioned that its normal projection upon said vane divides the vane into two equal halves h_1 and h_2. In such a case, an inclined position of balance intermediately of its vertically and horizontally disposed operational positions is achieved by providing one of the remote ends of the vane with a suitable counterweight indicated at **24**. As a result of said counterweight, the center of gravity G of the vane is moved closer to the weighted end of the vane, and the vane, therefore, has to assume the slanting position indicated in solid lines in FIG. 3 to find its position of balance wherein said center of gravity G is located vertically below its hinge axis x. Electrode means **26** and **28** are placed near the weighted edge of the vane in both its vertical and its horizontal positions in the same manner as in the embodiment illustrated in FIGS. 1 and 2. Energization of electrode **26** while electrode **28** remains in de-energized condition is effective to pull the vane from its inclined position of balance into its vertically disposed display position and to hold it in said position; and energization of electrode **28** while electrode **26** is de-energized swings the vane dependably and with minimum power requirement into its horizontally disposed position wherein any information on its surfaces is concealed from view.

The embodiment of the invention illustrated in FIG. 4 differs from the embodiment of the invention shown in FIGS. 1, 2 and 3, in that the axis of rotation x of its vane **31** lies in the plane of the vane itself. Said axis divides the vane into two unequal portions s and l, as it does in the embodiments shown in FIGS. 1 and 2. To achieve a pre-determined slanted position of balance for the vane intermediately of its intended vertical and horizontal operational positions, a counterweight **32** is supported from the upper portion s of the vane **31** as in the embodiment of the invention illustrated in FIG. 2, but in this instance the counterweight is supported a pre-determined distance below and removed from the plane of the vane. This moves the common center of gravity G of vane and counterweight out of the plane of the vane to a point a distance below the plane of the vane. As a result thereof, in seeking its position of balance wherein the center of gravity is loctaed below the axis of rotation of the vane, the vane assumes the slanting position intermediately of its intended vertical and horizontal operational positions shown in solid lines in FIG. 4. Size of the counterweight **32** and its particular location relative to the end edge of portion s of the vane and its distance relative to the plane of the vane may be employed to pre-determine the exact angular location of its position of balance.

It should be noted that in all four embodiments of the invention illustrated in the accompanying drawing, the slanting position of balance of the vane intermediately of its intended operational positions is achieved by mounting the vane in such a manner that the plane p determined by its axis of rotation and its center of gravity G intersects the plane of the vane at an angle w.

As in the embodiments of the invention illustrated in FIGS. 1, 2 and 3, electrode means **34** and **36** are arranged adjacent the heavier end of the vane in its intended vertical and horizontal positions, and upon appropriate energization and de-energization, respectively, the electrodes **34** and **36** are effective to pull the vane dependably and with a minimum power requirement into their intended operational positions in the same manner as previously explained in connection with the embodiments of the invention illustrated in FIGS. 1 and 2.

In display devices constructed in accordance with the invention the effect of gravity which formerly aggravated proper operation of the display devices of the type here under consideration in moving them into at least one of their operational positions, is now utilized to advantage in initiating movement of the vane from either of its extreme operational positions into the opposite position, thus increasing dependability of performance, while at the same time reducing the power requirements. It is, however, also possible to obtain the same dependability of operation in the spirit of the present invention by employing spring means, such as a spiral spring interposed between the vane and a suitable support, rather than the force of gravity, to set the vane yieldably to an interme-

diate position of balance between its intended operational positions.

I claim:

1. An electrostatically controlled display device comprising a vane, means mounting said vane for movement between substantially horizontally and vertically disposed operational positions about a substantially horizontally disposed axis of rotation in such a manner that the plane determined by said axis of rotation and the center of gravity of said vane intersects the plane of said vane, at an angle causing the vane to assume an inclined position of balance intermediately of said operational positions thereof, and electrode means located adjacent said vane in said operational positions and selectively operable to pull said vane from said intermediate position into said operational positions.

2. A display device according to claim 1 wherein said vane is mounted in such a manner that its axis of rotation is removed from the plane of said vane, and the normal projection of said vane upon the plane of said vane is arranged to divide said vane into uneven portions.

3. A display device according to claim 2 including a counterweight supported from the smaller one of the portions into which said vane is divided by the normal projection of its axis of rotation upon its plane.

4. A display device according to claim 1 wherein said vane is mounted in such a manner that said axis of rotation thereof is removed from the plane of said vane,

and including a counterweight supported from one of the portions into which said vane is divided by a normal projection of said axis onto said vane.

5. A display device according to claim 4 wherein said axis of rotation is so located that its normal projection upon the plane of the vane divides the vane into two unequal portions and wherein said counterweight is supported from the smaller one of said portions.

6. A display device according to claim 1 wherein said axis of rotation of said vane is contained in the plane of said vane, and including a counterweight supported from said vane a distance removed from the plane of said vane.

7. A display device according to claim 6 wherein said axis or rotation is arranged to divide said vane into two unequal portions and said counterweight is supported from the smaller one of said portions.

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U.S. Cl. X.R.

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