Sept. 23, 1969 D. WINROW 3,469,258

ROTATING MAGNETICALLY ACTUATED DISPLAY OR INDICATOR

Filed Nov. 4, 1966 2 Sheets-Sheet 1

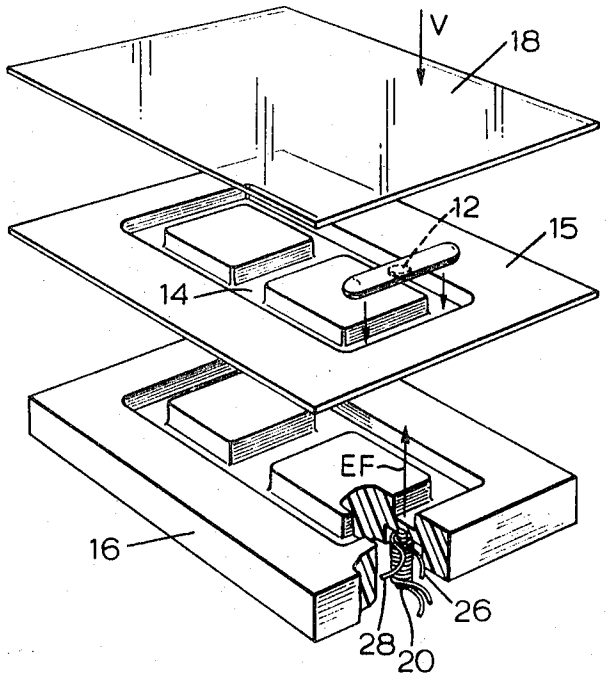


FIG. 1

FIG. 3

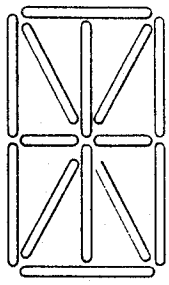
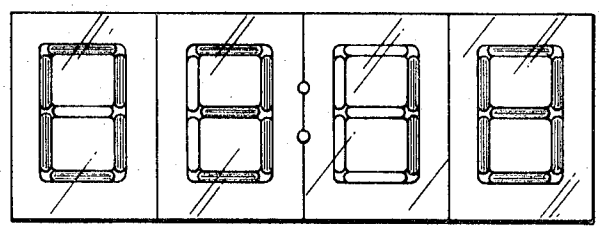


FIG. 2



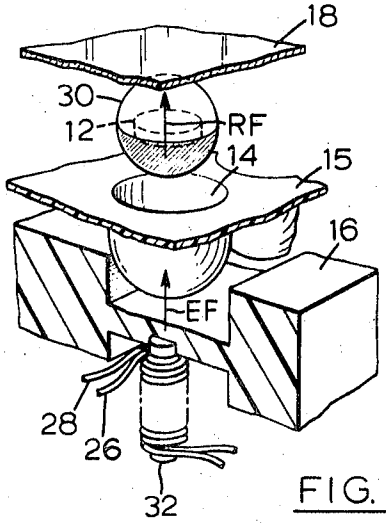


FIG. 4

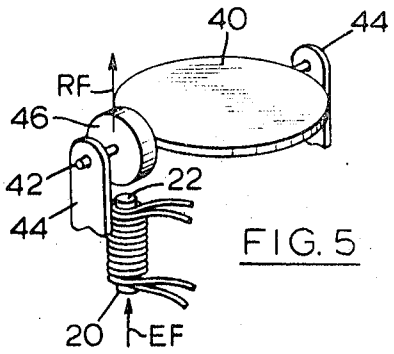


FIG. 5

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ROTATING MAGNETICALLY ACTUATED DISPLAY OR INDICATOR

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FIG. 6

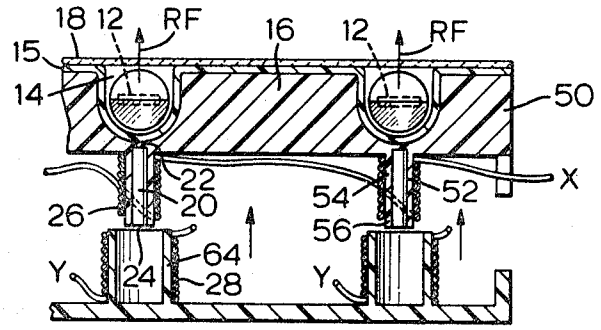


FIG. 7

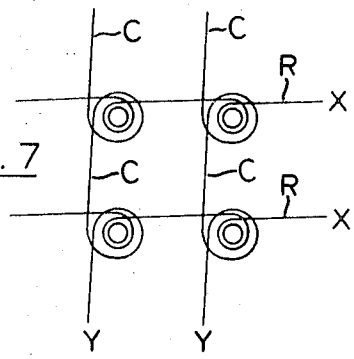
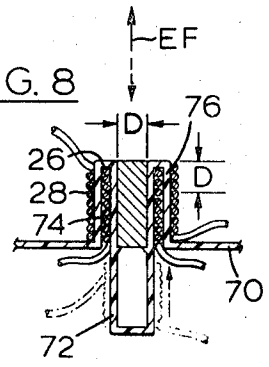


FIG. 8



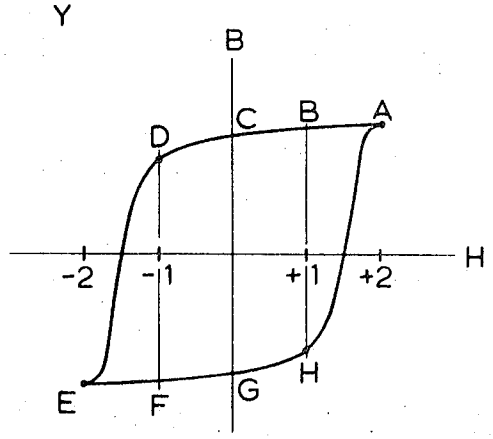


FIG. 9

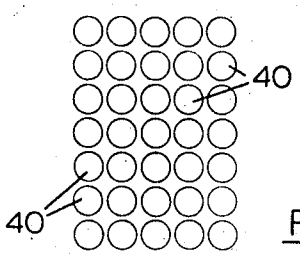


FIG. 10

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United States Patent Office 3,469,258
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3,469,258

ROTATING MAGNETICALLY ACTUATED DISPLAY OR INDICATOR

Donald Winrow, Downsview, Ontario, Canada, assignor, by mesne assignments, to Ferranti-Packard Limited, Toronto, Ontario, Canada

Filed Nov. 4, 1966, Ser. No. 592,178
Int. Cl. G08b 5/22
U.S. Cl. 340—373 13 Claims

ABSTRACT OF THE DISCLOSURE

A magnetically actuable display or indicating member carrying a permanent magnet is actuated by an exterior, reversible, permanently magnetizable magnet. The magnet is energized by a pair of windings which each surround said exterior magnet along extents which are at least partially overlapping.

This invention relates to a magnetically actuable visual device and operating elements therefor.

As disclosed in Patent 3,140,553, which issued July 14, 1964 it is known to provide a magnetically actuable visual element having two surfaces of contrasting appearance. The application to said element of exterior magnetic fields of selectively opposite polarities results in different orientations of the element. The arrangement of the surfaces is such, that in each orientation, a different one of the contrasting surfaces is shown.

By this means a number of such elements may be provided in an array and selectively displayed to provide a display sign, or a number may be used and selectively displayed to provide an indicator.

The use of a reversibly magnetizable permanent magnet exterior to the magnetically actuable visual member has allowed the exterior field to be switched by the use of a pulse in the energizing winding for the exterior magnet so that the remanent field thereby produced in the exterior magnet will retain the magnetically actuable element in position without the necessity of a sustaining current.

As disclosed in my U.S. application Ser. No. 534,273 filed Feb. 14, 1966 the wiring for a plurality of such elements may be simplified by designing the exterior field producing means so that there are two energizing windings for each exterior field forming member arranged so that the simultaneous pulsing of both windings is required to switch the field forming element from one polarity to the other. Through the use of two energizing windings for each exterior field forming element simplifications in wiring may be achieved.

This is accomplished by connecting pluralities of such windings in series circuits arranged so that each winding in a pair is connected in a different circuit. If the individual elements are arranged, or are considered to be arranged as a rectangular array of rows and columns then it will be seen that a series circuit may be provided for each row and for each column so that switching of a field forming element may be achieved by the simultaneous energization of a row circuit and a column circuit each carrying a winding for the field forming element to be energized. On the other hand, a particular combination of the row and column circuit is unique to only one element position. Considerable savings are achieved by such wiring, which is herein termed X–Y energization where the combination of two circuits is unique to only one field forming element whether or not the elements are arranged in rectangular array.

Heretofore, in a display sign, where two windings are used for a single exterior field forming member, each

winding has been placed upon a separate shunt extending between pole forming members which are each located to influence the magnetically actuable member. It will be noted that each pole piece projects beyond the energizing windings which are located on shunts between the pole pieces.

This design has been found however, to produce less flux at the pole pieces than desired, considering the energization used. In addition, the use of two pole pieces has increased the precision and cost required in design, construction and assembly and has tended to decrease the overall area in an array in the viewing direction which is covered by the selectable display elements. Moreover, since the plural shunts must be connected to other members, at both ends, the winding problems are complex.

When dual windings are used for each exterior field forming member, higher exterior field flux per ampere turn is obtained when an open ended reversible permanent magnet is used exterior to said actuable element with one pole thereof directed toward the locus of movement of the magnetically actuable member (and to produce an exterior field encompassing such locus) and the two windings are placed about said exterior magnet. For best results it has been found that the windings must approach relatively close to the permanent magnet pole, hence the windings must be at least partially coextensive along the exterior magnet length. This may be achieved by having the two windings intertwined, side by side or with one winding surrounding the other.

Through the use of an open ended exterior permanent magnet, with the surrounding windings approaching the pole nearer the actuable element, a considerable increase in flux has been achieved relative to the energization supplied. The measure of energization being the ampere turns.

Since only one of the two magnet poles need be placed in proximity to the magnetically actuable member assembly time and precision of tolerances has been reduced, while the need for only a single pole in proximity to the actuable element reduces the "dead area" of an indicator or display i.e. the area seen in the viewing direction which is not subtended by the magnetically actuable elements. This reduction may be achieved whatever is the location of the single pole, but the advantage is increased where the exterior magnet is located to be occluded by the elements in the viewing direction.

When the nearer pole is located to be occluded by its respective magnetically actuable member, it will be noted that when an approximately straight extent is used the farther pole projects in the opposite direction from the viewing direction where its free end allows easy mounting of the energizing windings thereon.

While the strands of the two windings for the pole piece may be intertwined, or side by side, convenient assembly may be achieved by providing for each exterior magnet, two sets of windings designed to fit inside each other. As a result, series circuits incorporating a plurality of inner windings may be prewound, and series circuits incorporating a plurality of outer windings also prewound. The windings may be quickly assembled on the exterior magnet, the inner ones on each exterior magnet then the outer with the respective circuits arranged so that a particular combination of circuits is unique to an exterior magnet.

In drawings which illustrate a preferred embodiment of the invention:

FIGURE 1 shows an arrangement wherein a part of a module is formed of magnetically actuable elements which are cylindrical and the windings are shown schematically;

FIGURES 2 and 3 show arrangement of cylindrical elements;

FIGURE 4 shows an arrangement where the elements are spherical;

FIGURE 5 shows an arrangement where the elements are discs;

FIGURE 6 illustrates a preferred method of prewinding;

FIGURE 7 schematically shows circuitry for magnet winding;

FIGURE 8 shows an alternative method of prewinding; and

FIGURE 9 shows a graph of the operation of individual pole pieces;

FIGURE 10 shows a rectangular array of visual elements seen from the viewing direction.

In the drawings is shown a device wherein a plurality of magnetically actuable visual elements **10** are each shaped like cylinders and are each colored black on one side and white on the other. These elements **10** are preferably made from plastic.

It will be appreciated that the colors may be varied or the appearance between may be varied in another manner than by color but that the cylindrical elements **10** as shown are designed to rotate about the axis of the cylinder and hence are divided about a plane through such axis on the surface between black and white surfaces. It will also be appreciated that although the examples shown herein indicate that the magnetic element rotates through 180°, that rotations of less than 180° are possible within the scope of this invention in manners (for example) as shown in my U.S. application Ser. No. 554,472, filed June 1, 1966 and Ser. No. 565,856 filed July 18, 1966.

A permanent magnet **12** is placed in the cylindrical elements **10** to create flux defining a magnetic polar axis RF making an angle with and preferably perpendicular to the axis of the cylinder. It will be appreciated that the physical dimensions of the magnet may not always extend longitudinally along the polar axis, since with magnetic materials now available the magnetic polar axis does not necessarily extend along the longitudinal axis of the magnetic material. With material sold under the trade name "Indox," the polar axis may extend in the direction of the smallest dimension, and of course this assists in the convenient placing of the magnetically actuable element in the cylinder **10**.

A fuller discussion of some of the factors affecting the use of cylindrical, magnetically actuable elements may be found in my co-pending application Ser. No. 555,053 filed June 3, 1966.

The polar axis RF of the magnetically actuable member may extend in any direction relative to the border between the black and white surfaces except parallel to the member rotational axis it being understood that the correct alternative orientation of each cylindrical element may be achieved by correct orientation of the exterior reversible field, EF which is individually provided for each element **10**.

However, it will be found that for this application the preferred orientation of the polar axis is perpendicular to the plane dividing the half-cylindrical white surface from the half cylindrical black surface so that whether the white or black surface is on display, the exterior field forming member is behind the actuable element, i.e. occluded by the actuable element in the viewing direction.

Again as disclosed in my application Ser. No. 555,053 filed June 3, 1966, the cylindrical elements are mounted in complementary shaped troughs **14** in liquid tight member **15** attached to a complementarily grooved base **16** in any desired arrangement such as a 7-element arrangement shown in FIGURE 2 which will produce digits or the 14-element arrangement in FIGURE 3 which allows the production of letters as well as digits; the dimension

of elements **10** in relation to their complementary troughs **14** such as to have enough freedom of movement to rotate in the casing when the latter is filled with a liquid to provide an environment for the elements **10** of a liquid which is as closely as possible of the same density as the elements so that the elements have neutral buoyancy. Thus the elements in their complementary casing are provided with a cover **18** which is attached to the member **15** to seal in the liquid yet with the elements being allowed sufficient freedom of movement to allow them to rotate under the change in the magnetic field. On the other hand, the size of the troughs **14** while allowing rotation of the elements does not allow them to translate or misalign substantially from the positions shown in FIGURES 2 and 3.

All this is shown in my co-pending application Ser. No. 566,115 and the invention here disclosed relates to the means for providing the external field to actuate the element.

By "density of the elements **10**" is meant the average value thereof, bearing in mind the element components including the magnet. It should be realized that the element does not have to be of precisely the same density as the liquid. This should of course be approached as closely as possible, but it will be found that proper operation will be achieved if the element slightly floats or slightly sinks in the liquid.

Corresponding to each of the elements **10** there is provided a reversibly magnetizable permanent magnet **20** which may be of any desired material which under selectively reversible magnetizations will produce sufficient remanence flux and will have sufficient coercivity (in the absence of an applied field) to retain the element in its desired orientation or to return it thereto if displaced, but which is preferably "Alnico V" or "Cunife I."

Such permanently magnetizable member **20** which provides the exterior or actuating field EF must be open-ended with one of the ends directed generally toward the locus of movement of magnet **12**.

Such permanently magnetizable member which provides the exterior or actuating field EF, is preferably formed into a substantially straight extent with one end called the nearer pole **22** projecting toward the locus of rotation or movement of the magnet of the adjacent actuable element **10**; but located so as not to materially affect the operation of adjacent elements **10**. The corresponding remote pole **24** projects away from such locus and the exterior magnet **20** is mounted by any desired means in the casing in this orientation and with the remote pole preferably projecting away from the element.

A pair of windings **26** and **28** for energizing the exterior magnet are provided to magnetize in one sense or another the field forming extent. The two windings may have their strands intertwined as they are wound in the desired sense about the pole forming member or the strands may be side by side. In preferred forms of the invention the windings **26** and **28** are arranged so that one is about the other to assist in the convenient pre-winding of pluralities of such windings for X–Y energization.

It has been found that, should the windings **26** and **28** end too far from the nearer pole tip, there is a considerable decrease in magnetic flux strength at the tip. Accordingly, it should be realized that for strong magnetizations each winding should approach the tip to within a distance D equal to the diameter of the exterior field magnet. By the diameter D of the exterior field magnet is meant the average diameter enclosed by the winding.

In operation reference should be had to the B–H curve of FIGURE 9 which is intended to illustrate the hysteresis curve of one exterior magnet **20** when the material is such as to give a relatively square curve, that is, where the area of the hysteresis loop is large and the slope of the upper and lower portions approaches parallelity to the X axis both qualities being relative to other materials.

Operation should be described in relation to the magnetically actuable element **10** and to the viewing direction which is shown as the arrow V in FIGURE 1. It will be obvious that when the pole forming member is magnetized in one sense that the magnetic interaction between the exterior magnet **20** and the moving magnet will rotate the latter bringing unlike poles closer together and display (say) the black surface. Reversal of the magnetic field emanating from the exterior magnet **20** will reverse the orientation of the cylindrical element **10**. With reference to FIGURE 9 it will be noted that on the B–H curve the points A and E at the right and left ends of the curve, denote the magnetization obtained with pulsing by both windings simultaneously in the respective polarities whereas the points B, D or F, H denote magnetization states achievable pulsing with one winding only.

Accordingly, on the simultaneous application of a pulse in both windings in a positive direction the magnetization reaches point A during existence of the pulse and as soon as the pulse has ceased, the exterior magnetization represented by the abscissa of the curve, has decreased to zero, and the point C represents the remanence flux which acts to maintain the magnetically actuable element in its predetermined position after the cessation of the pulse.

Accordingly the state of the exterior magnet **20** under discussion is now depicted as position C, on FIGURE 9. Assume now that two circuits are energized to switch an exterior magnet element other than the one under discussion and that one circuit so energized includes a winding (**26** or **28**) of the exterior magnet **20** whose characteristics are shown in FIGURE 8. If such pulse is positive, the magnetic state of magnet **20** will move from C to B on the curve and back to C.

On the other hand, if the pulse in the single winding is in the negative direction, the applied field will move from C to D and back to C. (Due to minor hysteresis effects the pulse will not in fact quite return to the position C after single winding pulse in either direction—however this may be here neglected since it does not for practical purposes affect the results obtained.) It will be noted however that the reduction in the exterior flux by the shift from C to D is, due to the "squareness" of the B–H curve, much less than half the remanence flux. Thus the use of X–Y wiring is suitable with the choice of material and arrangement of the windings as claimed since an exterior magnet once "set" will retain its corresponding actuable element in position in spite of intermittent energization in either polarity of one winding.

On the other hand, when the two windings **26** and **28** of the exterior magnet referred to in FIGURE 9 are simultaneously energized negatively to orient the element in the opposite sense, the state of the exterior magnet is moved to the point E on the curve and on the cessation of the pulse flux moves to the point G representing the remanence flux which will maintain the element in the opposite position. Until again switched the state of the exterior magnet **20** will change state along the lines G–H–G without effecting movement of the actuable element or along the lines G–F–G, with the same result.

It is not, of course, claimed that the use of two independent windings **26** and **28** on a magnetic element, with the facet that by X–Y wiring, only one element at the X–Y intersection may be switched, is new, since this is a known phenomena with magnetic memories where the magnetic elements are toroidal and do not affect, by their state, mechanical movement.

It is however, claimed that this selective or X–Y energization with the exception of the particular application in our co-pending application Ser. No. 534,213, is the first time that this method has been applied to the selective actuation of visual elements in display signs or in indicators. It is new, with this application, as far as is known by applicants, to apply dual windings with X–Y wiring to a single open ended exterior magnet member in proximity to a magnetically actuable member, i.e. cylinder **10**.

It will be noted that there is no requirement that the magnetic polar axis of the actuable element **10** be perpendicular to the plane of the boundary between the black and white surfaces but that this is preferred since the exterior magnet may then be hidden behind the element as far as the viewer is concerned, and a larger area may be encompassed by the active portion of the sign, i.e. the black and white surfaces.

It is further clear that the elements **10** need not be cylindrical and in fact good results are obtainable with the spheres **30** as illustrated in FIGURE 4 which are again suspended in neutral buoyancy liquid in the complementary shaped casing having a black hemisphere and white hemisphere. Such spheres may be in whatever numbers are desired and in the arrangement or array preferred.

Here again for the occlusion of the pole forming member from the viewer it is preferred if the magnetic polar axis of the magnet **32** in the indicia forming element is perpendicular to the plane dividing the black and white surfaces and it will be noted that the axis, with the spherical element cannot be in the plane dividing the black and white surfaces.

The actuable elements **10** or **30** so far described for suspension under neutral buoyancy, have been surfaces of revolution. However, this has not been found essential. It has been found that surfaces other than those of revolution can be used, since the viscosity and turbulence of the liquids tested do not unduly interfere with the rotation of such shapes, although this is a factor varying with the liquid.

In the actuable elements, whether suspended in neutral buoyancy or otherwise (such as by a shaft in air) it will be obvious that the actuable element will have one axis (as with a pivoted disc or a neutral buoyancy cylinder) or a number of axes (as with a sphere) about which it may revolve under the control of the exterior magnet. However, it will be obvious that for operation of the actuable element within the limits of angular rotation required in a particular application it must be free to rotate about an axis at an angle to the magnetically actuable element polar axis. The contrasting surfaces must also of course be located in relation to the available axes of rotation so that rotation of the element within the limits allowed will switch the display of one contrasting surface to another, in the viewing direction.

In FIGURE 5 the invention is schematically shown as applied to a disc rotatable in air, of the type shown in my Patent 3,140,553 and application Ser. No. 524,273.

As shown, a disc **40** contrastingly colored on opposite sides is mounted on a shaft **42** extending approximately diametrically of the disc and the shaft **42** is mounted on bearings **44** which will be attached to the main base of the sign or indicator of which the disc **40** forms a part. The disc has a magnet **46** mounted to be rotatable therewith, defining a magnetic polar axis RF.

It will be noted that the magnetic element **46** is located on the shaft at the end of the disc **40** which allows the adjacent pole **22** of the exterior magnet **20** to be located in proximity to the locus of rotation of the magnet **46**. It will be obvious that as the magnetization of the exterior magnet **20** is switched, the disc **40** is moved due to the exterior field acting on magnet **46** from one position to the other to cease to display one of the contrasting surfaces and to start to display the other. It will thus be obvious that the invention has equal application to elements mounted on shafts as to elements movable under neutral buoyancy.

FIGURE 10 illustrates schematically, how the spheres of FIGURE 4 or the discs of FIGURE 5 may be arranged in a rectangular array to visually portray information. In such an array and in other arrangements for each magnetically actuable element there will be provided an exterior magnet energized as herein described.

However, it will be noted that it would be very difficult to satisfactorily operate the invention where as in Patent No. 3,140,553 the visual element magnet is mounted on the disc since the geometry of the disc would in its rotation, require that the exterior magnet shall be located a considerable distance from the visual element magnet.

FIGURE 6 shows a convenient method of achieving rapid assembly with X–Y wiring.

In FIGURE 6 is shown a plastic member **50** shaped to be a base where visual elements (say) cylindrical elements of the type and with a permanent magnet as shown in FIGURE 1, are mounted at predetermined locations to provide an indicator or display. Corresponding to each visual element, there is provided in the plastic member means for mounting a straight extent of reversibly permanently magnetizable material **20** as heretofore discussed, in a bore **52** on a boss or a flange **56** projecting from the plastic member **50** away from the magnetically actuable member. Any convenient means may be used to mount the exterior magnet **20** in the bore **52** by friction fit, by gluing or by any other desired means.

The exterior magnet **20** which is preferably a straight extent between poles will then be held with one end **22** in proximity to the visual element magnet **12** and the other end **24** projecting rearwardly from such visual element along the boss **56**. Assuming that the cylindrical elements are considered as being arranged in rows and columns (whether physically they are or not) then a winding **26** may be applied about each of the rearwardly extending bosses to produce a series circuit R corresponding to a row (it could equally have been a column). A second plastic member **62** is provided with bosses **64**, each adapted to slidably receive a boss **56** with a winding **26** thereon. The bosses **64** are shaped when the first plastic member **50** is assembled to the second to project toward the visual element **10** and to closely receive the first set of windings **26**. Windings **28** are placed on bosses **64**, in series circuits C as before corresponding to columns, however these series circuits are arranged so that when applied about the first set of windings **26** the combination of two series circuits about a single magnet **20** is unique for each magnet **20**. Thus it will be seen as schematically illustrated in FIGURE 7 that on inner bosses **52** a series of X series circuits R may be provided rapidly pre-wound and on the other member a plurality of Y series circuits C may be provided, each taking all the series circuits into account encompassing all the magnet **20** and element **10** positions. The schematic view of FIGURE 7 shows merely part of a rectangular array with two columns and two rows. However, it will be realized that there may be as many rows and columns as desirable with a circuit for each of such rows and columns. Similar arrangements may be made for other than rectangular arrays by making the circuit coincidences peculiar to only one exterior magnet. The pre-wound series circuits C and R may be quickly assembled by putting the complementary pieces together and it will be seen that the windings extend substantially along the extent of the magnet **20** member as previously required and that the projection of the magnet **20** from either winding toward the visual element is less than the diameter of the exterior winding—see FIGURE 8.

As previously explained, the outer winding **28** of a pair about an exterior magnet may have to be made slightly longer than the inner winding **26** of the order of 10% and to be empirically determined to achieve equality effects between the inner and outer winding but it should be noted that proper operation may be achieved where these effects are not unduly unequal.

In FIGURE 8 is shown alternative means for placing two concentric windings about an exterior magnet **20** where a single plastic mounting member **70** is shown adapted to be placed by any desired means, over the rear of the mounted visual element array. The member **70** is provided, corresponding to each visual element position and to influence the magnet **12** thereof, with a rearwardly projecting boss **72** from the main plane of member **70**. On the projecting portion of boss **72**, inner winding **26** may be wound as part of a circuit R and later slid along boss **72** into a recess **74** where an outer boss **76** defines recess **74** and projects forwardly from the main plane of member **70** on which pre-wound outer windings **28** may be placed. The series circuits may therefore be pre-wound and quickly located in position.

With the magnet **20** and windings **26** and **28** thereabout, assembled as just described, on member **70**; the member **70** may be assembled to the visual element holder in such a way that the end **22** of magnet **22** is in proximity to the locus of magnet **12**.

Although two methods of assembly and the two windings per exterior magnet have been shown, it will be noted that these are not intended to be limiting and that the use of inner windings easily slid about exterior magnet **20** and outer windings easily slid about the inner; allows easy assembly of pre-wound series circuits each containing a plurality of circuits.

I claim:

1. Electromagnetic actuation means comprising:

a base;

a magnetically actuable member;

a permanent magnet carried thereon defining a magnetic polar axis;

said magnetically actuable member being so supported on said base that it may rotate about an axis at an angle to said polar axis, the possible rotations of said member defining a locus of movement for said permanent magnet;

a reversibly magnetizable permanent magnet attached to said base exterior to said actuable member to provide, when magnetized in one or the other polarity a field encompassing the locus of movement of said permanent magnet;

a pair of windings each wound about said exterior magnet, to provide, when carrying current, a magnetization effect thereon, said windings being arranged to be at least partially coextensive along said magnet length.

2. Visual representation means comprising:

a base;

a magnetically actuable member;

said base and said magnetically actuable member defining a direction for viewing said member;

a permanent magnet mounted to be movable with said actuable member and defining a magnetic polar axis relative thereto;

said actuable member being designed and being supported on said base to be rotatable about an axis non-parallel to said magnetic axis, the permitted rotations of said member defining a locus of movement of said permanent magnet;

a reversibly magnetizable permanent magnet of open-ended form located on said base exterior to said actuable member and arranged when magnetized in either polarity to provide a magnetic field encompassing said locus;

whereby said magnetically actuable member will assume an orientation unique to each of said opposite magnetizations;

two surfaces of contrasting appearance on said element, one located to be displayed in said viewing direction in one of said orientations, and the other located to be displayed in said viewing direction in the other of said orientations;

a pair of energizing windings each wound about said exterior magnet, to provide, when carrying current, a magnetization effect thereon, said windings being

arranged to be at least partially coextensive along said magnet length.

3. Visual representation means comprising a plurality of means as claimed in claim 2, wherein:

said actuable members are arranged to provide in said viewing direction, visual effects;

each one of such winding in said pair of windings is so connected in circuits so that the selection of circuits energizing a pair of windings for an exterior magnet is unique.

4. Visual representation means comprising a plurality of means as claimed in claim 2, wherein:

said actuable elements are arranged into a rectangular array defining rows and columns;

wherein one winding of each pair is connected in a circuit characteristic of the row containing the actuable element;

and the other winding of each pair is connected in a circuit characteristic of the column containing the element.

5. A device as claimed in claim 1:

wherein said exterior magnet comprises an open-ended length of permanently magnetizable material oriented so that one end projects towards the locus of movement of said magnet and is closer thereto than the other end;

and each of said windings extends along said member to within a distance from said end less than the diameter of said exterior magnet.

6. A device as claimed in claim 2 wherein one end projects towards the locus of movement of said permanent magnet and is closer than the other end to said locus and each of said windings extends along said member to within a distance from said one end less than the diameter of said member.

7. A device as claimed in claim 3 wherein one end projects towards the locus of movement of said permanent magnet and is closer than the other end to said locus and each of said windings extends along said member to within a distance from said one end less than the diameter of said member.

8. A device as claimed in claim 4 wherein one end projects towards the locus of movement of said permanent magnet and is closer than the other end to said locus and each of said windings extends along said member to within a distance from said one end less than the diameter of said member.

9. A device as claimed in claim 4 wherein said exterior magnet is substantially straight with one end directed toward the locus of movement of said magnet.

10. A device as claimed in claim 5 wherein said exterior magnet is substantially straight with one end directed toward the locus of movement of said magnet.

11. A device as claimed in claim 1 wherein one of said pair of windings surrounds the other.

12. A device as claimed in claim 2 wherein one of said pair of windings surrounds the other.

13. A visual device comprising:

a plurality of magnetically actuable elements;

means providing a liquid tight housing for loosely receiving said actuable elements, said housing defining a viewing direction;

means allowing each of said actuable elements to rotate about at least one axis and for preventing substantial change of location of said actuable elements;

a permanent magnet mounted to move with each of said actuable elements defining a polar axis at an angle to at least one possible rotation axis;

means providing an environment for each of said elements comprising a liquid of approximately the same specific gravity;

a reversibly magnetizable permanent magnet of open-ended form attached to said housing exterior to said actuable member with the nearer pole of said member to said permanent magnet arranged to exert magnetic torque thereon;

a pair of electrically independent windings surrounding said exterior magnet to provide magnetic flux to affect the magnetization of said exterior magnet, said windings being coextensive along an extent of said core.

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