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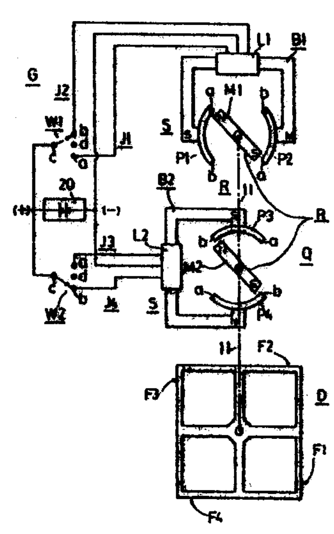
(54) Rotating display element and display unit using the same.

(57) A rotating display element which is provided with a display surface member having a plurality of display surfaces which are selected by rotating the display surface member, and a display unit which uses the display element. The display surface member of the rotating display element has incorporated therein a permanent magnet type motor mechanism and is driven by the permanent magnet type motor mechanism. The rotor of the permanent magnet type motor mechanism has first and second double-pole permanent magnet members, and its stator has first and second magnetic members having wound thereon first and second exciting windings, respectively. The display unit has first and second power supply means for supplying power to the first exciting winding of the permanent magnet type motor mechanism and third and fourth power supply means for supplying power to the second exciting winding. The plurality of display surfaces of the display surface member can selectively be directed to the front by supplying power to the first exciting winding via the first or second power supply means and by supplying power to the second exciting winding via the third or fourth power supply means. A display panel can be constituted by arranging, in a matrix form, a number of such display units each employing the rotating display element.

Fig.5



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a rotating display element which is provided with a display surface member having plural, for instance, four display surfaces and is adapted to select a desired one of the display surfaces by rotating the display surface member. Further, the invention pertains to improvement in or relating to a display unit using such a rotating display element.

Description of the Prior Art

Heretofore, various rotating display elements have been proposed, which are, however, defective in that a rotating mechanism for driving a display surface member must be provided separately of the rotating display element, or in that a selected display surface of the display surface member does not assume a correct display position.

Furthermore, a variety of display units employing such a rotating display element have also been proposed in the past, yet they possess the drawback of involving complex means for selecting a desired one of the display surfaces, in addition to the abovesaid defects of the rotating display element.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a novel rotating display element free from the above-mentioned defects and a display unit using such a display element.

According to an aspect of the present invention, a selected one of the display surfaces of the display surface member can be turned to face front, simply by connecting a power source to a first exciting winding of either one of a rotor and a stator (hereinafter referred to as a stator, for the sake of simplicity) of a motor mechanism through first or second power supply means and a power source to a second exciting winding of the stator through a third or fourth power supply means. Therefore, the display surfaces of the display surface member can selectively be turned to the front through use of a simple arrangement.

According to another aspect of the present invention, even if the power supply to the first and second exciting windings is cut off after turning a selected one of display surfaces to the front, the selected display surface can be held there because first and second double-pole permanent magnet members of the other of the rotor and stator (hereinafter referred to as the rotor, for the sake of simplicity) of the above-mentioned motor mechanism act on first and second magnetic members of the stator. This saves unnecessary power consumption.

According to another aspect of the present invention, the above-mentioned motor mechanism is incorporated in the display surface member, and so a display surface member driving mechanism need not be provided separately of the display element as in the prior art.

According to another aspect of the present invention, the rotor of the motor mechanism has first and second double-pole permanent magnet members, each magnetized with north and south magnetic poles. The double-pole permanent magnet members are each formed by a bar- or plate-like member of narrow rectangular cross section in a direction perpendicular to the axis of the rotor and has the north and south magnetic poles at its both free end faces spaced an angular distance of 180° apart around the rotor axis. The bar- or plate-like member is mounted on the rotor shaft, with the center of the former in the above-mentioned cross section held in agreement with the center of the latter. With such a structure, it is possible to rapidly and smoothly turn a selected display surface to the front and hold it in position.

The display unit of the present invention employs the above-mentioned display element, and means for driving the display element needs only to have first and second power supply means for supplying power to the first and second exciting windings of the display element and third and fourth power supply means for supplying power to the second exciting winding. Therefore, the display element can be driven with a simple arrangement.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram conceptually illustrating an embodiment of the display unit employing the rotating display element according to the present invention;

Fig. 2 is a plan view, partly in section, showing an example of the rotating display element used in the display unit depicted in Fig. 1;

Fig. 3 is a front view. partly in section, similar to Fig. 2;

Fig. 4 is a side view, partly in section, as viewed from the line IV-IV in Fig. 2; and

Figs. 5 to 17 are schematic diagrams for explaining the operation of the display unit of the present invention shown in Fig. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 conceptually illustrates an embodiment of the display unit employing the rotating display element of the present invention. The display element is provided with the rotating display element (hereinafter referred to simply as a display element. for the sake of brevity) E and a driving device G for driving it.

The display element E has a display surface member D and a permanent magnet type motor mechanism (hereinafter referred to simply as a motor mechanism, for the sake of brevity) identified by Q in Figs. 2 to 4.

As will be seen from Figs. 2 to 4, the display surface member D is, for instance, tubular in shape and has four display panels H1, H2, H3 and H4 disposed around its axis at equiangular intervals of 90°. On the outer surfaces of the four display panels H1, H2, H3 and H4 are formed display surfaces F1, F2, F3 and F4, respectively.

An example of the motor mechanism Q has a rotary shaft 11, on which two double-pole permanent magnet members M1 and M2, each magnetized with north and south magnetic poles are mounted side by side lengthwise thereof.

The double-pole permanent magnet members M1 and M2 are each formed by a bar- or plate-like member which is of narrow rectangular cross section in a direction perpendicular to the rotary shaft 11 and magnetized with north and south magnetic poles at its both free end faces spaced an angular distance of 180° apart around the rotary shaft 11. The bar- or plate-like member is mounted on the rotary shaft 11, with the center of the former in the above-mentioned cross section held in agreement with the center of the latter. In this instance, it is preferable that the both end faces of the bar- or plate-like member, magnetized with north and south magnetic poles, respectively, each form a circular arc with the center at the rotary shaft 11. The length of this circular arc is as small as less than 45°, for example, 90°/3 or so around the rotary shaft 11. Such a bar- or plate-like member has a structure which is obtained by cutting a disc or columnar member along a pair of opposed planes equidistant from a plane containing its axis.

The north and south poles of the double-pole permanent magnet member M2 are disposed around the rotary shaft 11 at an angular distance $\pm\alpha°$ (where $\alpha°$ has a value represented by $0° \leq \alpha° < 180°$ and including 0°) apart from the north and south magnetic poles of the double-pole permanent magnet members M1. In the drawings, there is shown the case where $\alpha° = 0°$, for the sake of simplicity.

The rotary shaft 11 and the double-pole permanent magnet members M1 and M2, mentioned above, constitute a rotor R of the motor mechanism Q.

The rotor R of the motor mechanism Q is rotatably supported by a support 15 which is composed of left-hand, right-hand and rear panels 12, 13 and 14. That is, the rotary shaft 11 of the rotor R is pivotally mounted between the left- and right-hand panels 12 and 13 of the support 15.

The motor mechanism Q comprises, for example, a magnetic member B1 provided with magnetic poles P1 and P2, which act on the north and south magnetic poles of the double-pole permanent magnet member M1, a magnetic member B2 similarly provided with magnetic poles P3 and P4, which act on the north and south magnetic poles of the double-pole permanent magnet member M2, an exciting winding L1 wound on the magnetic member B1 in a manner to excite the magnetic poles P1 and P2 in reverse polarities, and an exciting winding L2 wound on the magnetic member B2 in a manner to excite the magnetic poles P3 and P4 in reverse polarities.

The magnetic poles P1 and P2 of the magnetic member B1 are spaced apart an angular distance of 180° around the axis of the rotor R, i. e. the rotary shaft 11.

The magnetic poles P3 and P4 of the magnetic member B2 are also spaced apart an angular distance of 180 around the rotary shaft 11 of the rotor R, but these magnetic poles P3 and P4 are held at an angular distance $\pm 90° \pm \alpha°$ from the magnetic poles P1 and P2 of the magnetic member B1. In the drawings, there is shown the case where $\alpha = 0$ as mentioned previously and $+90°$ is selected from $\pm 90°$, and so the former magnetic poles P3 and P4 are shown to be spaced $+90°$ apart from those P1 and P2.

The magnetic poles P1 and P2 of the magnetic member B1 and the magnetic poles P3 and P4 of the magnetic member B2 respectively extend over an angular range of about 90° around the axis of the rotary shaft 11 of the rotor R.

The magnetic members B1 and B2 and the exciting windings L1 and L2 form a stator S of the motor mechanism Q.

The stator S of the motor mechanism Q is fixedly mounted on the aforementioned support 15. That is, the magnetic member B1 and the exciting winding L1 wound thereon are fixed to the support 15 by a support rod 16 which extends between the position of the exciting winding L1 and the inner side wall of the right-hand panel 13 of the support 15. Likewise the magnetic member B2 and the exciting winding L2 wound thereon are fixed to the support 15 by a support rod 17 which extends between the position of the exciting winding L2 and the inner side wall of the left-hand panel 12 of the support 15.

The display surface member D is mounted on the rotor R of the motor mechanism Q in such a manner that it houses therein the motor mechanism Q. That is, four support rods K1, K2, K3 and K4, extending radially of the rotary shaft 11 at 90° intervals, are fixed at one end to the rotary shaft 11 between the double-pole permanent magnet members M1 and M2 mounted thereon, the free ends of the support rods K1, K2, K3 and K4 being secured to the display panels H1, H2, H3 and H4 of the display surface member D on the inside thereof, respectively.

In this case, the display surface member D is mounted on the rotor R in such a manner that the display surface F1 of the display surface member D faces to the front when the rotor R assumes such a rotational position where the centers of the north and south magnetic poles of the double-pole permanent magnet member M1 are opposite to trailing ends a of the magnetic poles P1 and P2 of the magnetic member B1 in the clockwise direction, respectively, and the centers of the north and south magnetic poles of the double-pole permanent magnet member M2 are opposite to leading ends b of the magnetic poles P3 and P4 of the magnetic member B2 in the clockwise direction, respectively, as shown in Figs. 5, 9, 12 and 15. The above rotational position will hereinafter be referred to as the first rotational position.

Further, the display surface member D is mounted on the rotor R in such a manner that the display surface F4 of the display surface member D faces to the front when the rotor R assumes such a rotational position where the centers of the north and south magnetic poles of the double-pole permanent magnet member M1 confront the leading ends b of the magnetic poles P1 and P2 of the magnetic member B1 in the clockwise direction, respectively, and the centers of the north and south magnetic poles of the double-pole permanent magnet member M2 confront the trailing ends a of the magnetic poles P4 and P3 of the magnetic member B2 in the clockwise direction, respectively, as shown in Figs. 6, 13 and 16. The above rotational position will hereinafter be referred to as the fourth rotational position.

Moreover, the display surface member D is mounted on the rotor R in such a manner that the display surface F2 of the display surface member D faces to the front when the rotor R assumes such a rotational position where the centers of the north and south magnetic poles of the double-pole permanent magnet member M1 are opposite to the leading ends b of the magnetic poles P2 and P1 of the magnetic member B1 in the clockwise direction, respectively, and the centers of the north and south magnetic poles of the double-pole permanent magnet member M2 are opposite to the trailing ends a of the magnetic poles P3 and P4 of the magnetic member B2 in the clockwise direction, respectively, as shown in Figs. 7, 10 and 17. The above rotational position will hereinafter be referred to as the second rotational position.

Furthermore, the display surface member D is mounted on the rotor R in such a manner that the display surface F3 of the display surface member D faces to the front when the rotor R assumes such a rotational position where the centers of the north and south magnetic poles of the double-pole permanent magnet member M1 confront the trailing ends a of the magnetic pole portions P2 and P1 of the magnetic member B1 in the clockwise direction, respectively, and the centers of the north and south magnetic poles of the double-pole permanent magnet member M2 confront the leading ends b of the magnetic poles P4 and P3 of the magnetic member B2 in the clockwise direction, respectively, as shown in Figs. 8, 11 and 14. The above rotational position will hereinafter be referred to as the third rotational position.

As illustrated in Figs. 5 to 17, the driving device G is provided with power supply means J1 for supplying power to the exciting winding L1 of the stator S of the motor mechanism Q to make the magnetic poles P1 and P2 of the magnetic member B1 serve as north and south magnetic poles, respectively, power supply means J2 for supplying power to the exciting winding L1 to make the magnetic poles P1 and P2 of the magnetic member B1 serve as south and north magnetic poles, respectively, power supply means J3 for supplying power to the exciting winding L2 of the stator S of the motor mechanism Q to make the magnetic poles P3 and P4 of the magnetic member B2 act as north and south magnetic poles, respectively, and power supply means J4 for supplying power to the exciting winding L2 to make the magnetic poles P3 and P4 of the magnetic member B2 act as south and north magnetic poles, respectively.

The power supply means J1 has, for example, an arrangement in which the positive side of a DC power source 20 is connected to one end of the exciting winding L1 via a movable contact c and a fixed contact a of a change-over switch W1 and the negative side of the DC power source 20 is connected directly to the mid point of the exciting winding L1.

The power supply means J2 has, for example, an arrangement in which the positive side of the DC power source 20 is connected to the other end of the exciting winding L1 via the movable contact c and another fixed contact b of the change-over switch W1 and the negative side of the DC power source 20 is connected directly to the mid point of the exciting winding L1.

The power supply means J3 has, for example, an arrangement in which the positive side of the DC power source 20 is connected to one end of the exciting winding L2 via a movable contact c and a fixed contact a of a change-over switch W2 and the negative side of the DC power source 20 is connected directly to the mid point of the exciting winding L2.

The power supply means J4 has, for example, an arrangement in which the positive side of the DC power source 20 is connected to the other end of the exciting winding L2 via the movable contact c and another contact b of the change-over switch W2 and the negative side of the DC power source 20 is connected directly to the mid point of the exciting winding L2.

Next, a description will be given of details of the arrangement and its operation.

With the above-described arrangement of the display unit employing the rotating display element according to the present invention, the rotor R of the motor mechanism Q has the two double-pole permanent magnet members M1 and M2 mounted on the rotary shaft 11. The north and south magnetic poles of the double-pole permanent magnet member M1 and the double-pole permanent magnet member M2 are spaced an angular distance of $\pm\alpha°$ (where $\alpha° = 0°$, in this example) apart around the rotary shaft 11.

On the other hand, the stator S of the motor mechanism Q has the magnetic member B1 provided with the magnetic poles P1 and P2 which are spaced a 180° angular distance apart around the rotary shaft 11 and act on the north and south magnetic poles of the double-pole permanent magnet member M1 and the magnetic member B2 provided with the magnetic poles P3 and P4 which are spaced an angular distance of $\pm 90° \pm\alpha°$ apart from the magnetic poles P1 and P2 of the double-pole permanent magnet member M1 and disposed at 90° intervals around the rotary shaft 11 and on the north and south magnetic poles of the double-pole permanent magnet member M2. The magnetic poles P1 and P2 of the magnetic member B1 over an angular range of 90° extend around the rotary shaft 11, and the magnetic poles P3 and P4 of the magnetic member B2 similarly extend over an angular rang of 90° around the rotary shaft 11.

With such an arrangement, when the movable contacts c of the aforesaid change-over switches W1 and W2 are connected to fixed contacts d, that is, when no power is supplied to either of the exciting windings L1 and L2 of the stator S, the rotor R of the motor mechanism Q assumes the first rotational position described previously with regard to Figs. 5, 9, 12 and 15, the fourth rotational position described previously with regard to Figs. 6, 13 and 16, the second rotational position described previously with regard to Figs. 7, 10 and 17, or the third rotational position described previously with regard to Figs. 8, 11 and 14.

The reason for this is as follows:

In a case where the rotor R tends to rotate counterclockwise from its first rotational position shown in Figs. 5, 9, 12 and 15, since the north and south magnetic poles of the double-pole permanent magnet member M1 stay opposite the magnetic poles P1 and P2 of the magnetic member B1, there does not develop in the double-pole permanent magnet member M1 a rotating torque which prevents the rotor R from rotating counterclockwise. However, since the north and south magnetic poles of the double-pole permanent magnet member M2 move out of the opposing relation to the magnetic poles P3 and P4 of the magnetic member B2, there develops in the double-pole permanent magnet member M2 a rotating torque which prevents the rotor R from rotating counterclockwise. Further, in a case where the rotor R tends to rotate clockwise from its first rotational position shown in Figs. 5, 9 and 16, since the north and south magnetic poles of the double-pole permanent magnet member M2 stay opposite the magnetic poles P3 and P4 of the magnetic member B2, there does not develop in the double-pole permanent magnet member M2 a rotating torque which prevents the rotor R from rotating clockwise. However, since the north and south magnetic poles of the double-pole permanent magnet member M1 leave the magnetic poles P1 and P2 of the magnetic member B1, there develops in the double-pole permanent magnet M1 a rotating torque which prevents the rotor R from rotating clockwise.

In a case where the rotor R tends to rotate clockwise from its fourth rotational position shown in Figs. 6, 13 and 16, since the north and south magnetic poles of the double-pole permanent magnet member M1 stay opposite the magnetic poles P1 and P2 of the magnetic member B1, there does not develop in the double-pole permanent magnet member M1 a rotating torque which prevents the rotor R from rotating clockwise. However since the north and south magnetic poles of the double-pole permanent magnet member M2 leave the magnetic poles P4 and P3 of the magnetic member B2, there develops in the double-pole permanent magnet member M2 a rotating torque which prevents the rotor R from rotating clockwise. Further, in a case where the rotor R tends to rotate counterclockwise from its fourth rotational position shown in Figs. 6, 13 and 16, since the north and south magnetic poles of the double-pole permanent magnet member M2 stay opposite the magnetic poles P4 and P3 of the magnetic member B2, there does not develop in the double-pole permanent magnet member M2 a rotating torque which prevents the rotor R from rotating counterclockwise. However, since the north and south magnetic poles of the double-pole permanent magnet member M1 leave the magnetic poles P1 and P2 of the magnetic member B1, there develops in the double-pole permanent magnet member M1 a rotating torque which prevents the rotor R from rotating counterclockwise.

In a case where the rotor R tends to rotate clockwise from its second rotational position shown in Figs. 7, 10 and 17, since the north and south magnetic poles of the double-pole permanent magnet member M1 stay opposite the magnetic poles P2 and P1 of the magnetic member B1, there does not develop in the double-pole permanent magnet member M1 a rotating torque which prevents the rotor R from rotating clockwise. However since the north and south magnetic poles of the double-pole permanent magnet member M2 leave the magnetic poles P3 and P4 of the magnetic member B2, there develops in the double-pole permanent magnet member M2 a rotating torque which prevents the rotor R from rotating clockwise. Further, in a case where the rotor R tends to rotate counterclockwise from its second rotational position shown in Figs. 7, 10 and 17, since the north and south magnetic poles of the double-pole permanent magnet member M2 stay opposite the magnetic poles P3 and P4 of the magnetic member B2, there does not develop in the double-pole permanent magnet member M2 a rotating torque which prevents the rotor R from rotating counterclockwise. However, since the north and south magnetic poles of the double-pole permanent magnet member M1 leave the magnetic poles P2 and P1 of the magnetic member B1, there develops in the double-pole permanent magnet M1 a rotating torque which prevents the rotor R from rotating counterclockwise.

In a case where the rotor R tends to rotate counterclockwise from its third rotational position shown in Figs. 8, 11 and 14, since the north and south magnetic poles of the double-pole permanent magnet member M1 stay opposite the magnetic poles P2 and P1 of the magnetic member B1, there does not develop in the double-pole permanent magnet member M1 a rotating torque which prevents the rotor R from rotating counterclockwise. However, since the north and south magnetic poles of the double-pole permanent magnet member M2 leave the magnetic poles P4 and P3 of the magnetic member B2, there develops in the double-pole permanent magnet member M2 a rotating torque which prevents the rotor R from rotating counterclockwise. Further, in a case where the rotor R tends to rotate clockwise from its third rotational position shown in Figs. 8, 11 and 14, since the north and south magnetic poles of the double-pole permanent magnet member M2 stay opposite the magnetic poles P4 and P3 of the magnetic member B2, there does not develop in the double-pole permanent magnet member M2 a rotating torque which prevents the rotor R from rotating clockwise. However, since the north and south magnetic poles of the double-pole permanent magnet member M1 leave the magnetic poles P2 and P1 of the magnetic member B1. there develops in the double-pole permanent magnet M1 a rotating torque which prevents the rotor R from rotating clockwise.

For the reasons given above, when no power is supplied to either of the exciting windings L1 and L2 of the stator S, the rotor R assume any one of the first, second, third and fourth rotational positions.

Furthermore, the display surface member D is mounted on the rotor R of the motor mechanism Q so that the display surfaces F1, F2. F3 and F4 respectively face to the front when the rotor R assumes the first, second, third and fourth rotational positions as described previously.

Now, let it be assumed that the rotor R of the motor mechanism Q lies at the first rotational position and, consequently, the display element E is in such a state that the display surface F1 of the display surface member D faces to the front (This state will hereinafter be referred to as the first state). In such a first state of the display element E, even if power is supplied via the power supply means J2 to the exciting winding L1 of the stator S of the motor mechanism Q and to the exciting winding L2 via the power supply means J4 for a very short time at about the same time, as shown in Fig. 5. the display element E will be retained in the first state.

The reason for this is as follows:

By the power supply to the exciting winding L1 via the power supply means J2, the magnetic poles P1 and P2 of the magnetic member B1 are magnetized with south and north magnetic poles to produce a small counterclockwise rotating torque in the double-pole permanent magnet member M1. urging the rotor R to turn counterclockwise. By the power supply to the exciting winding L2 via the power supply means J4, however, the magnetic poles P3 and P4 of the magnetic member B2 are magnetized with south and north magnetic poles to produce a small clockwise rotating torque in the double-pole permanent magnet member M2, urging the rotor R to turn clockwise. Accordingly, there develops in the rotor R no rotating torque or only a small counterclockwise or clockwise rotating torque. In a case where the small counterclockwise rotating torque is yielded in the rotor R, the north and south magnetic poles of the double-pole permanent magnet member M1 remain opposite the magnetic poles P1 and P2 of the magnetic member B1 now magnetized as the south and north magnetic poles; so that there does not develop in the double-pole permanent magnet member M1 a rotating torque which prevents the rotor R from rotating counterclockwise. However, since the north and south magnetic poles of the double-pole permanent magnetic member M2 leave the magnetic poles P3 and P4 of the magnetic member B2 now magnetized as the south and north magnetic poles, there is produced in the double-pole permanent magnet member M2 a rotating torque which prevents counterclockwise rotational movement of the rotor R. Further, in a case where the abovesaid small clockwise rotating torque is produced in the rotor R, the north and south magnetic poles of the double-pole permanent magnet member M2 stay opposite the magnetic poles P3 and P4 of the magnetic member B2 magnetized as the south and north magnetic poles; so that there does not develop in the double-pole permanent magnet member M2 a rotating torque which prevents the rotor R from rotating clockwise. However, since the north and south magnetic poles of the double-pole permanent magnet member M1 leave the magnetic poles P1 and P2 acting as the south and north magnetic poles, there is produced in the double-pole permanent magnet member M1 a rotating torque which prevents the clockwise rotational movement of the rotor R.

For the reason given above, the display element E remains in the first state even if power is supplied to the exciting windings L1 and L2 via the power supply means J2 and J4 when the display element E is in the first state.

When the display element E is in the first state, if power is supplied via the power supply means J2 to the exciting winding L1 and to the exciting winding L2 via the power supply means J3 for a very short time at about the same time, as shown in Fig. 6, the rotor R of the motor mechanism Q will assume the afore-mentioned fourth rotational position. That is, the display element E is switched to and held in the state in which its display surface F4 faces front (which state will hereinafter be referred to as the fourth state).

The reason for this is as follows:

By the power supply means to the exciting winding L1 via the power supply means J2, the magnetic poles P1 and P2 of the magnetic member B1 are magnetized with the south and north magnetic poles. In this case, however, since the north and south magnetic poles of the double-pole permanent magnet member M1 are opposite the ends a of the magnetic poles P1 and P2, respectively, no rotating torque is produced in the double-pole permanent magnet member M1, or even if produced, it is only a small counterclockwise rotating torque. By the power supply to the exciting winding L2 via the power supply means J3, however, the magnetic poles P3 and P4 of the magnetic member B2 are magnetized with the north and south magnetic poles. In this case, since the north and magnetic poles of the double-pole permanent magnet M2 lie opposite the ends b of the magnetic poles P3 and P4, a large counterclockwise rotating torque is produced in the double-pole permanent magnet M2 owing to repulsive force between its north magnetic pole and the north-magnetized pole P3 and between its south magnetic pole and the south-magnetized pole P4. In consequence, a large counterclockwise rotating torque is produced in the rotor R, turning it counterclockwise.

When the rotor R thus turns counterclockwise and if it further rotates in excess of 45° from the first rotational position. the north and south magnetic poles of the double-pole permanent magnet M1 turn into opposing relation to the magnetic poles P1 and P2 of the magnetic member B1 now magnetized with the south and north magnetic poles, and consequently no rotating torque is produced in the double-pole permanent magnet M1, or even if generated, it is only a small clockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M2 approach the magnetic poles P4 and P3 now magnetized with the south and north magnetic poles, a large counterclockwise rotating torque is generated in the double-pole permanent magnet M2 by virtue of attractive force between its north magnetic pole and the south-magnetized pole P4 and between its south magnetic pole and the north-magnetized pole P3. As a result of this, the rotor R turns counterclockwise.

When the rotor R thus turns counterclockwise and if it further rotates in excess of 90° from the first rotational position, the north and south magnetic poles of the double-pole permanent magnet M2 turn into opposing relation to the magnetic poles P4 and P3 of the magnetic member B2 now magnetized with the south and north magnetic poles; so that no rotating torque is developed in the double-pole permanent magnet M2, or even if produced, it is only a small counterclockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M1 are out of opposing relation to the magnetic poles P1 and P2 now magnetized with the south and north magnetic poles, there is produced in the double-pole permanent magnet M1 a large rotating torque which prevents the rotor R from rotating counterclockwise in excess of 90° from the first state. Therefore, the rotor R does not turn counterclockwise in excess of 90° from the first rotational position.

For the reason given above, supplying power to the exciting windings L1 and L2 via the power supply means J2 and J3 when the display element E assumes the first state, the display element E is switched to and held in the fourth state.

When the display element E is in the first state, if power is supplied via the power supply means J1 to the exciting winding L1 and to the exciting winding L2 via the power supply means J4 for a very short time at about the same time, as shown in Fig. 7, the rotor R of the motor mechanism Q will assume the second rotational position, where the display element E is switched to and held in the state in which its display surface F2 faces front (which state will hereinafter be referred to as the second state).

The reason for this is as follows:

By the power supply to the exciting winding L2 via the power supply means J4, the magnetic poles P3 and P4 of the magnetic member B2 are magnetized with the south and north magnetic poles. In this case, however, since the north and south magnetic poles of the double-pole permanent magnet member M2 are opposite to the ends b of the magnetic poles P3 and P4, no rotating torque is produced in the double-pole permanent magnet member M2 and, even if produced, it is only a small clockwise rotating torque. By the power supply to the exciting winding L1 via the power supply means J1, however, the magnetic poles P1 and P2 of the magnetic member B1 are magnetized with the north and south magnetic poles. In this case, since the north and magnetic poles of the double-pole permanent M1 lie opposite to the ends a of the magnetic poles P1 and P2, a large clockwise rotating torque is produced in the double-pole permanent magnet M1 owing to repulsive force between its north magnetic pole and the north-magnetized pole P1 and between its south magnetic pole and the south-magnetized pole P2. In consequence, a large clockwise rotating torque is produced in the rotor R, turning it clockwise.

When the rotor R thus turns clockwise and if it further rotates in excess of 45° from the first rotational position, the north and south magnetic poles of the double-pole permanent magnet M2 turn into opposing relation to the magnetic poles P3 and P4 of the magnetic member B2 now magnetized with the south and north magnetic poles, and so no rotating torque is produced in the double-pole permanent magnet M2, or even if generated, it is only a small counterclockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M1 approach the magnetic poles P2 and P1 now magnetized with the south and north magnetic poles, a large clockwise rotating torque is generated in the double-pole permanent magnet M1 by virtue of attractive force between its north magnetic pole and the south-magnetized pole P2 and between its south magnetic pole and the north-magnetized pole P1. As a result of this, the rotor R turns clockwise.

When the rotor R thus turns clockwise and if it further rotates in excess of 90° from the first state, the north and south magnetic poles of the double-pole permanent magnet M1 turn into opposing relation to the magnetic poles P2 and P1 of the magnetic member B1 now magnetized with the south and north magnetic poles, no rotating torque is developed in the double-pole permanent magnet M1, or even if produced, it is only a small clockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M2 get out of opposing relation to the magnetic poles P3 and P4 now magnetized with the south and north magnetic poles, there is produced in the double-pole permanent magnet M2 a large rotating torque which prevents the rotor R from rotating clockwise in excess of 90° from the first state, Therefore, the rotor R does not turn clockwise in excess of 90° from the first rotational position.

For the reason given above, supplying power to the exciting windings L1 and L2 via the power supply means J1 and J4, when the display element E assumes the aforesaid first state, the display element E is switched to and held in the second state.

When the display element E is in the first state, if power is supplied via the power supply means J1 to the exciting winding L1 and to the exciting winding L2 via the power supply means J3 for a very short time at about the same time, as shown in Fig. 8, the rotor R of the motor mechanism Q will assume the third rotational position, where the display element E is switched to and held in the state in which its display surface F3 faces front (which state will hereinafter be referred to as the third state).

The reason for this is as follows:

Let it be assumed that power is supplied first to the exciting winding L1 via the power supply means J1 and then to the exciting winding L2 via the power supply means J3 a little after the start of the power supply to the former.

In such a case, the power supply to the exciting winding L1 via the power supply means J1 magnetizes the magnetic poles P1 and P2 of the magnetic member B1 with the north and south magnetic poles. In this case, since the north and magnetic poles of the double-pole permanent magnet M1 lie opposite the ends a of the magnetic poles P1 and P2, a large clockwise rotating torque is produced in the double-pole permanent magnet M1 owing to repulsive force between its north magnetic pole and the north-magnetized pole P1 and between its south magnetic pole and the south-magnetized pole P2. In consequence, a clockwise rotating torque is produced in the rotor R, turning it counterclockwise.

When the rotor R thus turns clockwise and if it further rotates in excess of 45° from the first state, the north and south magnetic poles of the double-pole permanent magnet M1 approach the magnetic poles P2 and P1 now magnetized with the south and north magnetic poles. Hence a large clockwise rotating torque is generated in the double-pole permanent magnet M1 by virtue of attractive force between its north magnetic pole and the south-magnetized pole P2 and between its south magnetic pole and the north-magnetized pole P1.

Further, if the power supply to the exciting winding L2 via the power supply means J3 is effected at or in the vicinity of the point of time when the rotor R has just turned clockwise more than 45° from the first rotational position, then the magnetic poles P3 and P4 of the magnetic member B2 will be magnetized with the north and south magnetic poles at that point of time. In this case, since the north and south magnetic poles of the double-pole permanent magnet M2 lie opposite the magnetic poles P3 and P4, a clockwise rotating torque is generated in the double-pole permanent magnet M2 by virtue of repulsive force between its north magnetic pole and the north-magnetized pole P3 and between its south magnetic pole and the south-magnetized pole P4.

As a result of this, the rotor R turns clockwise.

When the rotor R thus turns clockwise and if it further rotates in excess of 90° from the first state, the north and south magnetic poles of the double-pole permanent magnet M1 turn into opposing relation to the ends b of the magnetic poles P2 and P1 of the magnetic member B1 now magnetized with the south and north magnetic poles, and so no rotating torque is developed in the double-pole permanent magnet M1, or even if produced, it is only a small clockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M2 are opposite the ends a of the magnetic poles P3 and P4 now magnetized with the north and south magnetic poles, there is produced in the double-pole permanent magnet M2 a large clockwise rotating torque owing to repulsive force between its north magnetic pole and the north-magnetized pole P3 and between its south magnetic pole and the south-magnetized pole P4. In consequence, a clockwise rotating torque is produced in the rotor R, turning it clockwise.

When the rotor R thus turns clockwise and if it further rotates in excess of 135° from the aforesaid first rotational position, the north and south magnetic poles of the double-pole permanent magnet M1 turn into opposing relation to the magnetic poles P2 and P1 of the magnetic member B1 now magnetized with the south and north magnetic poles, so that no rotating torque is produced in the double-pole permanent magnet M1, or even if generated, it is only a small counterclockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M2 approach the magnetic poles P4 and P3 now magnetized with the south and north magnetic poles, respectively, a large clockwise rotating torque is generated in the double-pole permanent magnet M2 by virtue of attractive force between its north magnetic pole and the south- magnetized pole P4 and between its south magnetic pole and the north-magnetized pole P3. As a result of this, the rotor R turns clockwise.

When the rotor R thus turns clockwise if it further rotates in excess of 180° from the first rotational position, the north and south magnetic poles of the double-pole permanent magnet M2 turn into opposing relation to the magnetic poles P4 and P3 of the magnetic member B2 now magnetized with the south and north magnetic poles, so that no rotating torque is developed in the double-pole permanent magnet M2, or even if produced, it is only a small clockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M1 are out of opposing relation to the magnetic poles P2 and P1 now magnetized with the south and north magnetic poles, there is produced in the double-pole permanent magnet M1 a large rotating torque which prevents the rotor R from rotating clockwise in excess of 180° from the first state. Therefore, the rotor R does not turn clockwise in excess of 180° from the first rotational position.

The above description has been given of the case where the power supply to the exciting winding L1 via the power supply means J1 takes place a little earlier than the power supply to the exciting winding L2 via the power supply means J3, but in the opposite case the rotor R turns by 180 from the first rotational position in the counterclockwise direction reverse from that in the above, though not described in detail.

For the reason given above, when supplying power to the exciting windings L1 and L2 via the power supply means J1 and J3 in the state in which the display element E assumes the aforesaid first state, the display element E is switched to and held in the third state.

Now, let it be assumed that the rotor R of the motor mechanism lies at the fourth rotational position, with the display element E in the fourth state in which the display surface F4 of the display surface member D faces to the front. In such a fourth state of the display element E, even if power is supplied via the power supply means J2 to the exciting winding L1 of stator S of the motor mechanism Q and to the exciting winding L2 via the power supply means J3 for a very short time at about the same time, as shown in Fig. 6, the display element E will remain in the fourth state.

The reason for this is as follows:

By the power supply to the exciting winding L1 via the power supply means J2, the magnetic poles P1 and P2 of the magnetic member B1 are magnetized with south and north magnetic poles to produce a small clockwise rotating torque in the double-pole permanent magnet member M1, urging the rotor R to rotate clockwise. By the power supply to the exciting winding L2 via the power supply means J3, however, the magnetic poles P3 and P4 of the magnetic member B2 are magnetized with north and south magnetic poles to produce a small counterclockwise rotating torque in the double-pole permanent magnet member M2, urging the rotor R to rotate counterclockwise. Accordingly, there develops in the rotor R no rotating torque, or only a small clockwise or counterclockwise rotating torque. In a case where the small clockwise rotating torque is produced in the rotor R, the north and south magnetic poles of the double-pole permanent magnet member M1 remain in the opposing relation to the magnetic poles P1 and P2 of the magnetic member B1 now magnetized as the south and north magnetic poles; so that there does not develop in the double-pole permanent magnet member M1 a rotating torque which prevents the rotor R from rotating clockwise. However, since the north and south magnetic poles of the double-pole permanent magnet member M2 turn out of the opposing relation to the magnetic poles P4 and P3 of the magnetic member B2 now magnetized as the south and north magnetic poles, there is produced in the double-pole permanent magnet member M2 a rotating torque which prevents clockwise rotational movement of the rotor R. Further, in a case where the above-said small counterclockwise rotating torque is produced in the rotor R, the north and south magnetic poles of the double-pole permanent magnet member M2 do not turn out of the opposing relation to the magnetic poles P4 and P3 magnetized as the south and north magnetic poles, so that there does not develop in the double-pole permanent magnet member M2 a rotating torque which prevents the rotor R from rotating counterclockwise. In this instance, however, since the north and south magnetic poles of the double-pole permanent magnet member M1 get out of the opposing relation to the magnetic poles P1 and P2 magnetized as the south and north magnetic poles, there is created in the double-pole permanent magnet member M1 a rotating torque which prevents the counterclockwise rotational movement of the rotor R.

For the reason given above, even if power is supplied to the exciting windings L1 and L2 via the power supply means J2 and J3 when the display element E is in the fourth state, the display element E will remains in that state.

When the display element E is in the fourth state, if power is supplied via the power supply means J2 to the exciting winding L1 and to the exciting winding L2 via the power supply means J4 for a very short time at about the same time, as shown in Fig. 9, the rotor R of the motor mechanism Q will assume the afore-mentioned first rotational position, where the display element E is switched to and retained in the first state in which its display surface F1 faces front.

The reason for this is as follows:

By the power supply to the exciting winding L1 via the power supply means J2, the magnetic poles P1 and P2 of the magnetic member B1 are magnetized with the south and north magnetic poles. In this case, since the north and south magnetic poles of the double-pole permanent magnet member M1 are opposite the ends b of the magnetic poles P1 and P2, no rotating torque is produced in the double-pole permanent magnet member M1 and, even if produced, it is only a small clockwise rotating torque. By the power supply to the exciting winding L2 via the power supply means J4, however, the magnetic poles P3 and P4 of the magnetic member B2 are magnetized with the south and north magnetic poles, In this case, since the south and north magnetic poles of the double-pole permanent magnet M2 lie opposite to the ends a of the magnetic poles P3 and P4, a large clockwise rotating torque is created in the double-pole permanent magnet M2 owing to repulsive forces between its north magnetic pole and the north-magnetic pole P4 and between its south magnetic pole and the south-magnetized pole P3. In consequence, a clockwise rotating torque is produced in the rotor R, turning it clockwise.

When the rotor R thus turns clockwise and if it further rotates in excess of 45° from the fourth state, since the north and south magnetic poles of the double-pole permanent magnet M1 turn into opposing relation to the magnetic poles P1 and P2 of the magnetic member B1 now magnetized with the south and north magnetic poles, no rotating torque is yielded in the double-pole permanent magnet M1, or even if generated, it is only a small counterclockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M2 approach the magnetic poles P3 and P4 now magnetized with the south and north magnetic poles, a large clockwise rotating torque is generated in the double-pole permanent magnet M2 by virtue of attractive forces between its north magnetic pole and the south-magnetized pole P3 and between its south magnetic pole and the north-magnetized pole P4. As a result of this, the rotor R turns clockwise.

When the rotor R thus turns clockwise and if it further rotates in excess of 90° from the fourth state, the north and south magnetic poles of the double-pole permanent magnet M2 turn into opposing relation to the magnetic poles P3 and P4 of the magnetic member B2 now magnetized with the south and north magnetic poles, no rotating torque is developed in the double-pole permanent magnet M2, or even if produced, it is only a small clockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M1 stay out of opposing relation to the magnetic poles P1 and P2 now magnetized with the south and north magnetic poles, there is produced in the double-pole permanent magnet M1 a large rotating torque which prevents the rotor R from rotating clockwise in excess of 90° from the fourth state. Therefore, the rotor R does not turn clockwise in excess of 90° from the fourth state.

For the reason given above, when supplying power to the exciting windings L1 and L2 via the power supply means J2 and J4 in the state in which the display element E assumes the fourth state, the display element E is switched to and held in the first state.

When the display element E is in the fourth state, if power is supplied via the power supply means J1 to the exciting winding L1 and to the exciting winding L2 via the power supply means J4 for a very short time at about the same time, as shown in Fig. 10, the rotor R of the motor mechanism Q will assume the second rotational position, where the display element E is switched to and held in the second state in which its display surface F2 faces front.

The reason for this is as follows:
Let it be assumed that power is supplied first to the exciting winding L1 via the power supply means J1 and then to the exciting winding L2 via the power supply means J4 after a little while.

In such a case, the power supply to the exciting winding L1 via the power supply means J1 magnetizes the magnetic poles P1 and P2 of the magnetic member B1 with the north and south magnetic poles. In this case, since the north and south magnetic poles of the double-pole permanent magnet M1 lie opposite the ends b of the magnetic poles P1 and P2, a large counterclockwise rotating torque is produced in the double-pole permanent magnet M1 by repulsive forces between its north magnetic pole and the north-magnetized pole P1 and between its south magnetic pole and the south-magnetized pole P2. In consequence, a counterclockwise rotating torque occurs in the rotor R, driving the rotor R counterclockwise.

When the rotor R thus turns counterclockwise and if it further, rotates in excess of 45° from the fourth rotational position, the north and south magnetic poles of the double-pole permanent magnet M1 approach the magnetic poles P2 and P1 now magnetized with the south and north magnetic poles. This develops a large counterclockwise rotating torque in the double-pole permanent magnet M1 by virtue of attraction between its north magnetic pole and the south-magnetized pole P2 and between its south magnetic pole and the north-magnetized pole P1.

Further, if power is supplied to the exciting winding L2 via the power supply means J4 at exactly or substantially the same instant when the rotor R has just turned counterclockwise more than 45 from the fourth rotational position, then the magnetic poles P4 and P3 of the magnetic member B2 will be magnetized with the north and south magnetic poles immediately. In this case, the north and south magnetic poles of the double-pole permanent magnet M2 lie in opposing relation to the magnetic poles P4 and P3, generating a counterclockwise rotating torque in the double-pole permanent magnet M2 by virtue of repulsive force between its north magnetic pole and the north-magnetized pole P4 and between its south magnetic pole and the south-magnetized pole P3. As a result of this, the rotor R turns counterclockwise.

When the rotor R thus turns counterclockwise and if it further turns in excess of 90° from the fourth rotational position, the north and south magnetic poles of the double-pole permanent magnet member M1 enter into opposing relation to the ends a of the magnetic poles P2 and P1 of the magnetic member B1 now magnetized with the south and north magnetic poles, so that no rotating torque is created in the double-pole permanent magnet member M1, or even if generated, it is only a small counterclockwise torque. In this instance, however, since the north and south magnetic poles of the double-pole permanent magnet member M2 are opposite the ends b of the magnetic poles P4 and P3 of the magnetic member B2 now magnetized with north and south magnetic poles, a large counterclockwise rotating torque is yielded in the double-pole permanent magnet member M2 by repulsion between its north magnetic pole and the north-magnetized pole P4 and between its south magnetic pole and the south-magnetized pole P3. On this account, a large counterclockwise torque develops in the rotor R, turning it counterclockwise.

When the rotor R thus turns counterclockwise and if it further rotates in excess of 135° from the fourth rotational position, the north and south magnetic poles of the double-pole permanent magnet M1 enter into opposing relation to the magnetic poles P2 and P1 of the magnetic member B1 now magnetized with the south and north magnetic poles, and so no rotating torque is developed in the double-pole permanent magnet M1, or even if produced, it is only a small clockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M2 approach the magnetic poles P3 and P4 now magnetized with the south and north magnetic poles, a large counterclockwise rotating torque is generated in the double-pole permanent magnet M2 by virtue of attractive force between its north magnetic pole of the double-pole and the south magnetized pole P3 and between its south magnetic pole and the north-magnetized pole P4. As a result of this, the rotor R turns counterclockwise.

When the rotor R thus turns counterclockwise and if it further rotates in excess of 180° from the fourth rotational position, the north and south magnetic poles of the double-pole permanent magnet M2 turn into opposing relation to the magnetic poles P3 and P4 of the magnetic member B2 now magnetized with the south and north magnetic poles, and so, no rotating torque is developed in the double-pole permanent magnet M2, or even if produced, it is only a small counterclockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M1 do not face the magnetic poles P2 and P1 now magnetized with the south and north magnetic poles, there is produced in the double-pole permanent magnet M1 a large rotating torque which prevents the rotor R from rotating counterclockwise in excess of 180° from the first state. Therefore, the rotor R does not turn counterclockwise in excess of 180° from the first rotational position.

The above description has been given of the case where power is supplied first to the exciting winding L1 via the power supply means J1 and then power is supplied to the exciting winding L2 via the power supply means J4 a little after the above power supply, but in the opposite case, the rotor R turns by 180° from the fourth rotational position in the clockwise direction reverse from that in the above, though not described in detail.

For the reason given above, when supplying power to the exciting windings L1 and L2 via the power supply means J1 and J4 in the state in which the display element E assumes the said fourth state, the display element E is switched to and is held in the second state.

When the display element E is in the fourth state, if power is supplied to the exciting winding L1 via the power supply means J1 and to the exciting winding L2 via the power supply means J3 for a very short time at about the same time as shown in Fig. 11, the rotor R of the motor mechanism Q will assume the third rotational position, where the display element E is switched to and held in the third state in which its display surface F3 faces front.

The reason for this is as follows:
By the power supply to the exciting winding L2 via the power supply means J3, the magnetic poles P3 and P4 of the magnetic member B2 are magnetized with the north and south magnetic poles. In this case, however since the south and north magnetic poles of the double-pole permanent magnet member M2 are opposite the ends a of the magnetic poles P3 and P4, no rotating torque is produced in the double-pole permanent magnet member M2, or even if produced, it is only a small counterclockwise rotating torque. By the power supply to the exciting winding L1 via the power supply means J1, however, the magnetic poles P1 and P2 of the magnetic member B1 are magnetized with the north and south magnetic poles. In this case, since the north and magnetic poles of the double-pole permanent magnet M1 lie opposite the ends b of the magnetic poles P1 and P2, a large counterclockwise rotating torque is produced in the double-pole permanent magnet M1 by repulsive force between its north magnetic pole and the north-magnetized role P1 and between its south magnetic pole and the-south magnetized pole P2. In consequence, a counterclockwise rotating torque is produced in the rotor R, urging the rotor R to turn counterclockwise.

When the rotor R thus turns counterclockwise and if it further rotates in excess of 45° from the fourth rotational position, the north and south magnetic poles of the double-pole permanent magnet M2 enter into opposing relation to the magnetic poles P4 and P3 of the magnetic member B2 now magnetized with the south and north magnetic poles, and hence no rotating torque is produced in the double-pole permanent magnet M2, or even if generated, it is only a small clockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M1 approach the magnetic poles P2 and P1 now magnetized with the south and north magnetic poles, a large counterclockwise rotating torque is generated in the double-pole permanent magnet M1 by virtue of attractive force between its north magnetic pole and the south-magnetized pole P2 and between its south magnetic pole and the north-magnetized pole P1. As a result of this, the rotor R turns counterclockwise.

When the rotor R thus turns counterclockwise and if it further rotates counterclockwise in excess of 90° from the fourth rotational position, the north and south magnetic poles of the double-pole permanent magnet M1 turn into opposing relation to the magnetic poles P2 and P1 of the magnetic member B1 now magnetized with the south and north magnetic poles, so that no rotating torque is developed in the double-pole permanent magnet M1, or even if produced, it is only a small counterclockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M2 turn out of opposing relation to the magnetic poles P4 and P3 now magnetized with the south and north magnetic poles, there is produced in the double-pole permanent magnet M2 a large rotating torque which prevents the rotor R from rotating counterclockwise in excess of 90° from the fourth rotational position. Therefore, the rotor R does not turn counterclockwise in excess of 90° from the fourth rotational position.

For the reason given above, when supplying power to the exciting windings L1 and L2 via the power supply means J1 and J3 in the state in which the display element E assumes the fourth state, the display element E is switched to and held in the third state.

Now, let it be assumed that the rotor R of the motor mechanism lies at the second rotational position where the display element E is in the second state in which the display surface F2 of the display surface member D faces to the front. In such a second state of the display element E, even if power is supplied via the power supply means J1 to the exciting winding L1 of the stator S of the motor mechanism Q and to the exciting winding L2 via the power supply means J4 for a very short time at about the same time, as shown in Fig. 7, the display element E will remain in the second state.

The reason for this is as follows:
By the power supply to the exciting winding L1 via the power supply means J1, the magnetic poles P1 and P2 of the magnetic member B1 are magnetized with the north and south magnetic poles to produce a small clockwise rotating torque in the double-pole permanent magnet member M1, urging the rotor R to rotate clockwise. By the power supply to the exciting winding L2 via the power supply means J4, however, the magnetic poles P3 and P4 of the magnetic member B2 are magnetized with the south and north magnetic poles to produce a small counterclockwise rotating torque in the double-pole permanent magnet member M2, urging the rotor R to rotate counterclockwise. Accordingly, there develops in the rotor R no rotating torque, or only a small counterclockwise or clockwise rotating torque. In a case where the small clockwise rotating

torque is produced in the rotor R, the south and north magnetic poles of the double-pole permanent magnet member M1 remain in the opposing relation to the magnetic poles P1 and P2 of the magnetic member B1 now magnetized with the north and south magnetic poles, so that there does not develop in the double-pole permanent magnet member M1 a rotating torque which prevents the rotor R from rotating clockwise. However, since the north and south magnetic poles of the double-pole permanent magnet member M2 turn out of the opposing relation to the magnetic poles P3 and P4 of the magnetic member B2 now magnetized with the south and north magnetic poles there is produced in the double-pole permanent magnet member M2 a rotating torque which prevents clockwise rotational movement of the rotor R. Further, in a case where the above-said small counterclockwise rotating torque is produced in the rotor R, the north and south magnetic poles of the double-pole permanent magnet member M2 do not turn out of the opposing relation to the magnetic poles P3 and P4 magnetized with the south and north magnetic poles, so that there does not develop in the double-pole permanent magnet member M2 a rotating torque which prevents the rotor R from rotating counterclockwise. However, since the north and south magnetic poles of the double-pole permanent magnet member M1 get out of the opposing relation to the magnetic poles P2 and P1 magnetized with the south and north magnetic poles, there is produced in the double-pole permanent magnet member M1 a rotating torque which prevents the counterclockwise rotational movement of the rotor R.

For the reason given above, even if power is supplied to the exciting windings L1 and L2 via the power supply means J1 and J4 when the display element E is in the second state, the display element E will remain in that state.

When the display element E is in the second state, if power is supplied via the power supply means J2 to the exciting winding L1 and to the exciting winding L2 via the power supply means J4 for a very short time at about the same time, as shown in Fig. 12. the rotor R of the motor mechanism Q will assume the first rotational position, where the display element E is switched to the first state in which its display surface F1 faces front, thereafter being held in that state.

The reason for this is as follows:

By the power supply to the exciting winding L2 via the power supply means J4, the magnetic poles P3 and P4 of the magnetic member B2 are magnetized with the south and north magnetic poles. In this case, however, since the north and south magnetic poles of the double-pole permanent magnet member M2 are opposite the end a of the magnetic poles P3 and P4, no rotating torque is produced in the double-pole permanent magnet member M2, or even if produced, it is only a small counterclockwise rotating torque. By the power supply to the exciting winding L1 via the power supply means J2, however. the magnetic poles P1 and P2 of the magnetic member B1 are magnetized with the south and north magnetic poles. In this case. since the south and north magnetic poles of the double-pole permanent magnet M1 lie opposite the ends b of the magnetic poles P1 and P2, a large counterclockwise rotating torque is produced in the double-pole permanent magnet M1 by repulsive force between its north magnetic pole and the north magnetized pole P2 and between its south magnetic pole and the south-magnetized pole P1. In consequence, a counterclockwise rotating torque is produced in the rotor R, driving the rotor R counterclockwise.

When the rotor R thus turns counterclockwise and if it further rotates in excess of 45° from the second rotational position, the north and south magnetic poles of the double-pole permanent magnet M2 enter into opposing relation to the magnetic poles P3 and P4 of the magnetic member B2 now magnetized with the south and north magnetic poles, and hence no rotating torque is produced in the double-pole permanent magnet M2, or even if generated, it is only a small clockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M1 approach the magnetic poles P1 and P2 now magnetized with the south and north magnetic poles, a large counterclockwise rotating torque is generated in the double-pole permanent magnet M1 by virtue of attractive force between its north magnetic pole and the south-magnetized pole P1 and between its south magnetic pole and the north-magnetized pole P2. As a result of this, the rotor R turns counterclockwise.

When the rotor R thus turns counterclockwise and if it further rotates counterclockwise in excess of 90° from the second rotational position, the north and south magnetic poles of the double-pole permanent magnet M1 turn into opposing relation to the magnetic poles P1 and P2 of the magnetic member B1 now magnetized with the south and north magnetic poles, and so no rotating torque is developed in the double-pole permanent magnet M1, or even if produced, it is only a small counterclockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M2 are out of opposing relation to the magnetic poles P3 and P4 now magnetized with the south and north magnetic poles, there is produced in the double-pole permanent magnet M2 a large rotating torque which prevents the rotor R from rotating counterclockwise in excess of 90° from the second rotational position. Therefore, the rotor R does not turn counterclockwise in excess of 90° from the second rotational position.

For the reason given above, when supplying power to the exciting windings L1 and L2 via the power supply means J2 and J4 in the state in which the display element E assumes the aforesaid second state, the display element E is switched to and held in the first state.

When the display element E is in the second state, if power is supplied via the power supply means J2 to the exciting winding L1 and to the exciting winding L2 via the power supply means J3 for a very short time at about the same time. as shown in Fig. 13, the rotor R of the motor mechanism Q will assume the fourth rotational position, where the display element E is switched to the state in which its display surface F4 faces front, thereafter being held in that state.

The reason for this is as follows:
Let it be assumed that power is supplied to the exciting winding L1 via the power supply means J2 and then to the exciting winding L2 via the power supply means J3 a little after the start of the former power supply.

In such a case, by the power supply to the exciting winding L1 via the power supply means J2, the magnetic poles P1 and P2 of the magnetic member B1 are magnetized with the south and north magnetic poles. In this case, the south and north and magnetic poles of the double-pole permanent magnet M1 lie opposite to the ends b of the magnetic poles P1 and P2, a large counterclockwise rotating torque is produced in the double-pole permanent magnet M1 by repulsive force between its north magnetic pole and the north-magnetized pole P2 and between its south magnetic pole and the south-magnetized pole P1. In consequence, a counterclockwise rotating torque is produced in the rotor R, driving the rotor R counterclockwise.

When the rotor R thus turns counterclockwise and if it further rotates in excess of 45° from the second state, the north and south magnetic poles of the double-pole permanent magnet M1 approach the magnetic poles P1 and P2 now magnetized with the south and north magnetic poles, and so a large counterclockwise rotating torque is generated in the double-pole permanent magnet M1 by virtue of attractive force between its north magnetic pole and the south magnetized pole P1 and between its south magnetic pole and the north magnetized pole P2.

Further, if power is supplied to the exciting winding L2 via the power supply means J3 at exactly or nearly the same instant when the rotor R has just turned counterclockwise more than 45° from the second rotational position, then the magnetic poles P3 and P4 of the magnetic member B2 will be magnetized with the north and magnetic poles immediately. In this case, since the north and south magnetic poles of the double-pole permanent magnet M2 lie in opposing relation to the magnetic poles P3 and P4, a large counterclockwise rotating torque is generated in the double-pole permanent magnet M2 by virtue of repulsive force between its north magnetic pole and the north magnetized pole P3 and between its south magnetic pole and the south-magnetized pole P4. As a result of this, the rotor R turns counterclockwise.

When the rotor R thus turns counterclockwise and if it further rotates in excess of 90° from the second rotational position, the north and south magnetic poles of the double-pole permanent magnet M1 turn into opposing relation to the ends a of the magnetic poles P1 and P2 of the magnetic member B1 now magnetized with the south and north magnetic poles, and so no rotating torque is developed in the double-pole permanent magnet M1, or even if produced, it is only a small counterclockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M2 are in opposing relation to the ends b of the magnetic poles P3 and P4 now magnetized with the north and south magnetic poles, there is produced in the double-pole permanent magnet M2 a large counterclockwise rotating torque by a repulsive force between its north magnetic pole and the north-magnetized pole P3 and between its south magnetic pole and the south-magnetized pole P4. In consequence, a counterclockwise rotating torque is produced in the rotor R, driving the rotor R counterclockwise.

When the rotor R thus turns counterclockwise and if it further rotates in excess of 135° from the second rotational position, the north and south magnetic poles of the double-pole permanent magnet M1 enter into opposing relation to the magnetic poles P1 and P2 of the magnetic member B1 now magnetized with the south and north magnetic poles, and so no rotating torque is produced in the double-pole permanent magnet M1, or even if generated, it is only a small clockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M2 approach the magnetic poles P4 and P3 now magnetized with the south and north magnetic poles, a large counterclockwise rotating torque is generated in the double-pole permanent magnet M2 by virtue of attractive force between its north magnetic pole and the south-magnetized pole P4 and between its south magnetic pole and the north-magnetized pole P3. As a result of this, the rotor R turns counterclockwise.

When the rotor R thus turns counterclockwise and if it further rotates in excess of 180° from the second rotational position, the north and south magnetic poles of the double-pole permanent magnet M2 turn into opposing relation to the magnetic poles P4 and P3 of the magnetic member B2 now magnetized with the south and north magnetic poles, and so no rotating torque is developed in the double-pole permanent magnet M2, or even if produced, it is only a small counterclockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M1 are not opposite the magnetic poles P1 and P2 now magnetized with the south and north magnetic poles, there is produced in the double-pole permanent magnet M1 a large rotating torque which prevents the rotor R from rotating counterclockwise in excess of 180° from the second state. Therefore, the rotor R does not turn counterclockwise in excess of 180° from the second rotational position.

The above description has been given of the case where power is supplied first to the exciting winding L1 via the power supply means J2 and then power is supplied to the exciting winding L2 via the power supply means J3 a little after the former power supply, but in the opposite case the rotor R turns by 180° from the first rotational position in the clockwise direction reverse from that in the above, through not described in detail.

For the reason given above, when supplying power to the exciting windings L1 and L2 via the power supply means J2 and J3 in the state in which the display element E assumes the aforesaid second state, the display element E is switched to and held in the fourth state.

When the display element E is in the second state, if power is supplied via the power supply means J1 to the exciting winding L1 and to the exciting winding L2 via the power supply means J3 for a very short time at about the dame time, as shown in Fig. 14, the rotor R of the motor mechanism Q will assume the third rotational position, where the display element E is switched to the third state in which its display surface F3 faces front, thereafter being held in that state.

The reason for this is as follows:

By the power supply to the exciting winding L1 via the power supply means J1, the magnetic poles P1 and P2 of the magnetic member B1 are magnetized with the north and south magnetic poles. In this case, However, since the south and north magnetic poles of the double-pole permanent magnet member M1 are opposite the ends b of the magnetic poles P1 and P2, no rotating torque is produced in the double-pole permanent magnet member M1 and, even if produced, it is only a small clockwise rotating torque. By the power supply to the exciting winding L2 via the power supply means J3, however, the magnetic poles P3 and P4 of the magnetic member B2 are magnetized with the north and south magnetic poles. In this case, since the north and magnetic poles of the double-pole permanent magnet M2 lie opposite to the ends a of the magnetic poles P3 and P4, a large clockwise rotating torque is produced in the double-pole permanent magnet M2 by repulsive force between its north magnetic pole and the north magnetized pole P3 and between its south magnetic pole and the south-magnetized pole P4. In consequence, a clockwise rotating torque is produced in the rotor R, driving the rotor R clockwise.

When the rotor R thus turns clockwise and if it further rotates in excess of 45° from the second rotational position, the north and south magnetic poles of the double-pole permanent magnet M1 enter into opposing relation to the magnetic poles P2 and P1 of the magnetic member B1 now magnetized with the south and north magnetic poles. At this time, no rotating torque is produced in the double-pole permanent magnet M1, or even if generated, it is only a small counterclockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M2 approach the magnetic poles P4 and P3 now magnetized with the south and north magnetic poles, a large clockwise rotating torque is generated in the double-pole permanent magnet M2 by virtue of attractive force between its north magnetic pole and the south-magnetized pole P4 and between its south magnetic pole and the north-magnetized pole P3. As a result of this, the rotor R turns clockwise.

When the rotor R thus turns clockwise and if it further rotates in excess of 90° from the second rotational position, the north and south magnetic poles of the double-pole permanent magnet M2 turn into opposing relation to the magnetic poles P4 and P3 of the magnetic member B2 now magnetized with the south and north magnetic poles. At this time, no rotating torque is developed in the double-pole permanent magnet M2, or even if produced, it is only a small clockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M1 turn out of opposing relation to the magnetic poles P2 and P1 now magnetized with the south and north magnetic poles, there is produced in the double-pole permanent magnet M1 a large rotating torque which prevents the rotor R from rotating clockwise in excess of 90° from the second state. Therefore, the rotor R does not turn clockwise in excess of 90° from the second rotational position.

For the reason given above, when supplying power to the exciting windings L1 and L2 via the power supply means J1 and J3 in the state in which the display element E assumes the aforesaid second state, the display element E is switched to and held in the third state.

Now, let it be assumed that the rotor R of the motor mechanism lies at the third rotational position, and consequently the display element E is in the third state in which the display surface F3 of the display surface member D faces of the front. In such a third state of the display element E, even if power is supplied via the power supply means J1 to the exciting winding L1 of the stator S of the motor mechanism Q and to the exciting winding L2 via the power supply means J3 for a very short time a little before or after each other, as shown in Fig. 8, the display element E will remain in the third state.

The reason of this is as follows:

By the power supply to the exciting winding L1 via the power supply means J1, the magnetic poles P1 and P2 of the magnetic member B1 are magnetized with the north and south magnetic poles, to produce a small counterclockwise rotating torque in the double-pole permanent magnet member M1, urging the rotor R to rotate counterclockwise. By the power supply to the exciting winding L2 via the power supply means J3, however, the magnetic poles P3 and P4 of the magnetic member B2 are magnetized with the north and south magnetic poles, to produce a small clockwise rotating torque in the double-pole permanent magnet member M2, urging the rotor R to rotate clockwise. Acordingly, there develops in the rotor R no rotating torque, or only a small counterclockwise or clockwise rotating torque. In a case where the small clockwise rotating torque is produced in the rotor R, the north and south magnetic poles of the double-pole permanent magnet member M2 remain in the opposing relation to the magnetic poles P4 and P3 of the magnetic member B2 now magnetized with the south and north magnetic poles, so that there does not develop in the double-pole permanent magnet member M2 a rotating torque which prevents the rotor R from rotating clockwise. However, since the north and south magnetic poles of the double-pole permanent magnet member M1 turn out of the opposing relation to the magnetic poles P2 and P1 of the magnetic member B1 now magnetized with the south and north magnetic poles, there is produced in the double-pole permanent magnet member M1 a rotating torque which prevents clockwise rotational movement of the rotor R. Further, in a case where the small counterclockwise rotating torque is produced in the rotor R, the north and south magnetic poles of the double-pole permanent magnet member M1 do not turn out of the opposing relation to the magnetic poles P2 and P1 magnetized with the south and north magnetic poles, so that there does not develop in the double-pole permanent magnet member M1 a rotating torque which prevents the rotor R from rotating counterclockwise. However since the north and south magnetic poles of the double-pole permanent magnet member M2 get out of the opposing relation to the magnetic poles P4 and P3 of the magnetic member B2 magnetized with the south and north magnetic poles, there is produced in the double-pole permanent magnet member M2 a rotating torque which prevents the counterclockwise rotational movement of the rotor R.

For the reason given above, even if power is supplied to the exciting windings L1 and L2 via the power supply means J1 and J3 when the display element E is in the third state, the display element E will remain in that state.

When the display element E is in the third state, if power is supplied via the power supply means J2 to the exciting winding L1 for a very short time and power is supplied to the exciting winding L2 via the power supply means J4 for a very short time a little before or after the start of the former power supply, as shown in Fig. 15, the rotor R of the motor mechanism Q will assume the first rotational position, where the display element E is switched to the state in which its display surface F1 to the front, thereafter being held in that state.

The reason for this is as follows:
Let it be assumed that the power supply to the exciting winding L1 via the power supply means J2 slightly precedes the power supply to the exciting winding L2 via the power supply means J4.

In such a case, by the power supply to the exciting winding L1 via the power supply means J2, the magnetic poles P1 and P2 of the magnetic member B1 are magnetized with the south and north magnetic poles. In this case, since the south and north magnetic poles of the double-pole permanent magnet M1 lie opposite the ends a of the magnetic poles P1 and P2, a large clockwise rotating torque is produced in the double-pole permanent magnet M1 by repulsion between its north magnetic pole and the north-magnetized pole P2 and repulsion between its south magnetic pole and the south-magnetized pole P1. In consequence, a clockwise rotating torque is produced in the rotor R, driving rotor R clockwise.

When the rotor R thus turns clockwise and if it further rotates in excess of 45° from the third rotational position, the north and south magnetic poles of the double-pole permanent magnet M1 approach the magnetic poles P1 and P2 now magnetized with the south and north magnetic poles, a large clockwise rotating torque is generated in the double-pole permanent magnet M1 by virtue of attraction between its north magnetic pole and the south-magnetized pole P1 and attraction between its south magnetic pole and the north-magnetized pole P2.

Further, if the afore-said power supply to the exciting winding L2 via the power supply means J4 is effected at or in the vicinity of the point of time when the rotor R has just turned clockwise more than 45 from the third rotational position, then the magnetic poles P3 and P4 of the magnetic member B2 will be magnetized with the south and north magnetic poles immediately. In this case, since the south and north magnetic poles of the double-pole permanent magnet M2 lie in opposing relation to the magnetic poles P3 and P4, a clockwise rotating torque is generated in the double-pole permanent magnet M2 by virtue of repulsion between its north magnetic pole and the north magnetized pole P4 and repulsion between its south magnetic pole and the south-magnetized pole P3. As a result of this, the rotor R turns clockwise.

When the rotor R thus turns clockwise and if it further rotates in excess of 90° from the third rotational position, the north and south magnetic poles of the double-pole permanent magnet M1 turn into opposing relation to the ends b of the magnetic poles P1 and P2 of the magnetic member B1 now magnetized with the south and north magnetic poles. Therefore, no rotating torque is developed in the double-pole permanent magnet M1, or even if produced, it is only a small clockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M2 come into opposing relation to the ends a of the magnetic poles P4 and P3 now magnetized with the north and south magnetic poles, there is produced in the double-pole permanent magnet M2 a large clockwise rotating torque by repulsion between its north magnetic pole and the north magnetized pole P4 and repulsion between its south magnetic pole and the south-magnetized pole P3. In consequence, a clockwise rotating torque is produced in the rotor R, driving the rotor R clockwise.

When the rotor R thus turns clockwise and if it further rotates in excess of 135 from the third rotational position, the north and south magnetic poles of the double-pole permanent magnet M1 turn into opposing relation to the magnetic poles P1 and P2 of the magnetic member B1 now magnetized with the south and north magnetic poles. Therefore no rotating torque is produced in the double-pole permanent magnet M1, or even if generated, it is only a small counterclockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M2 approach the magnetic poles P3 and P4 now magnetized with the south and north magnetic poles, a large clockwise rotating torque is generated in the double-pole permanent magnet M2 by virtue of attraction between its north magnetic pole and the south-magnetized pole P3 and attraction between its south magnetic pole and the north-magnetized pole P4. As a result of this, the rotor R turns clockwise.

When the rotor R turns clockwise and if it further rotates in excess of 180° from the third rotational position, the north and south magnetic poles of the double-pole permanent magnet M2 turn into opposing relation to the magnetic poles P3 and P4 of the magnetic member B2 now magnetized with the south and north magnetic poles. Therefore, no rotating torque is developed in the double-pole permanent magnet M2, or even if produced, it is only a small clockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M1 turn out of opposing relation to the magnetic poles P1 and P2 now magnetized with the south and north magnetic poles, there is produced in the double-pole permanent magnet M1 a large rotating torque which prevents the rotor R form rotating clockwise in excess of 180° from the third rotational position. Accordingly, the rotor R does not turn clockwise in excess of 180° from the third state.

The above description has been given of the case where the power supply to the exciting winding L1 via the power supply means J2 slightly precedes the power supply to the exciting winding L2 via the power supply means J4. On the other hand, when the power supply to the exciting winding L2 via the power supply means J4 slightly precedes the power supply to the exciting winding L1 via the power supply means J2, the rotor R turns by 180° from the third rotational position in the counterclockwise direction reverse from that in the above, though not described in detail.

For the reason given above, when supplying power to the exciting windings L1 and L2 via the power supply means J2 and J4 in the state in which the display element E assumes the third state, the display element E is switched to and held in the first state.

When the display element E is in the third state, if power is supplied via the power supply means J2 to the exciting winding L1 for a very short time and power is supplied to the exciting winding L2 via the power supply means J3 for a very short time a little before or after the start of the former power supply, as shown in Fig.16, the rotor R of the motor mechanism Q will assume the fourth rotational position, by which the display element E is switched to the fourth state in which its display surface F4 faces front, thereafter being held in that state.

The reason for this is as follows:

By the power supply to the exciting winding L2 via the power supply means J3, the magnetic poles P3 and P4 of the magnetic member B2 are magnetized with the north and south magnetic poles. In this case, however, since the south and north magnetic poles of the double-pole permanent magnet member M2 are opposite the ends b of the magnetic poles P3 and P4, no rotating torque is produced in the double-pole permanent magnet member M2, or even if produced, it is only a small clockwise rotating torque. By the power supply to the exciting winding L1 via the power supply means J2, however, the magnetic poles P1 and P2 of the magnetic member B1 are magnetized with the south and north magnetic poles. In this case, since the south and north magnetic poles of the double-pole permanent magnet M1 lie opposite to the ends a of the magnetic poles P1 and P2, a large clockwise rotating torque is produced in the double-pole permanent magnet M1 by repulsive force between its north magnetic pole and the north-magnetized pole P2 and repulsive force between its south magnetic pole and the south-magnetized pole P1. In consequence, a clockwise rotating torque is produced in the rotor R, driving the rotor R clockwise.

When the rotor R thus turns clockwise and if it further rotates in excess of 45° from the third rotational position, the north and south magnetic poles of the double-pole permanent magnet M2 enter into opposing relation to the magnetic poles P4 and P3 of the magnetic member B2 now magnetized with the south and north magnetic poles. Therefore, no rotating torque is produced in the double-pole permanent magnet M2, or even if generated, it is only a small counterclockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M1 approach the magnetic poles P1 and P2 now magnetized with the south and north magnetic poles, a large clockwise rotating torque is generated in the double-pole permanent magnet M1 by virtue of attractive force between its north magnetic pole and the south-magnetized pole P1 and attractive force between its south magnetic and the north-magnetized pole P2. As a result of this, the rotor R turns clockwise.

When the rotor R thus turns clockwise and if it further rotates in excess of 90° from the third rotational position, the north and south magnetic poles of the double-pole permanent magnet M1 turn into opposing relation to the magnetic poles P1 and P2 of the magnetic member B1 now magnetized with the south and north magnetic poles. Therefore, no rotating torque is developed in the double-pole permanent magnet M1, or even if produced, it is only a small clockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M2 turn out of opposing relation to the magnetic poles P4 and P3 now magnetized with the south and north magnetic poles, there is produced in the double-pole permanent magnet M2 a large rotating torque which prevents the rotor R from rotating clockwise in excess of 90° from the third rotational position. On this account, the rotor R does not turn clockwise in excess of 90° from the third rotational position.

For the reason given above, when supplying power to the exciting windings L1 and L2 via the power supply means J2 and J3 in the state in which the display element E assumes the third state, the display element E is switched to and held in the fourth state.

When the display element E is in the third state, if power is supplied via the power supply means J1 to the exciting winding L1 for a very short time and power is also supplied to the exciting winding L2 via the power supply means J4 for a very short time a little before or after the start of the former power supply, as shown in Fig. 17, the rotor R of the motor mechanism Q will assume the second rotational position, by which the display element E is switched to the second state in which its display surface F2 faces the front, thereafter being held in the second state.

The reason for this is as follows:

By the power supply to the exciting winding L1 via the power supply means J1, the magnetic poles P1 and P2 of the magnetic member B1 are magnetized with the north and south magnetic poles. In this case, however, since south and north magnetic poles of the double-pole permanent magnet member M1 are opposite to the ends a of the magnetic poles P1 and P2, no rotating torque is produced in the double-pole permanent magnet member M1, or even if produced, it is only a small counterclockwise rotating torque. By the power supply to the exciting winding L2 via the power supply means J4, however, the magnetic poles P3 and P4 of the magnetic member B2 are magnetized with the south and north magnetic poles. In this case, since the south and north magnetic poles of the double-pole permanent magnet M2 lie opposite to the ends b of the magnetic poles P3 and P4, a large counterclockwise rotating torque is produced in the double-pole permanent magnet M2 by repulsive force between its north magnetic pole and the north-magnetized pole P4 and repulsive force between its south magnetic pole and the south-magnetized pole P3. In consequence, a counterclockwise rotating torque is produced in the rotor R, driving the rotor R counterclockwise.

When the rotor R thus turns counterclockwise and if it further rotates in excess of 45° from the third rotational position, the north and south magnetic poles of the double-pole permanent magnet M1 turn into opposing relation to the magnetic poles P2 and P1 of the magnetic member B1 now magnetized with the south and north magnetic poles. Therefore, no rotating torque is produced in the double-pole permanent magnet M1, or even if generated, it is only a small clockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M2 approach the magnetic poles P3 and P4 now magnetized with the south and north magnetic poles, a large counterclockwise rotating torque is generated in the double-pole permanent magnet M2 by virtue of attractive force between its north magnetic pole and the south-magnetized pole P3 and attractive force between its south magnetic pole and the north-magnetized pole P4. As a result of this, the rotor R turns clockwise.

When the rotor R thus turns counterclockwise and if it further rotates in excess of 90° from the third rotational position, the north and south magnetic poles of the double-pole permanent magnet M2 turn into opposing relation to the magnetic poles P3 and P4 of the magnetic member B2 now magnetized with the south and north magnetic poles. Therefore, no rotating torque is developed in the double-pole permanent magnet M2, or even if produced, it is only a small counterclockwise rotating torque. However, since the north and south magnetic poles of the double-pole permanent magnet M1 turn out of opposing relation to the magnetic poles P2 and P1 now magnetized with the south and north magnetic poles, there is produced in the double-pole permanent magnet M1 a large rotating torque which prevents the rotor R from rotating counterclockwise in excess of 90° from the third rotational position. On this account, the rotor R does not turn counterclockwise in excess of 90° from the third rotational position.

For the reason given above, when supplying power to the exciting windings L1 and L2 via the power supply means J1 and J4 in the state in which the display element E assumes the aforesaid third state, the display element E is switched to the held in the second state.

As will be appreciated from the foregoing description, according to the present invention, the display surfaces F1, F4, F2 and F3 of the display surface member D constituting the display element E can selectively be directed to the front by simply selecting operations of:

(i) Supplying power to the exciting winding L1 of the stator S of the motor mechanism Q of the display element E via the power supply means J2 forming the drive device G, and supplying power to the exciting winding L2 of the stator S of the motor mechanism Q via the power supply means J4 of the drive device G a little before or after the above power supply;

(ii) Supplying power to the exciting winding L1 via the power supply means J2, and supplying power to the exciting winding L2 via the power supply means J3 of the drive device G a little before or after the above power supply;

(iii) Supplying power to the exciting winding L1 via the power supply means J1, and supplying power to the exciting winding L2 via the power supply means J4 a little before or after the above power supply; and

(iv) Supplying power to the exciting winding L1 via the power supply means J1, and supplying power to the exciting winding L2 via the power supply means J3 a little before or after the above power supply.

In the case where one of the display surfaces F1, F2, F3 and F4 of the display surface member D is selected to face to the front, even if the power supply to the exciting windings L1 and L2 of the stator S of the motor mechanism Q is OFF, the north and south magnetic poles of the double-pole permanent magnet members M1 and M2 of the rotor R of the motor mechanism Q act on the magnetic poles P1 and P2 of the magnetic member B1 and the magnetic poles P3 and P4 of the magnetic member B2 of the stator S of the motor mechanism Q. Accordingly, the selected display surface can be retained in position, without the necessity of providing any particular means therefor. Further, no power consumption is involved therefor.

Since the motor mechanism Q for turning the display surface member D is incorporated therein, a drive mechanism for turning the display surface member D need not be provided separately of the display element E.

The means for selecting a desired one of the display surfaces F1, F2, F3 and F4 of the display surface member D of the display element E is very simple because it is formed by the power supply means J1 and J2 for the exciting winding L1 of the stator S of the motor mechanism Q and the power supply means J3 and J4 for the exciting winding L2 of the stator S.

The double-pole permanent magnet members M1 and M2 of the rotor R of the motor mechanism Q are each formed by a bar- or plate-like member which is of narrow rectangular cross section in the direction perpendicular to the axis of the otary shaft 11 and magnetized with north and south magnetic poles at its both free end faces spaced an angular distance of 180° apart around the axis of the rotary shaft 11. Therefore, the effective angular ranges of the north and south magnetic poles of the double-pole permanent magnet members M1 and M2 around the rotary shaft 11 are effectively limited by their bar- or plate-like configurations. Accordingly, a desired one of the display surfaces F1, F2, F3 and F4 of the display element E can be selected rapidly and smoothly, and an error in positioning the selected display surface can be effectively eliminated.

The foregoing description should be construed as being merely illustrative of the display unit employing the rotating display element of the present invention and should not be construed as limiting the invention specifically thereto.

For example, the double-pole permanent magnet members M1 and M2 of the rotor R of the motor mechanism Q can be formed as if constituted by a single double-pole permanent magnet member in which its portions divided into two in its axial direction serve as the double-pole permanent magnet members M1 and M2, although no detailed description will be given (In this case, afore-mentioned angle $\alpha°$ is 0°). With such an arrangement, too, the same operational effects as those described previously can be obtained, though not described in detail.

While in the above the bar- or plate-like members, which form the double-pole permanent magnet members M1 and M2 and limit the effective angular ranged of their north and south magnetic poles, are of narrow rectangular cross section and the widths of their end faces are less than 45° around the axis of the rotary shaft 11, these width may be any value so long as they are smaller than 45°. although it is preferable that they are relatively small within the angular range of less than 45°.

While the foregoing description has been given of the case where the rotor R is a so-called inner rotor type, it will be seen that the rotor can be formed as an outer rotor type. Moreover, the rotor may also be substituted with the stator, in which case the latter may be substituted with the former.

By assembling a number of display units of the present invention a panel which has many display elements arranged in a matrix form on a common flat or curved surface, a plurality of display surfaces of the many display elements can selectively be directed to the front, making it possible to display letters, symbols, graphic forms, patterns and so forth on the panel. Accordingly, the present invention can be applied, for example, to an advertising panel, a traffic sign board and the like.

Various other modifications and variations may be effected without departing from the scope of the spirits of the present invention.

Claims

1. A rotating display element, comprising:
a display surface member having a plurality of display surfaces;
and a permanent magnet type motor mechanism:
wherein the display surface member is mounted on a rotor of the permanent magnet type motor mechanism so that it incorporates therein the permanent magnet type motor mechanism;
wherein the plurality of display surfaces of the display surface member are arranged side by side around the axis of the rotor;
wherein either one of the rotor and stator of the permanent magnet type motor mechanism has first and second double-pole permanent magnet members respectively having north and south magnetic poles and disposed side by side in the axial direction of the rotor;
Wherein the first double-pole permanent magnet member is formed by a bar- or plate-like member which is of narrow rectangular cross section in a direction perpendicular to the axis of the rotor and magnetized with north and south magnetic poles at its both free end faces spaced an angular distance of 180 apart around the axis of the rotor, the bar- or plate-like member being mounted on the rotor shaft, with the center of the former in the above cross section held in agreement with the center of the latter;
Wherein the second double-pole permanent magnet member is formed by a bar- or plate-like member which is of narrow rectangular cross section in the direction perpendicular to the axis of the rotor and magnetized with north and south magnetic poles at its both free end faces spaced an angular distance of 180° apart around the axis of the rotor, the bar- or plate-like member being mounted on the rotor shaft, with the center of the former in the above cross section held in agreement with the center of the latter, in such a manner that the north and south magnetic poles of the second double-pole permanent magnet member are disposed around the axis of the rotor at an angular distance of $\pm\alpha°$ (where $0° \leqq \alpha° < 180°$) from the north and south magnetic poles of the first double-pole permanent magnet member and at an angular distance of 180° from each other;
wherein the other of the rotor and the stator of the permanent magnet type motor has a first magnetic member provided with first and second magnetic poles which act on the north and south magnetic poles of the first double-pole permanent magnet member, a second magnetic member provided with third and fourth magnetic poles which act on the north and south magnetic poles of the second double-pole permanent magnet member, a first

exciting winding wound on the first magnetic member in manner to excite its first and second magnetic poles in reverse polarities, and a second exciting winding wound on the second magnetic member in a manner to excite its third and fourth magnetic poles in reverse polarities; wherein the first and second magnetic poles of the first magnetic member are disposed around the rotor shaft of an angular distance of 180°; wherein the third and fourth magnetic poles of the second magnetic member are disposed around the axis of the rotor shaft at an angular distance of $\pm 90° \ \pm \alpha°$ from the first and second magnetic poles of the first magnetic member and at an angular distance of 180 from each other; and wherein the first and second magnetic poles of the first magnetic member and the third and fourth magnetic poles of the second magnetic member respectively extend over an angular range of about 90 around the axis of the rotor shaft.

2. A display unit comprising:
a rotating display element and a drive unit for driving the rotating display element;
wherein the rotating display element is provided with a display surface member having a plurality of display surfaces, and a permanent magnet type motor mechanism;
wherein the display surface member is mounted on a rotor of the permanent magnet type motor mechanism so that it incorporates therein the permanent magnet type motor mechanism;
wherein the plurality of display surfaces of the display surface member are arranged side by side around the axis of the rotor;
wherein either one of the rotor and stator of the permanent magnet type motor mechanism has first and second double-pole permanent magnet members respectively having north and south magnetic poles and disposed side by side in the axial direction of the rotor;
Wherein the first double-pole permanent magnet member is formed by a bar- or plate-like member which is of narrow rectangular cross section in a direction perpendicular to the axis of the rotor and magnetized with north and south magnetic poles at its both free end faces spaced an angular distance of 180° apart around the axis of the rotor, the bar- or plate-like member being mounted on the rotor shaft, with the center of the former in the above cross section held in agreement with the center of the latter;
Wherein the second double-pole permanent magnet member is formed by a bar- or plate-like member which is of narrow rectangular cross section in the direction perpendicular to the axis of the rotor and magnetized with north and south magnetic poles at its both free end faces spaced an angular distance of 180° apart around axis of the the rotor, the bar- or plate-like member being mounted on the rotor shaft, with the center of the former in the above cross section held in agreement with the center of the latter, in such a manner that the north and south magnetic poles of the second double-pole permanent magnet member are disposed around the axis of the rotor at an angular distance of $\pm \alpha°$ (where $0° \leqq \alpha° < 180°$) from the north and south magnetic poles of the first double-pole permanent magnet member and at an angular distance of 180° from each other;
wherein the other of the rotor and the stator of the permanent magnet type motor has a first magnetic member provided with first and second magnetic poles which act on the north and south magnetic poles of the first double-pole permanent magnet member, a second magnetic member provided with third and fourth magnetic poles which act on the north and south magnetic poles of the second double-pole permanent magnet member, a first exciting winding wound on the first magnetic member in manner to excite its first and second magnetic poles in reverse polarities, and a second exciting winding wound on the second magnetic member in a manner to excite its third and fourth magnetic poles in reverse polarities;
wherein the first and second magnetic poles of the first magnetic member are disposed around the axis of the rotor at an angular distance of 180°;
wherein the third and fourth magnetic poles of the second magnetic member are disposed around the axis of rotor at an angular distance of $\pm 90° \ \pm \alpha°$ from the first and second magnetic poles of the first magnetic member and at an angular distance of 180 from each other; and
wherein the first and second magnetic poles of the first magnetic member and the third and fourth magnetic poles of the second magnetic member respectively extend over an angular range of about 90 around the axis of the rotor.
wherein the drive unit has first power supply means for supplying power to the first exciting winding so that the first and second magnetic poles of the first magnetic member are magnetized with the north and south magnetic poles, second power supply means for supplying power to the first exciting winding so that the first and second magnetic poles of the first magnetic member are magnetized with the south and north magnetic poles, third power supply means for supplying power to the second exciting winding so that the third and fourth magnetic poles of the second magnetic member are magnetized with the north and south magnetic poles, and fourth power supply means for supplying power to the second exciting winding so that the third and fourth magnetic poles of the second magnetic member are magnetized with the south and north magnetic poles.

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Fig.1

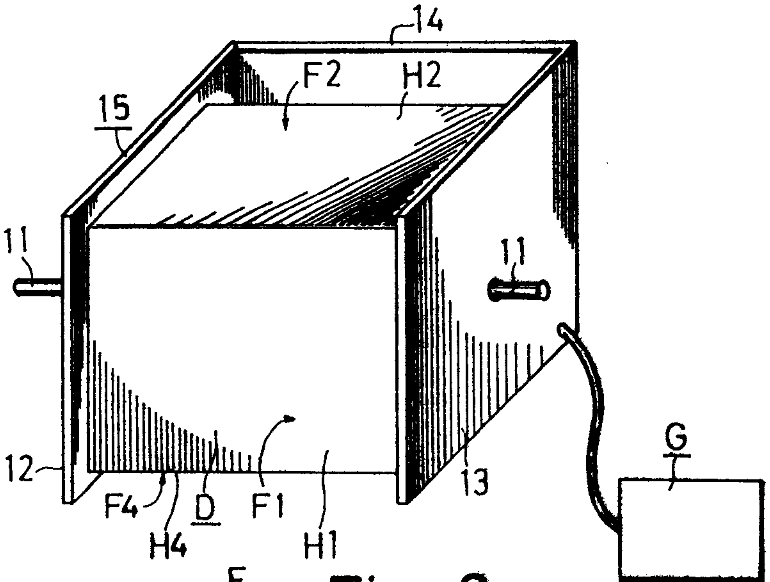


Fig.2

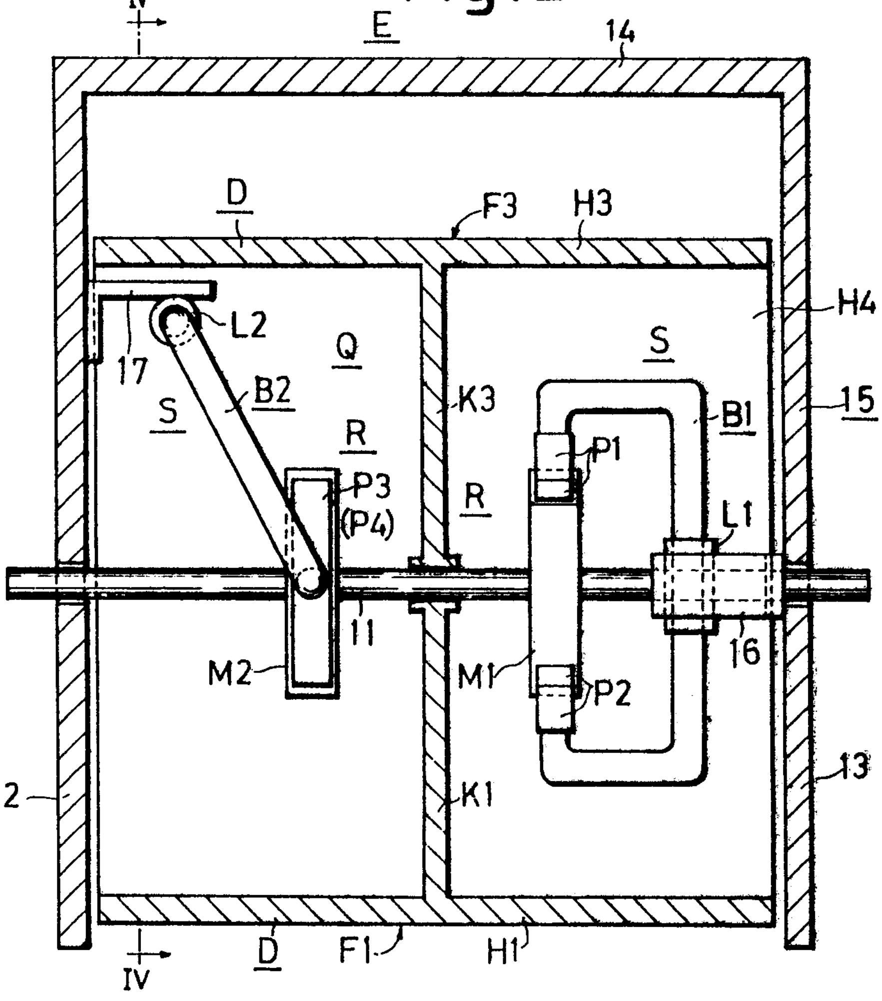
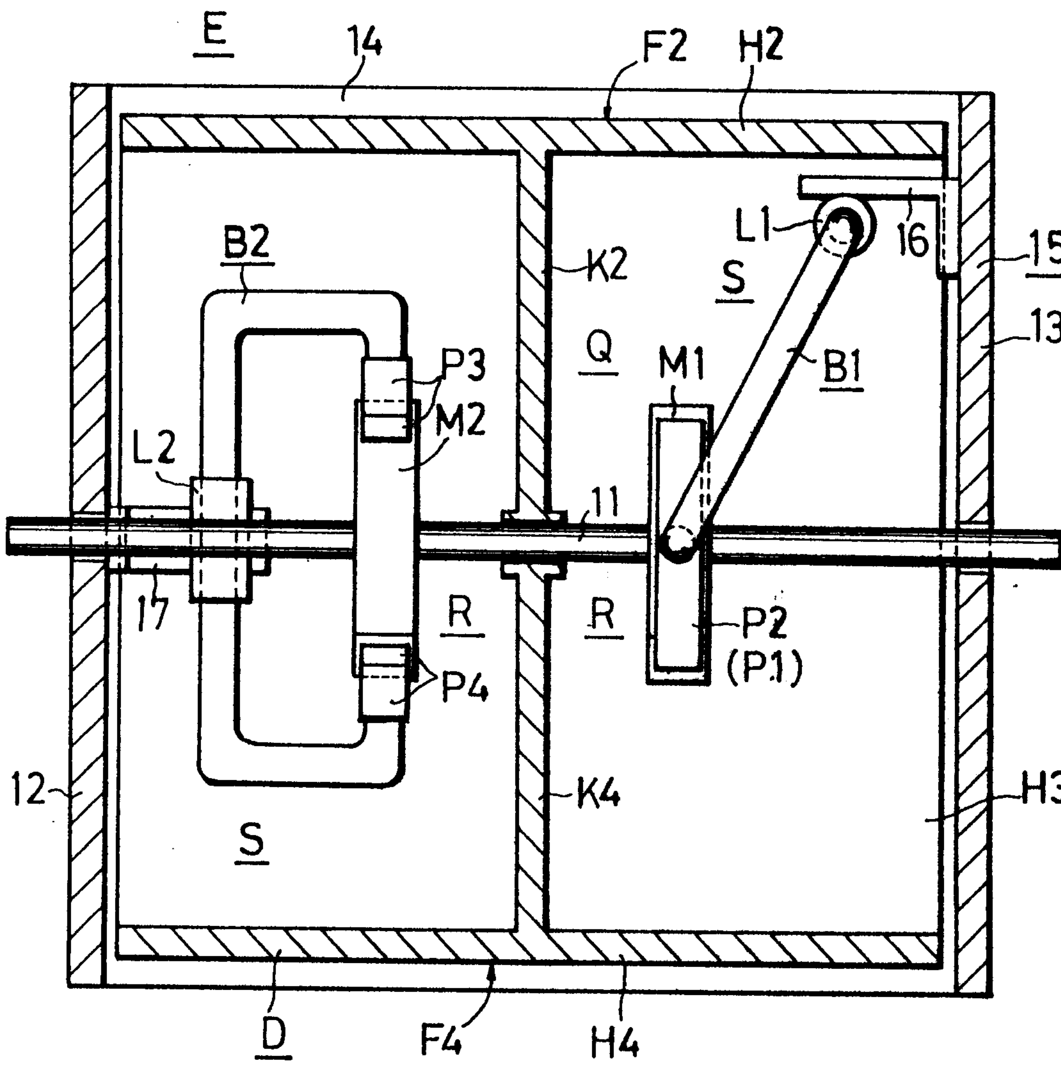


Fig.3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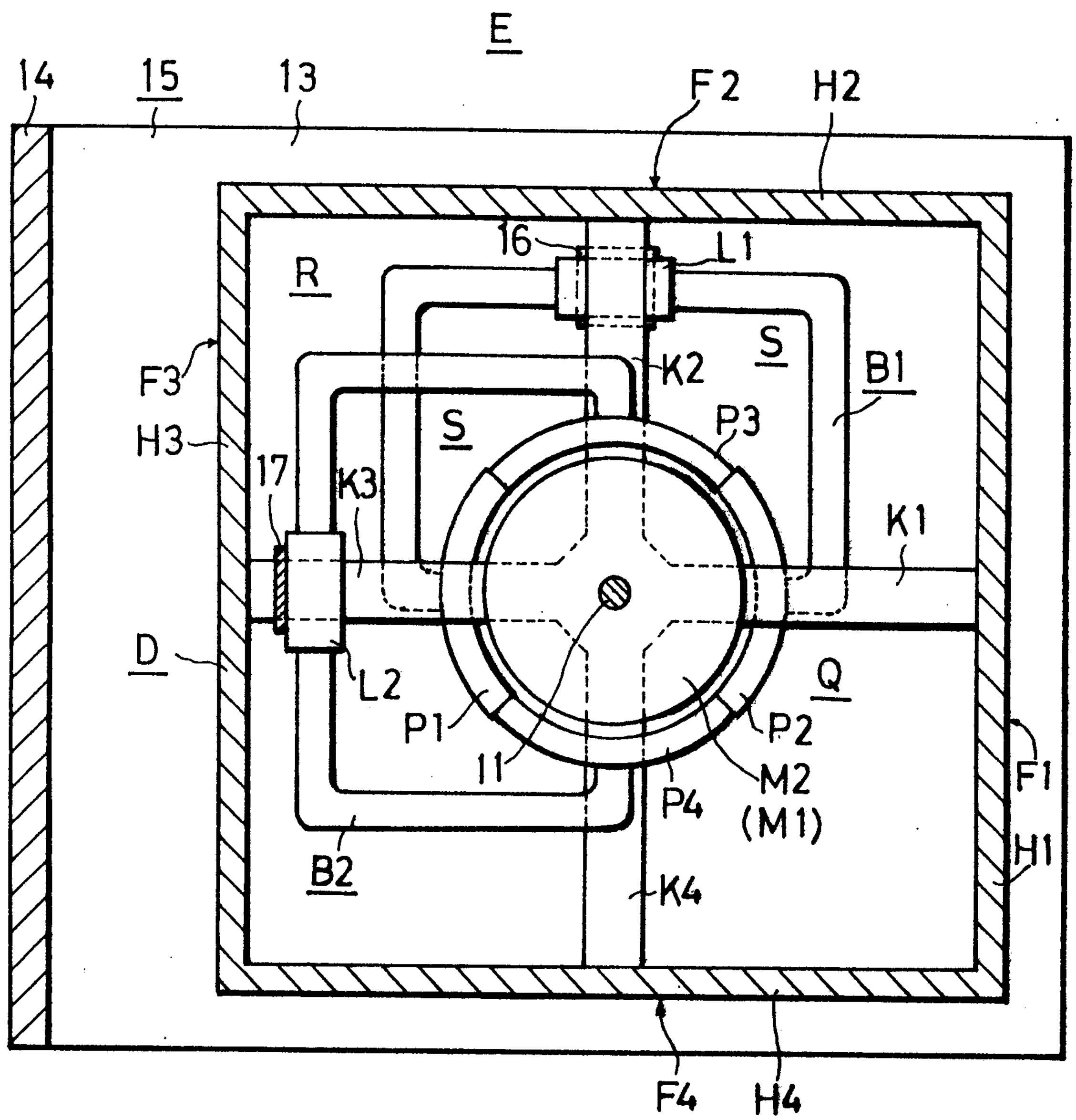
H2
L1
16
15
B2
K2
S
13
Q
M1
B1
P3
M2
L2
11
17
R
R
P2
(P1)
P4
12
K4
H3
S
D
F4
H4

Fig.4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F2
H2
16
L1
R
S
F3
K2
B1
S
P3
H3
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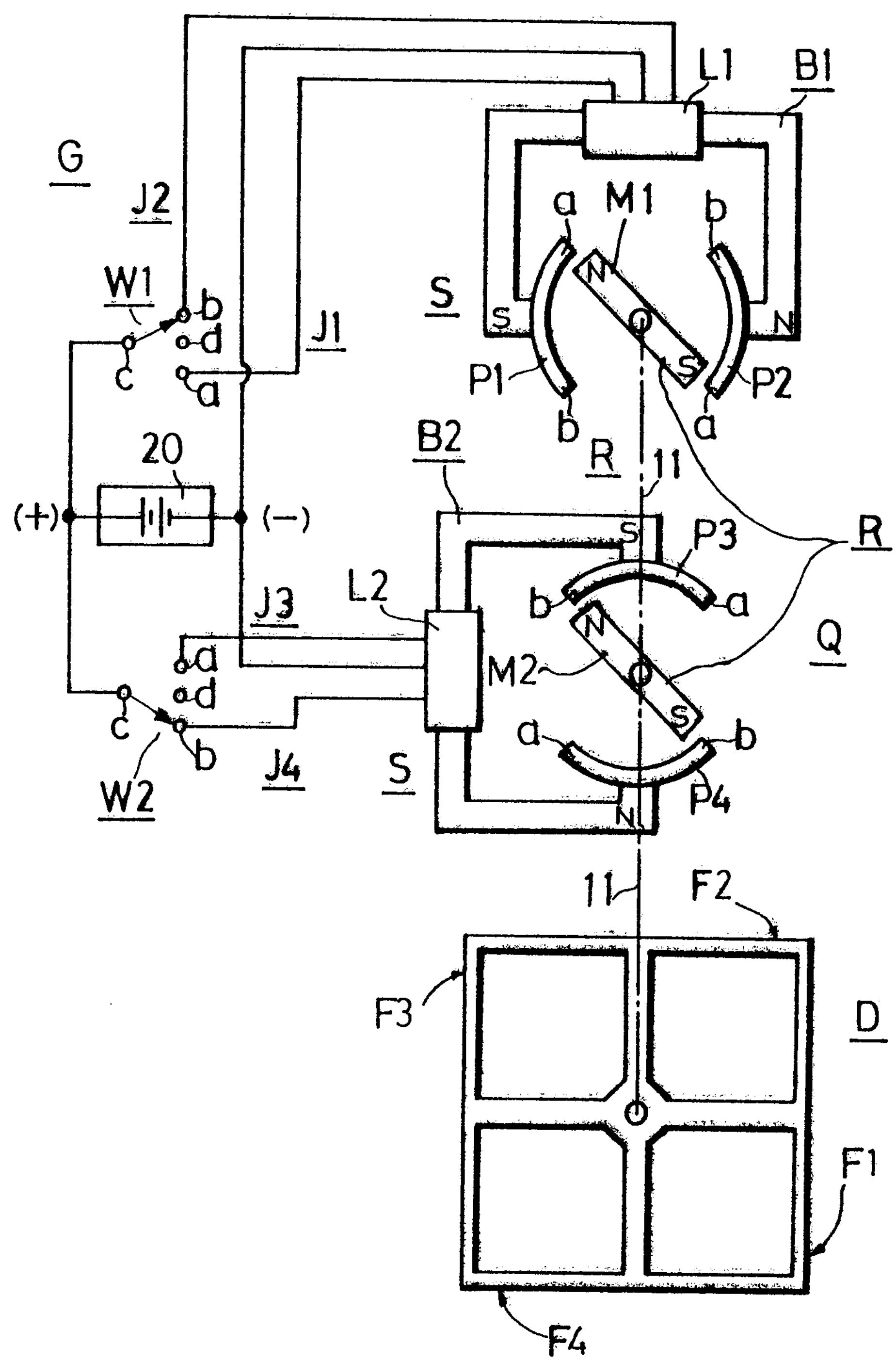
K3
K1
D
L2
Q
P1
P2
F1
11
P4
M2
(M1)
B2
H1
K4
F4
H4

Fig.5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W1
b
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J1
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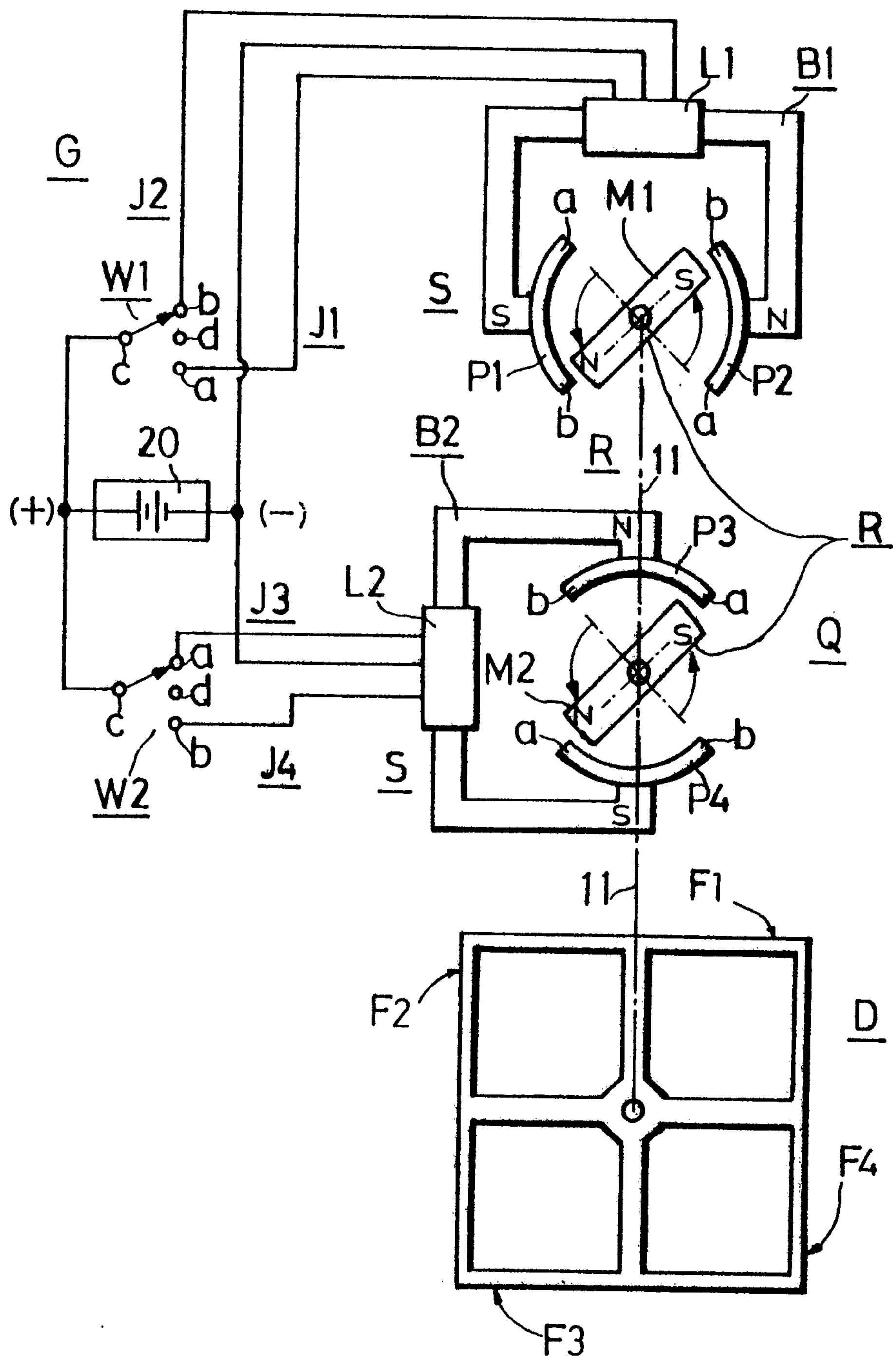
c
a
s
P1
P2
b
a
20
B2
R
11
(+)
(−)
s
P3
R
L2
J3
b
a
N
Q
a
M2
d
s
c
b
a
b
J4
S
W2
P4
N
11
F2
F3
D
F1
F4

Fig.6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(−)
J3
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d
c
b
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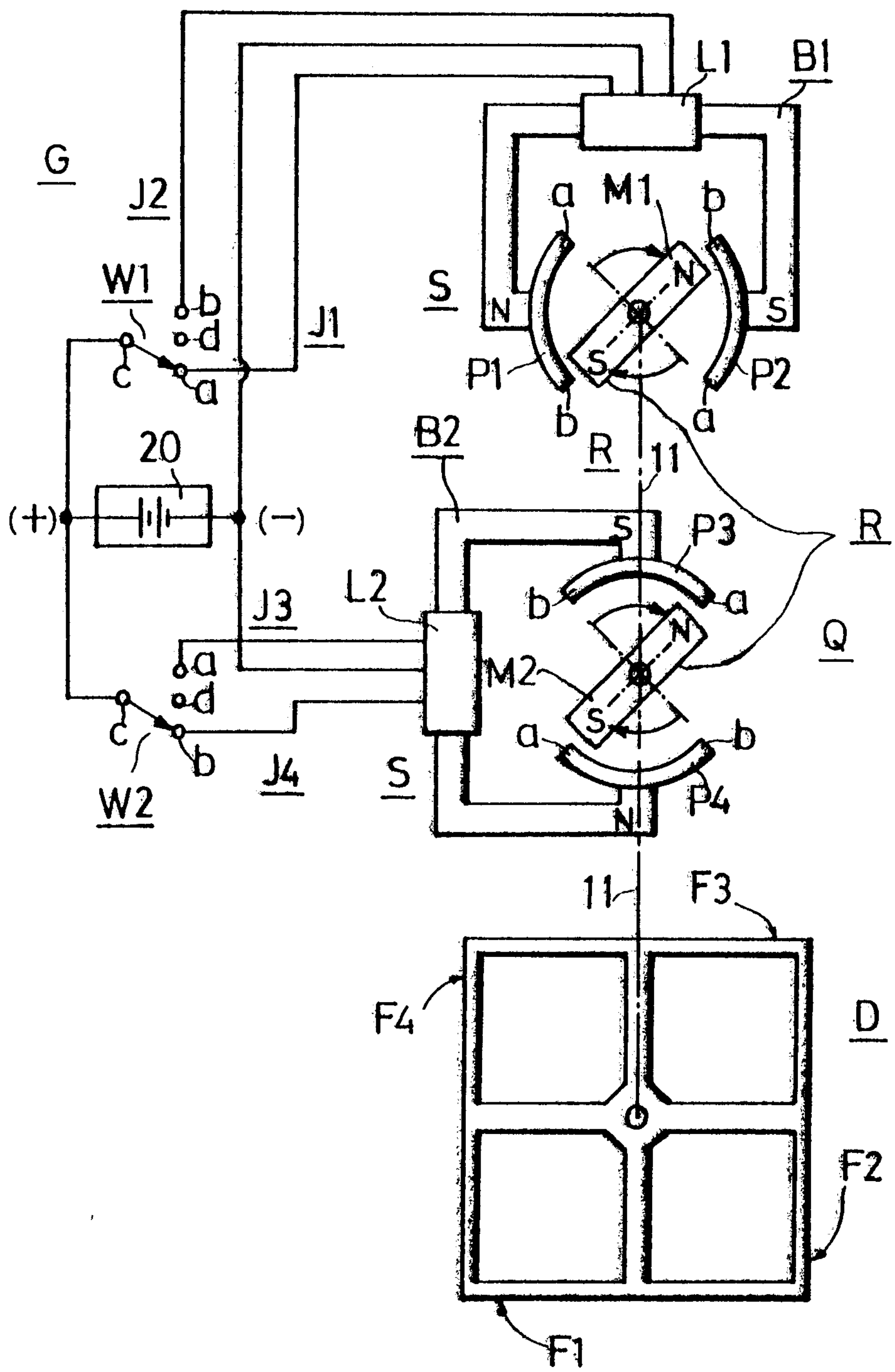
L1
B1
a
M1
b
S
S
S
N
N
P1
P2
b
a
R
11
B2
N
P3
b
a
R
Q
M2
S
N
a
b
P4
S
11
F1
F2
D
F4
F3

Fig.7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B1
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M1
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P1
P2
b
a
B2
R
11
S
P3
b
a
R
Q
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M2
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a
b
P4
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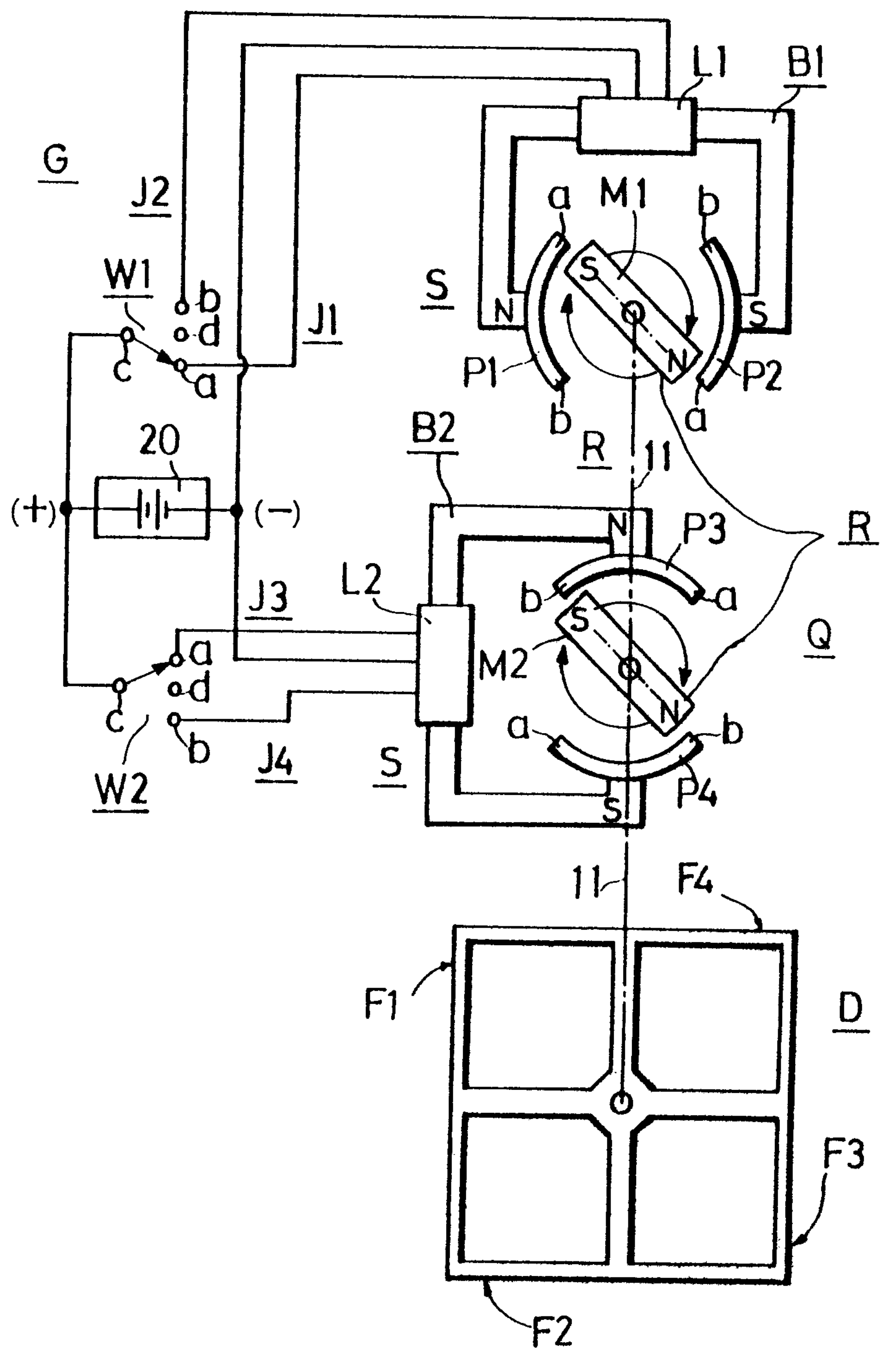
N
11
F3
F4
D
F2
F1

Fig.8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P1
P2
b
a
B2
R
11
R
N
P3
b
a
L2
J3
a
d
c
W2
b
J4
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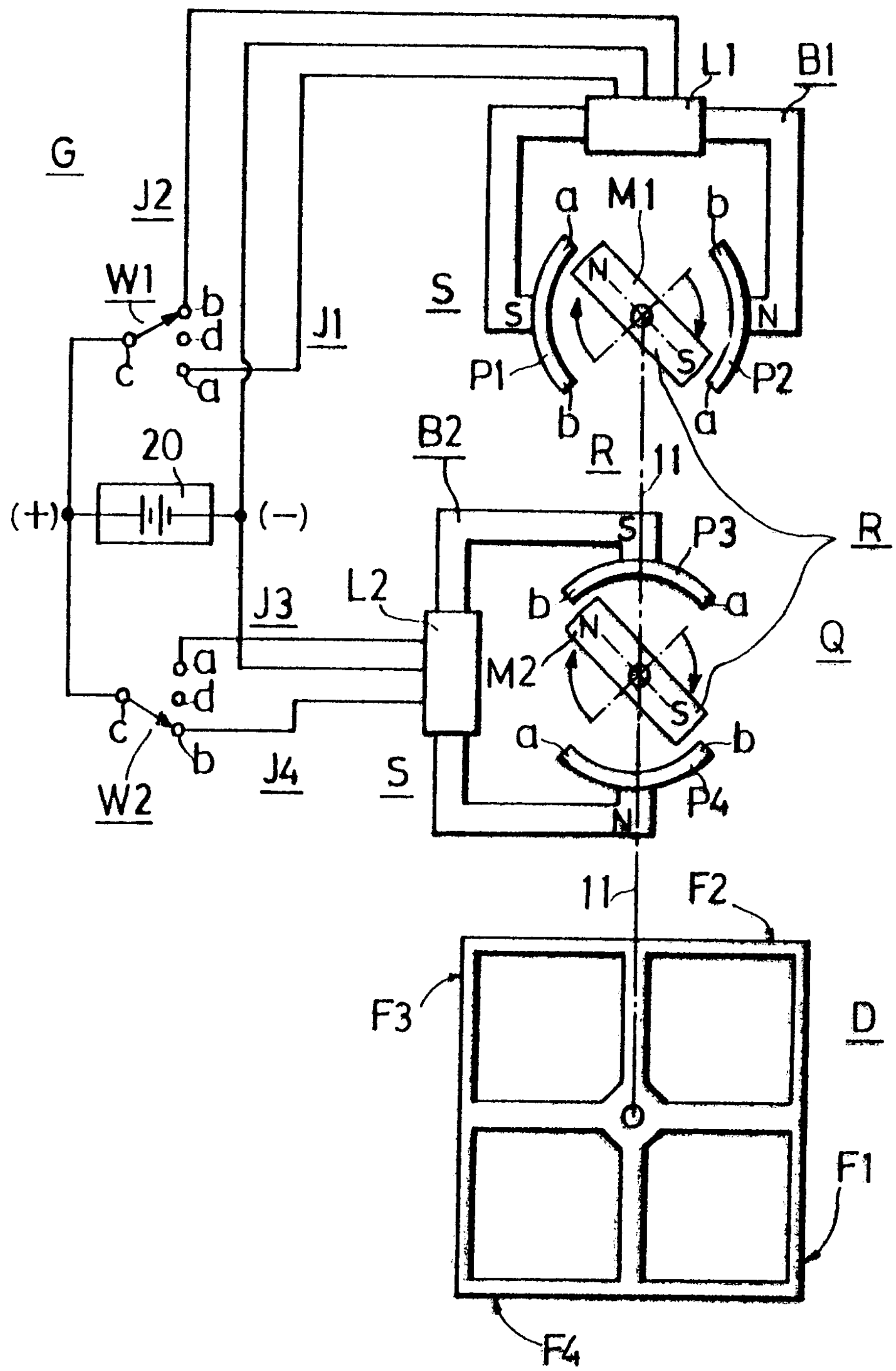
b
P4
S
11
F4
F1
D
F3
F2

Fig.9



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b
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R
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B2
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(−)
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P3
J3
L2
b
a
a
d
M2
N
S
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P4
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F2
F3
D
F1
F4
R

Fig. 10

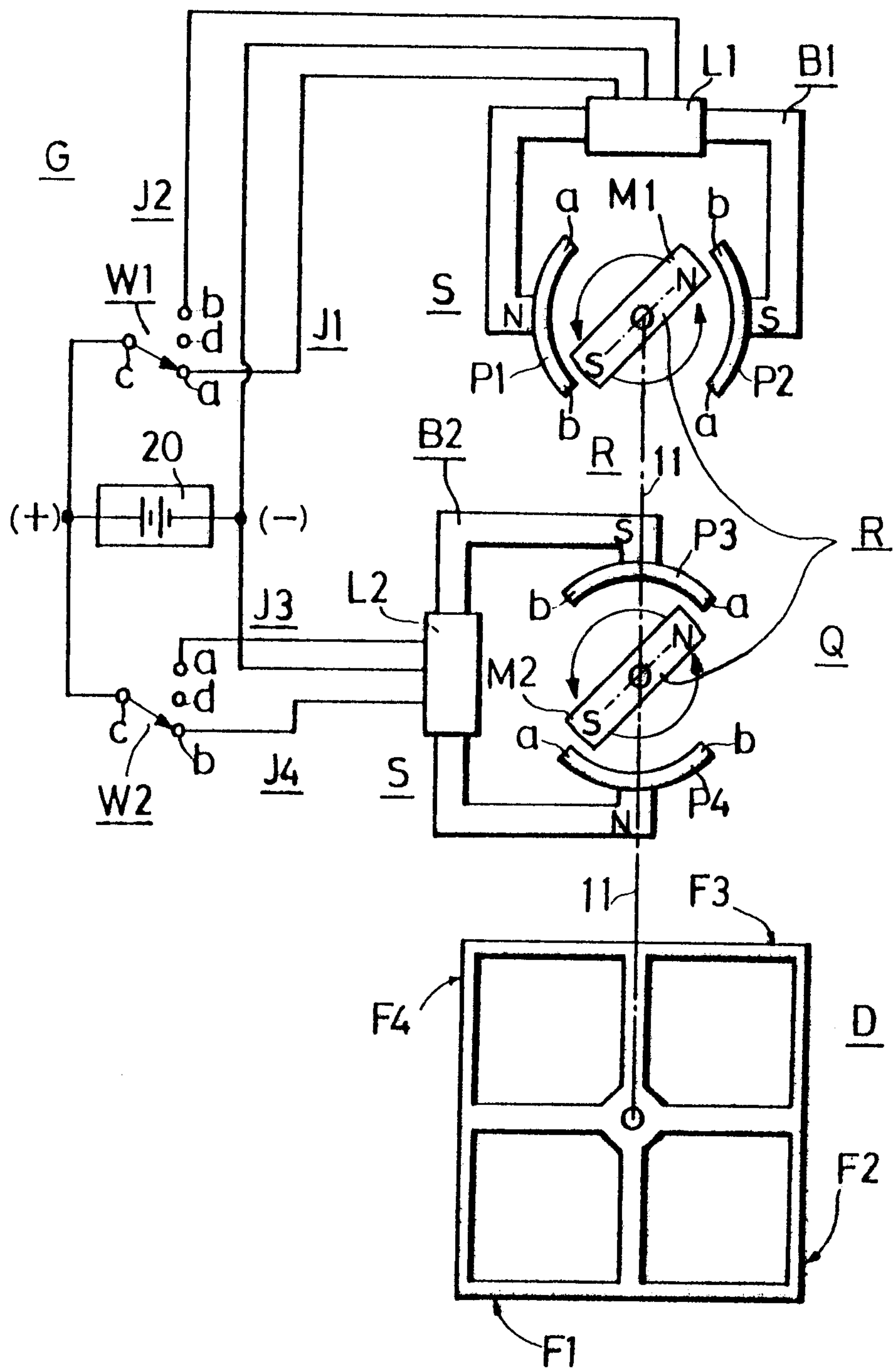
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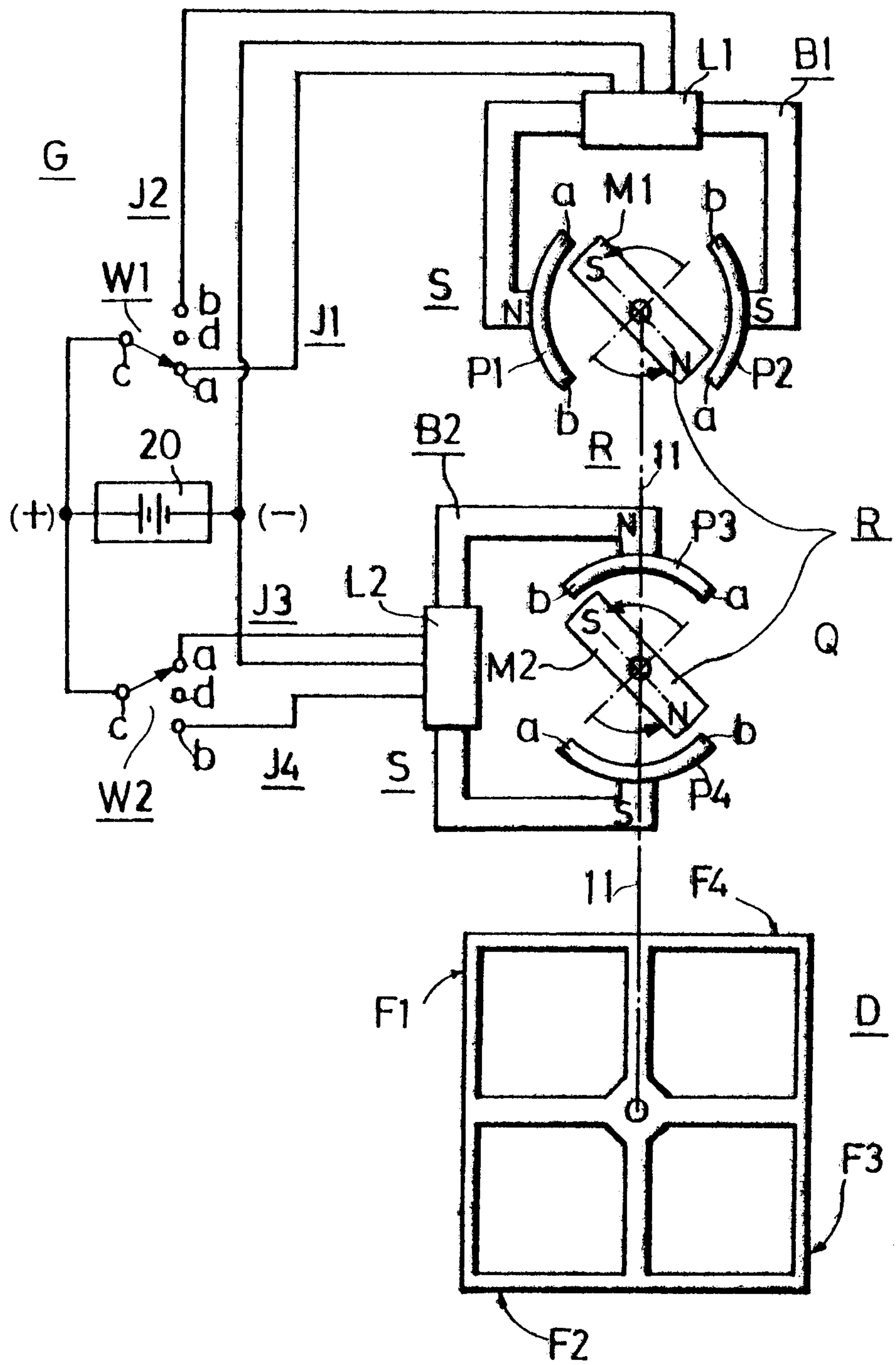
Fig.11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Q
M2
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F4
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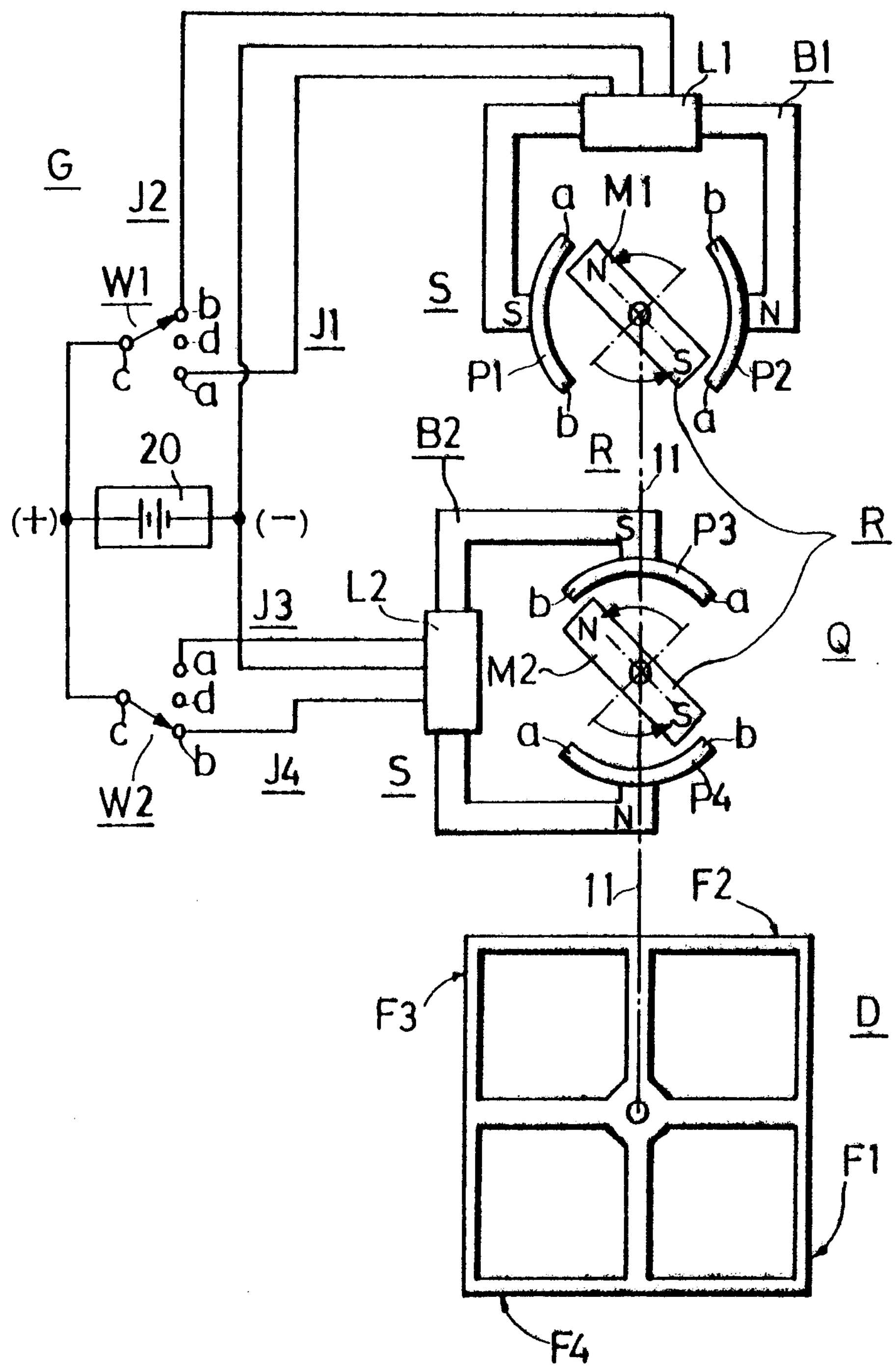
F3
F2

Fig. 12



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Q
M2
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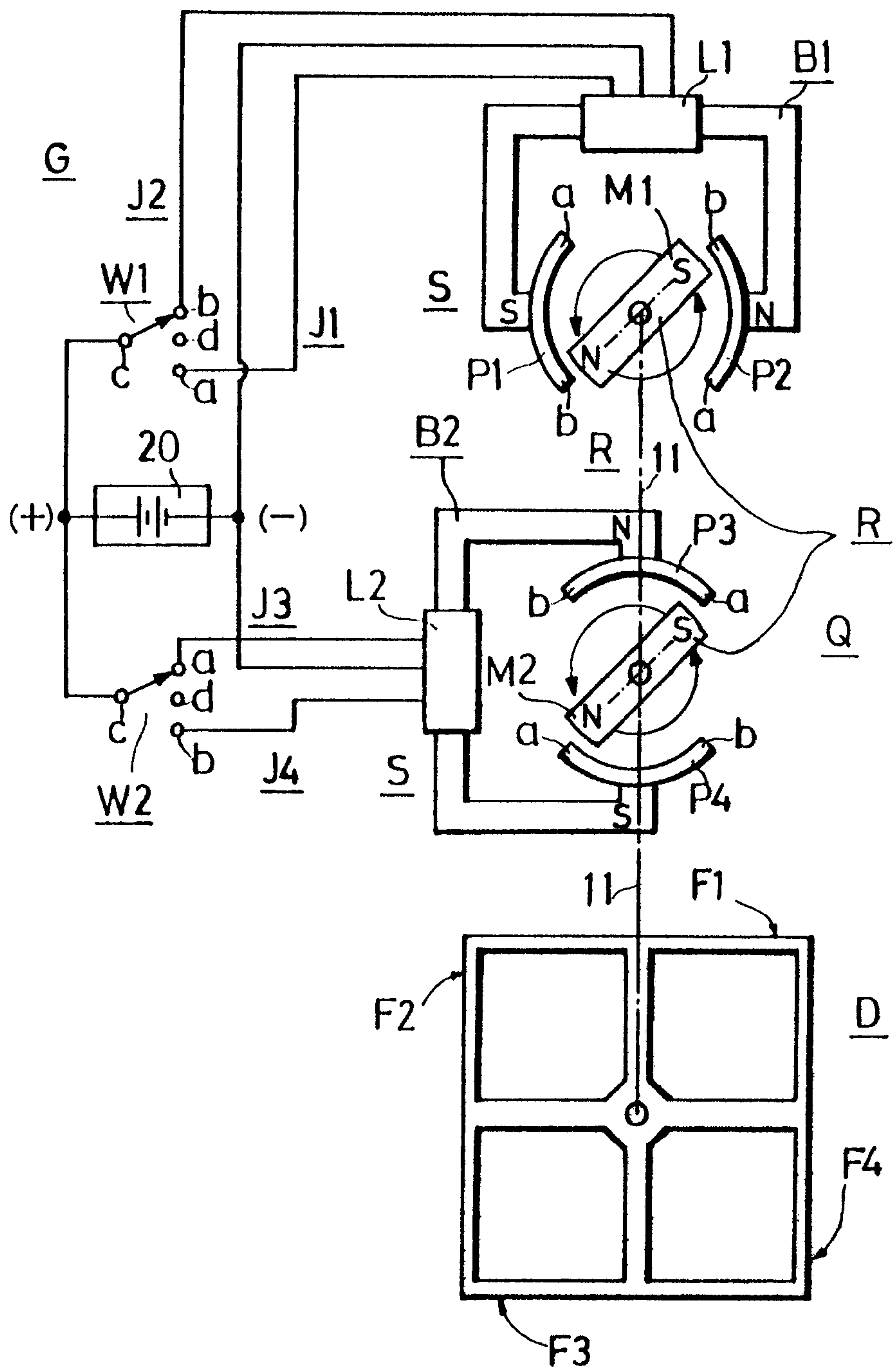
Fig.13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M2
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Fig.14

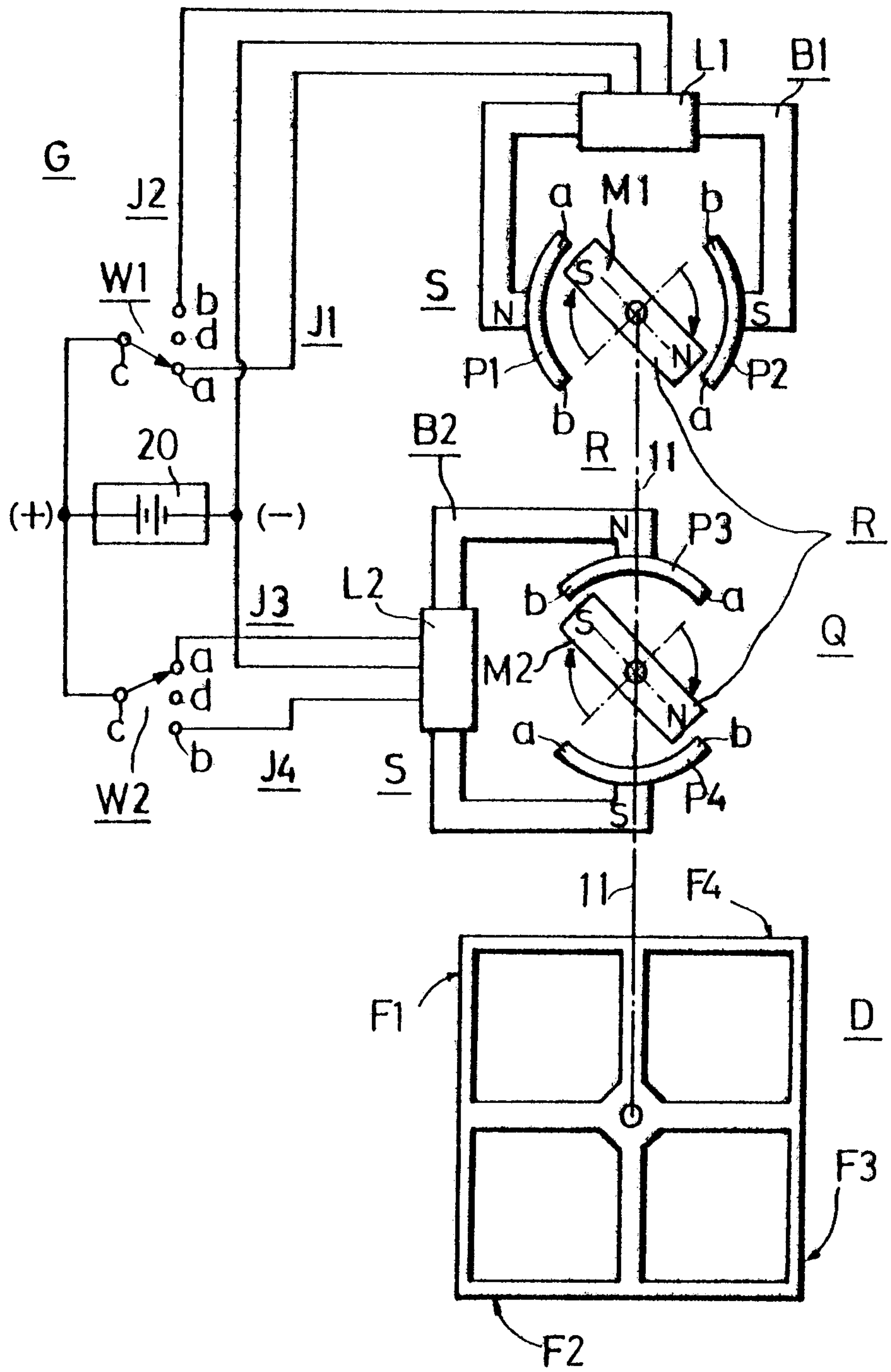
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Fig.15

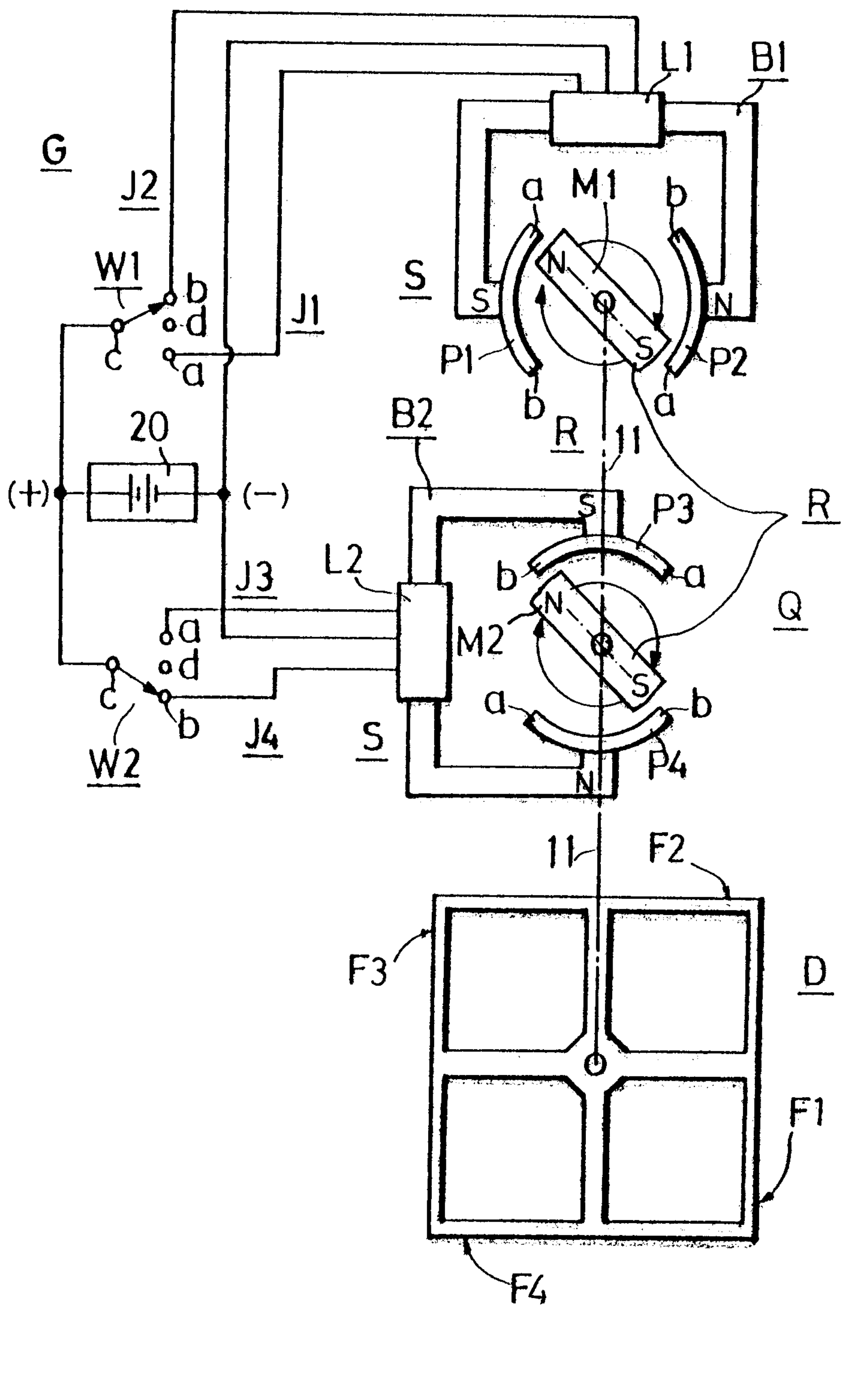
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Fig.16

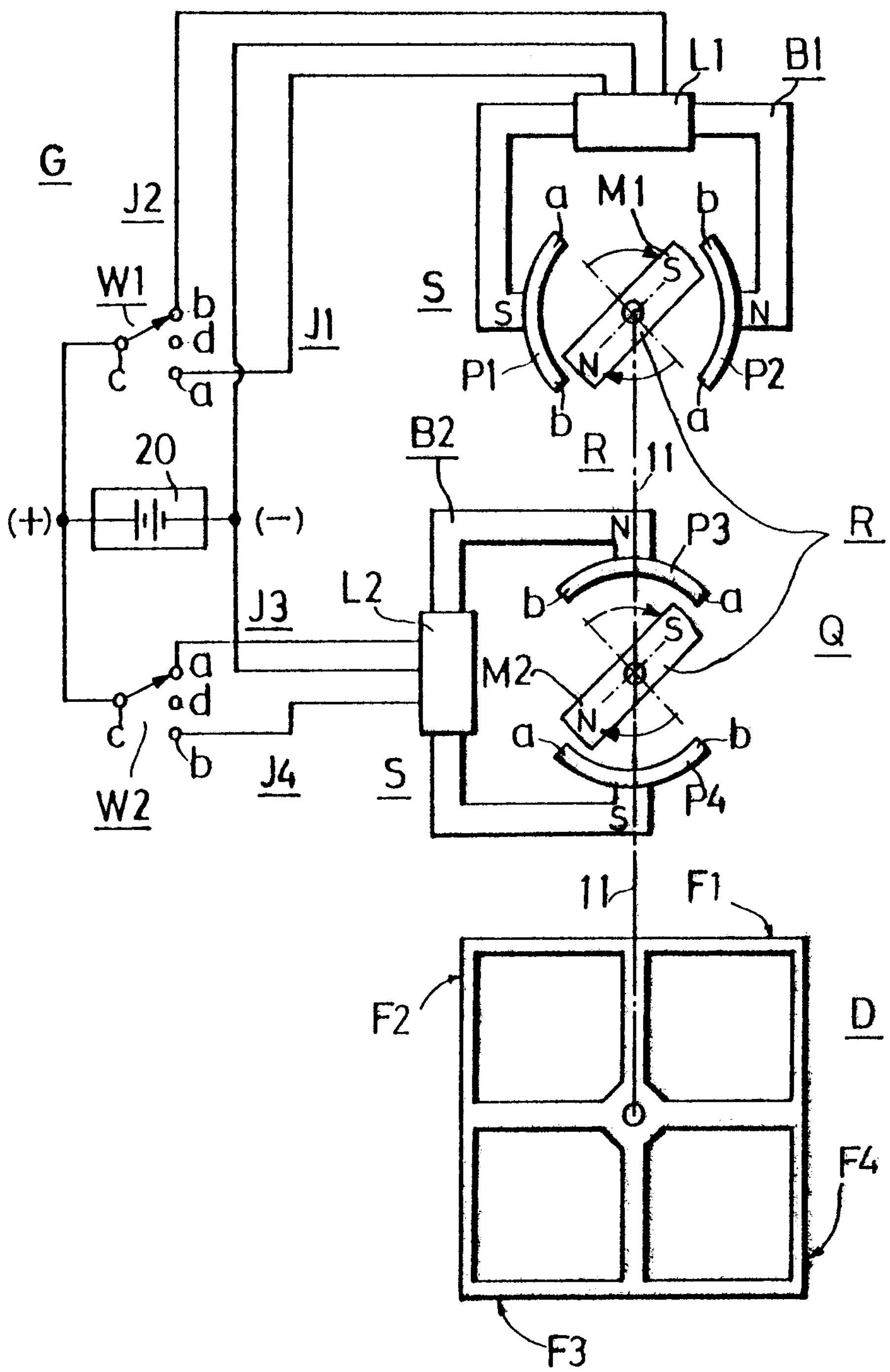
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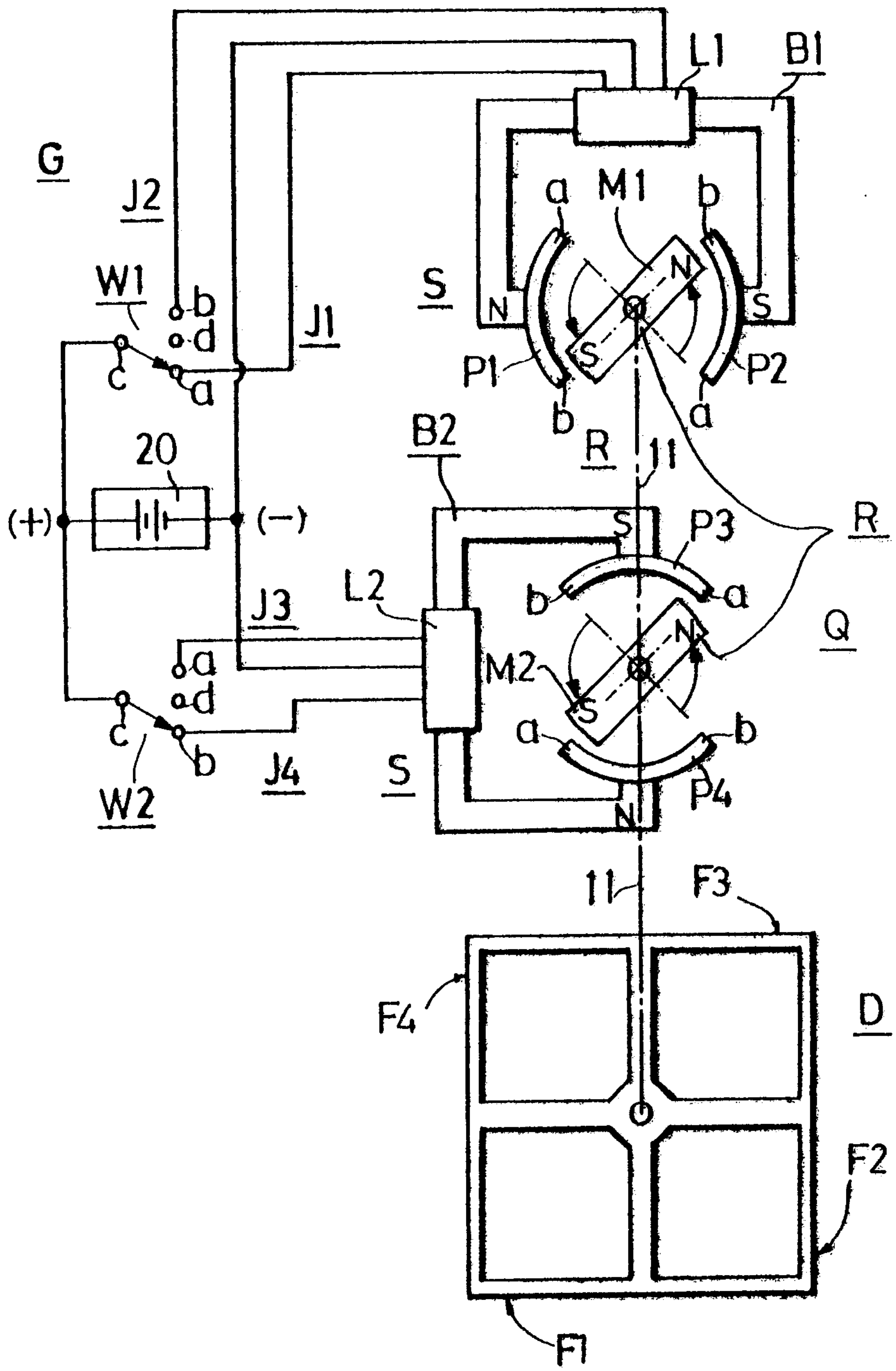
Fig.17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European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 86 30 7478

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.4)
Y	EP-A-0 122 288 (WAKATAKE) * Figures 1-5; pages 4-13 * ---	1,2	G 09 F 9/37 G 09 F 11/02
Y	EP-A-0 093 600 (WAKATAKE) * Figures 1-5; pages 4-12 * ---	1,2	
A	EP-A-0 126 543 (WAKATAKE) * Figures 1-5; pages 5-15; page 91, last paragraph; page 92 * ---	1,2	
A	DE-A-2 804 169 (FISCHBACH AND MOORE INC.) * Figures 1,11a,11b; pages 31,32 * ---	1,2	
A	US-A-3 465 334 (COHEN et al.) * Figures 1-3; column 5, lines 22-75; column 6, lines 1-47 * ---	1,2	TECHNICAL FIELDS SEARCHED (Int. Cl.4) G 09 F
A	FR-A-2 368 172 (TELDIX GmbH) * Figures 3,4; page 5, lines 5-25 * -----	1,2	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	01-12-1986	ALLEN E.F.

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