United States Patent

[11] 3,623,084

[72] Inventor **Robert P. McCormick**
Broad Brook, Conn.

[21] Appl. No. **730,989**
[22] Filed **May 22, 1968**
[45] Patented **Nov. 23, 1971**

[73] Assignee **Veeder Industries Inc.**
Hartford, Conn.

[54] **MAGNETIC INDICATOR WITH CAPACITOR CONNECTED COILS**
1 Claim, 16 Drawing Figs.

[52] **U.S. Cl.** **340/378,** 340/332, 340/373, 40/28
[51] **Int. Cl.** **G08b 5/26,** G08b 5/30
[50] **Field of Search** 340/378, 373, 332; 40/28

[56] **References Cited**

UNITED STATES PATENTS

3,096,594	7/1963	Skrobisch	40/28 C
3,289,199	11/1966	Watkins	340/378 MN
3,089,131	5/1963	Morgan	340/378 MN
3,307,170	2/1967	Aoyama	340/334 X
3,444,551	5/1969	Winrow	340/373 X
2,779,016	1/1957	Snell	340/378
2,964,742	12/1960	Godet	340/378 X
3,036,300	5/1962	Knight	340/378 X

Primary Examiner—Harold I. Pitts
Attorney—Prutzman, Hayes, Kalb and Chilton

ABSTRACT: An electromagnetically operated indicator having three parallel rotatably mounted indicating elements which are mounted in side-by-side relationship, which may be independently electromagnetically positioned in each of four equiangularly spaced operating positions and which are marked to collectively indicate each of the sequence of characters of 0 through 9. A viewing window formed to provide convex magnifying lenses for enlarging the viewing angle and for magnifying the forward surface portions of the indicating elements is provided in front of the indicating elements and a pair of rearwardly extending electromagnets is provided for selectively and individually positioning each of the indicating elements in each of its four operating positions. The indicator may be modified to include auxiliary magnetic detents for holding the indicating elements in offset angular positions when the electromagnets are deenergized so as to prevent rotational hangup of the indicating elements when the electromagnetic fields are reversed. Alternative antihangup arrangements include a magnetic shunt between the cores of the electromagnets and means for electrically interconnecting the electromagnets for momentarily energizing the "inactive" electromagnet or operating the "inactive" electromagnet at a lower level when the other electromagnet is energized.

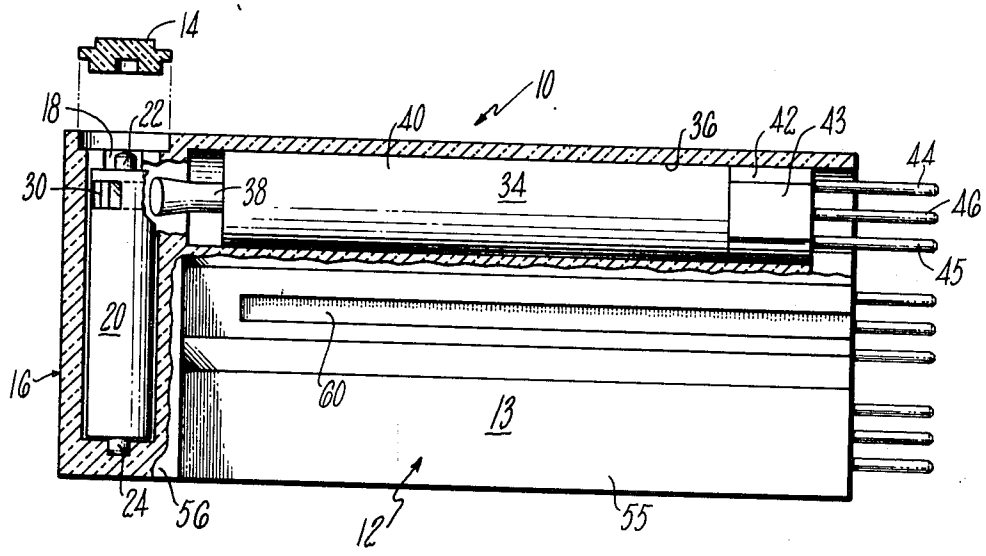


FIG. 1

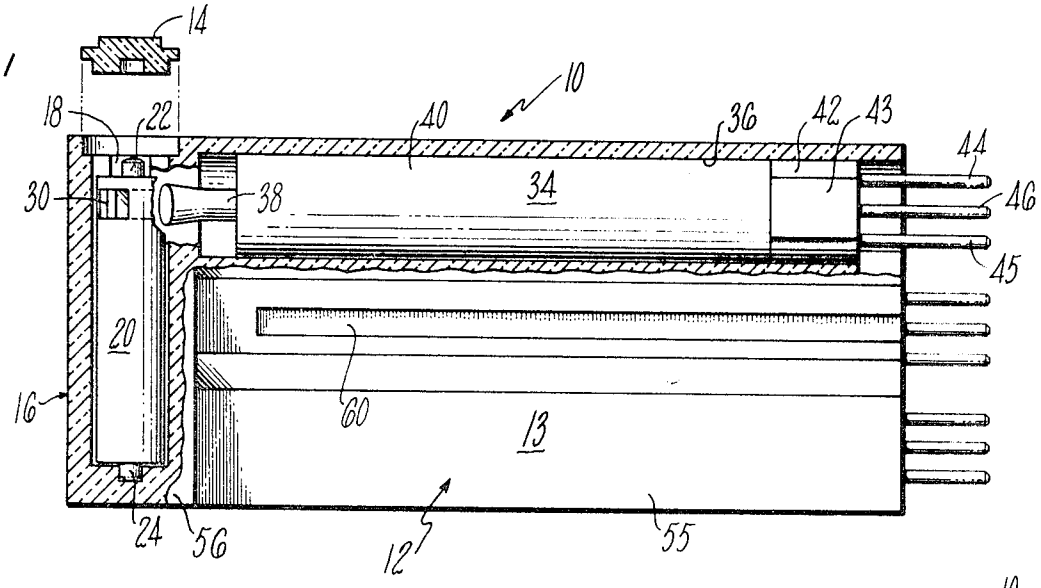


FIG. 2

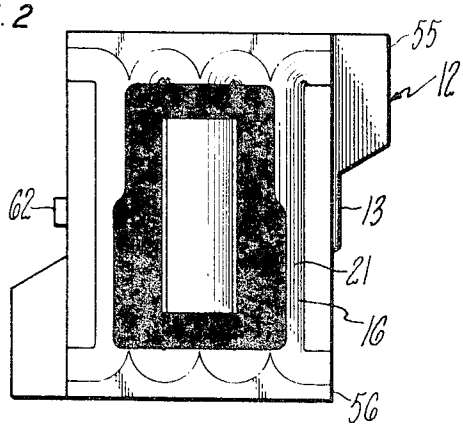


FIG. 4

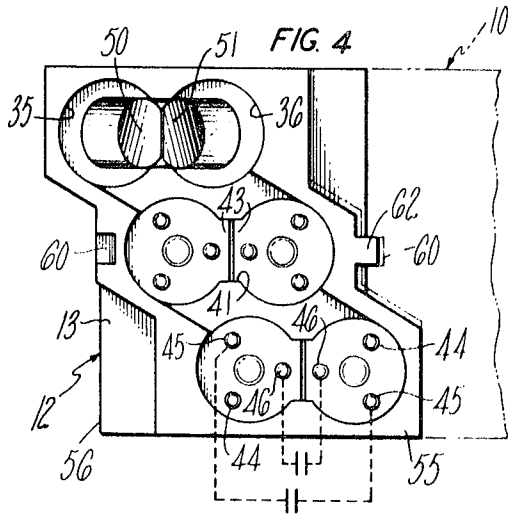
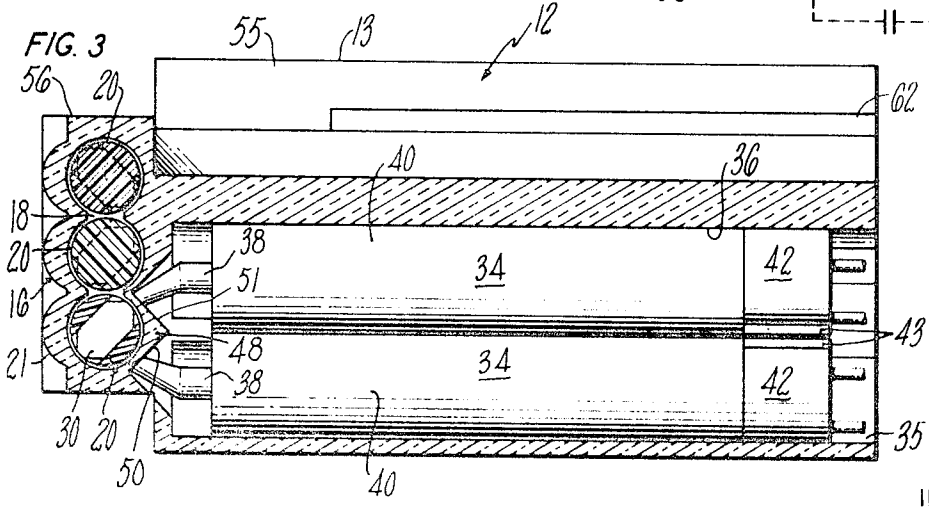


FIG. 3



INVENTOR
ROBERT P. McCORMICK

BY Lindsey, Prutzman and Hayes
ATTORNEYS

FIG. 5

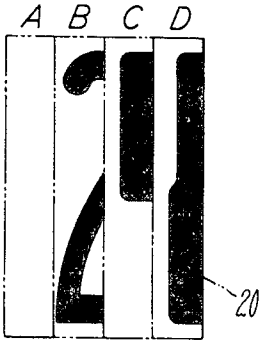


FIG. 6

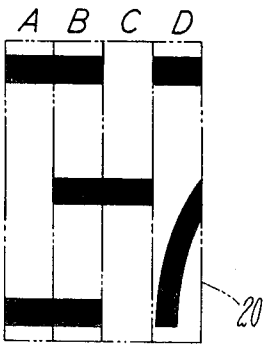


FIG. 7

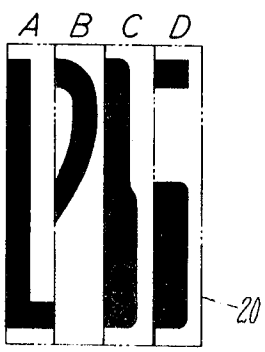
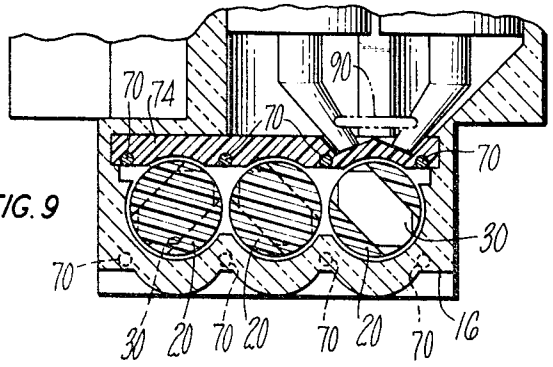


FIG. 8



FIG. 9



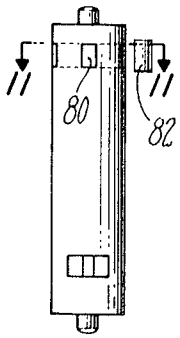


FIG. 10

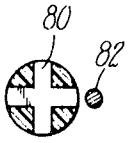


FIG. 11

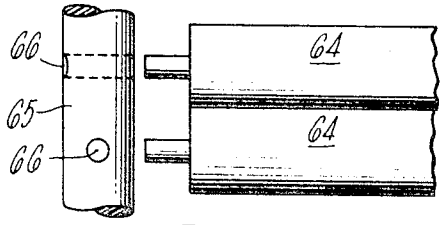


FIG. 12

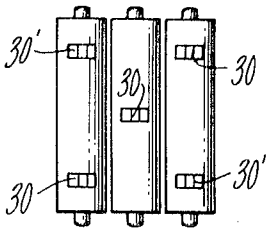


FIG. 13

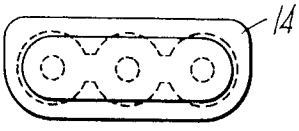


FIG. 14

FIG. 15

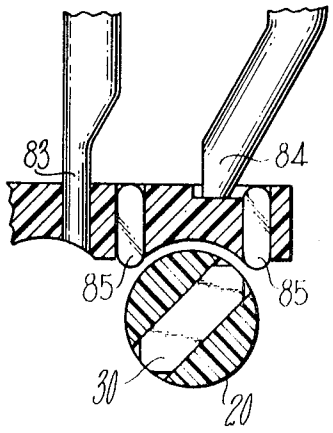
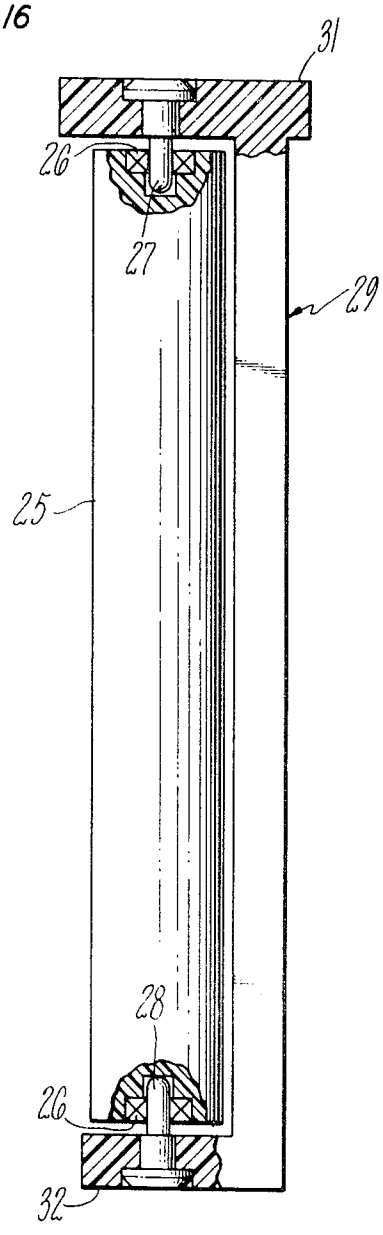


FIG. 16



MAGNETIC INDICATOR WITH CAPACITOR CONNECTED COILS

BRIEF SUMMARY OF THE INVENTION

The present invention generally relates to indicators and more particularly to a new and improved indicator of the type having a plurality of rotatable indicating elements or bars for displaying each of a plurality of available characters.

It is a principal aim of the present invention to provide a new and improved indicator having a plurality of parallel indicating elements mounted in side-by-side relationship which may be independently selectively positioned at each of a plurality of angular positions to provide for selectively indicating each of a plurality of available characters.

It is another aim of the present invention to provide a new and improved indicator which is electromagnetically operated and which is adapted to be selectively energized to selectively indicate each of a plurality of available characters or displays.

It is a further aim of the present invention to provide a new and improved electromagnetically operated indicator for selectively displaying each of a plurality of available characters and which is adapted to retain a selected display if and when the indicator is deenergized, thereby permitting the power consumption and heat generation to be reduced to a minimum.

It is another aim of the present invention to provide a new and improved indicator which may be constructed to provide an easily readable indicator with a maximum character size for any given frontal area as for example for aircraft instrumentation.

It is a further aim of the present invention to provide a new and improved parallel bar indicator for selectively indicating the sequence of characters of 0 through 9.

It is another aim of the present invention to provide a new and improved electromagnetically operated indicator for selectively displaying each of a plurality of available characters which has a short response period and which is adapted to be operated with a short pulse to maintain a selected display even under shock, inertia or vibration loading.

It is another aim of the present invention to provide a new and improved electromagnetically operated indicator having a basic design which may be used to present a variety of different display sequences, for example the sequence of indicia of 0 through 9, or a sequence of two or more letters or words.

It is another aim of the present invention to provide a new and improved electromagnetically operated indicator for selectively displaying each of a plurality of available characters which is operable with a simple and reliable decoding circuit.

It is a further aim of the present invention to provide a new and improved electromagnetically operated indicator which provides an easily readable display through a large viewing angle and under both low- and high-intensity ambient lighting conditions.

It is another aim of the present invention to provide a compact indicator of the type described which may be mounted in an indicator bank to provide a plurality of aligned closely associated characters.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth, and the scope of the application of which will be indicated in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a partly exploded side elevation view partly broken away and partly in section of an embodiment of an indicator incorporating the present invention;

FIG. 2 is a front elevation view of the indicator;

FIG. 3 is a top plan view, partly broken away and partly in section, of the indicator;

FIG. 4 shows a rear elevation view of the indicator with parts removed, and additionally shows in broken lines the outline of a second indicator mounted in association therewith and an embodiment of an antihangup circuit;

FIGS. 5, 6 and 7 show the surface developments of the left, center and right indicating elements of the indicator;

FIG. 8 shows reduced views of the sequence of characters of 0 through 9 as presented by the indicator;

FIG. 9 is an enlarged partial top plan section view partly broken away and partly in section of a modified indicator, and additionally showing in broken lines alternative antihangup means;

FIG. 10 is an elevation view of a modified indicating element and an associated magnetic detent;

FIG. 11 is a transverse section view taken along line 11—11 of FIG. 10;

FIG. 12 is a partial side elevation view partly broken away and partly in section showing an indicating element and a pair of electromagnets associated therewith of another modified indicator;

FIG. 13 is a front elevation view of a set of modified indicating elements;

FIG. 14 is a top plan view of a cap of the indicator of FIG. 1;

FIG. 15 is an enlarged partial top plan section view partly broken away and partly in section showing an indicating element and a pair of electromagnets associated therewith of another modified indicator; and

FIG. 16 is an enlarged side elevation view partly broken away and partly in section showing an indicating element subassembly of a modified indicator.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings in greater detail wherein like reference numerals indicate like parts throughout the several figures, an embodiment 10 of the present invention shown in FIGS. 1–4 comprises an elongated molded frame 12 of transparent plastic consisting of an elongated body 13 and a cap 14 and having a forward rectangular viewing face or window 16. A chamber or cavity 18 having three parallel generally cylindrical chamber portions is formed in the body 13 behind the window 16 and three indicating elements or bars 20 are mounted in the chamber portions respectively in close parallel association and side-by-side association such that the forward faces or forward angular segments of the indicating elements 20 are adapted to provide a viewing surface for selectively displaying each of a plurality of available characters for which purpose the indicating elements 20 are appropriately marked to bear suitable character segments, an exemplary embodiment of which is hereinafter described.

The indicator is shown designed for selectively displaying each of the sequence of characters of 0 through 9, but may alternatively be designed for displaying other characters in which case two, or more than three indicating elements may be preferred. Also the indicating elements may be mounted with their axes extending vertically as in the shown embodiment or with their axes extending horizontally as may be preferred for the particular presentation to be displayed and the indicator application.

For the purpose of increasing the readability of the indicator, the viewing window 16 is formed as shown in FIGS. 2 and 3 to provide magnifying lenses 21 for magnifying the forward operative faces or angular segments of the indicating elements (in the shown embodiment the forward 90° surface portions), to optically "bridge" the spacing between those operative surfaces, and to enlarge the viewing angle.

The rotatable indicating elements are preferably statically and dynamically balanced and of lightweight molded plastic construction and as shown in the embodiment of FIG. 1 may be rotatably mounted in their operating chambers on axially extending pivot pins 22,24 integrally formed with the body of the indicating elements. Alternatively the indicating elements may be rotatably mounted on fixed pivot pins as shown in the

embodiment of FIG. 16 in which an indicating element 25 is shown provided with suitable jewel bearings 26 which receive a pair of fixed pivot pins 27,28. Although the indicating elements 20 are preferably cylindrical in cross section, alternative appropriate shapes such as polygonal (e.g., square) may be used. Also the indicating elements 20 may be immersed in a suitable transparent liquid as in the typical liquid compass to improve the readability of the indicator and the rotational operation of the indicating elements.

The frame body 13 and cap 14 are shown formed with suitable opposed recesses or journal bearings for receiving the pivot pins 22, 24 of the indicating elements and for thereby rotatably and axially supporting the indicating elements. The cap 14 has three depending generally cylindrical bosses snugly received in the chamber 18 for accurately locating the journal bearings of the cap directly above the journal bearings of the frame body, and the cap 14 is suitably adhered to the frame body 13 to seal the chamber 18 against foreign impurities and against the loss of liquid where such is used. Alternatively the indicating elements may be preassembled as shown in FIG. 16 with a suitable generally U-shaped insert 29 to provide an indicating element subassembly which is mounted in a conforming opening in the frame body 13 and, if desired, so that the upper and lower flanges 31,32 of the insert provide upper and lower caps for the indicating element chamber.

The indicating elements 20 are shown having diametrically extending generally rectangular permanent magnets 30 with radially outwardly tapered poles for increasing the angular sensitivity of the permanent magnet and having circumferentially narrow pole faces generally conforming to the cylindrical surface of the indicating elements. (With a polygonal indicating bar, the magnet would preferably be mounted to extend diagonally between opposed edges of the bar and could be provided with V-shaped ends conforming to the flat sides of the bar.) Each of the indicating elements 20 is adapted to be angularly positioned in each of its four angular operating positions by a pair of identical elongated electromagnets 34 which are mounted to extend rearwardly from the indicating elements in conforming bores 35, 36 in the frame body 13. Each electromagnet comprises an iron core 38, a winding 40 encircling the core 38 and an end plug 42 having a projection or key portion 43 receivable in a rectangular key way or slot 41 between the bores 35, 36 for positioning the electromagnets in appropriate angular relationship with the respective indicating element 20. The winding 40 in the shown embodiment comprises a single coil with a center tap lead and a pair of end leads to provide for energizing the electromagnet to produce either a north or a south magnetic pole adjacent the indicating element, for which purpose three coil connector pins 44–46 are mounted in the end plug with the pins 45 and 46 connected to the ends of the coil and the pin 44 connected to the center of the coil. Of course, a different type of winding, such as a single two-lead coil or a pair of separate two-lead coils, could alternatively be used to selectively produce a north and south polarity. As best seen in FIG. 3 the forward ends of the bores 35,36 are contoured to provide a generally V-shaped rearwardly facing abutment 48 having perpendicularly related faces 50, 51 providing abutment faces for accurately locating the pole faces of the electromagnets with respect to the respective indicating element 20.

The inner ends of the cores 38 are formed to incline generally radially inwardly toward the corresponding indicating element and are shown provided with elliptically shaped pole faces with major axes parallel to the axis of rotation of the indicating element. Thus, even though the electromagnets are mounted in parallel relationship with their longitudinal axes laterally spaced greater than the diameter of the indicating element, the pole faces may be positioned 90° apart (as shown in FIG. 9 or alternatively positioned more or less than 90° apart) relative to the indicating element and adjacent its cylindrical surface. Each of the pair of electromagnets is accordingly adapted to position the indicating element in each of two diametrically opposed positions and the indicating element is adapted to be positioned in each of four equiangularly spaced positions by the pair of electromagnets.

The three pairs of electromagnets for the three indicating elements are axially as well as sidewise or laterally offset with respect to each other as seen in FIG. 4, and the permanent magnet 30 of each indicating element 20 is axially positioned in the plane of the pole faces of the corresponding pair of electromagnets. Also, the elongated sides of the rear or control section 55 of the frame body 13 are sidewise laterally outwardly offset from the generally rectangular forward or indicating section 56 of the frame body at the upper right and the lower left of the frame body as viewed in FIG. 2, and the portions of the elongated sides of the rear section 55 opposite the outward offset portions are appropriately recessed in general conformity therewith to provide for mounting and keying two or more units together in a bank as shown in FIG. 4 with the indicating sections 56 of adjacent indicators in engagement. Thus the frontal area of the indicating sections of a bank of indicators is dependent substantially entirely on the size of the display desired and is substantially independent of the size of the electromagnets 34 employed and the overall width of the rear section 55. In addition the rear section 55 is provided with a longitudinally extending slot or key way 60 on one side thereof and an opposed projection or key 62 on the opposite side receivable in the slot of an adjacent indicator to maintain the units in proper alignment, and so that the units of a bank may be readily assembled by lateral association and held in association by merely employing suitable lateral clamping means (not shown).

An alternative arrangement of electromagnets and permanent magnets is shown in FIG. 12 in which a pair of elongated electromagnets 64 are mounted one above the other in parallel relationship and with their axes perpendicular to and lying in the plane of the axis of the indicating element 65. The indicating element 65 has a pair of axially spaced permanent magnets 66 (with circular cross sections) shown having an angular spacing of approximately 90°. Thus, the pair of electromagnets 64 and corresponding permanent magnets 66 provide for selectively positioning the indicating element 65 in each of four equiangularly spaced operating positions.

Although the electromagnets of the indicator may be held energized, if desired, after the indicating elements have been selectively positioned, the indicating elements are adapted to be retained in their selected positions if, as may be preferred the indicator is then deenergized. In the embodiments of FIGS 1–4 and 12 each indicating element is adapted to be retained in its selected position if and when the electromagnets are deenergized by reason of the magnetic attraction of the permanent magnet with the pole of the electromagnet which had been energized. Alternatively, as shown in FIG. 9, suitable auxiliary soft iron magnetizable pieces 70 may be positioned for locking or detenting the indicating element in position after the electromagnet is deenergized. The auxiliary magnetic detents 70 may be offset from the pole faces of the electromagnets as shown in FIG. 9 such that the indicating element will be caused to rotate a few degrees when the electromagnet is deenergized as a result of the attraction of the permanent magnet with the adjacent auxiliary detent 70, in which instance it is preferred that the indicating elements be mounted on fixed pins as shown in FIG. 16 to increase the distance between the line of bearing contact and the auxiliary detent and to thereby reduce or eliminate (depending upon the amount of radial play of the indicating element) the amount of bearing sliding friction which accompanies the few degrees of "rotation" of the indicating element.

When provided, the detents 70 may have an effective angular spacing of 90° and the pole faces of the electromagnets may then be spaced slightly less than 90° as seen in FIG. 9 such that the four detent positions of the indicating element are equiangularly spaced. Also, with the detents 70 properly located between adjacent indicating elements the detents 70 may be made sufficiently long to serve as a detent post for each of the adjacent indicating elements. Preferably, however,

the detents **70** are sufficiently short to serve as a detent for only one of the indicating elements so as to minimize the magnetic influence of adjacent indicating elements. As seen in FIG. **9** the auxiliary detents **70** may be mounted on the face of a plastic plate **74** which may be inserted and suitably secured in appropriate position prior to the assembly of the indicating elements **20** and cap **14** or which may form the back plate of the insert **29** of the indicating element subassembly shown in FIG. **16**. Alternatively the auxiliary detents **70** could be provided in the window **16** of the indicator as shown in broken lines in FIG. **9** in which case the viewing face could be provided as an insert in the manner of the insert **74**. Or the indicating element could be detented by the provision of an additional cross-shaped permanent magnet **80** and a suitable auxiliary detent **82** as shown in FIGS. **10** and **11**, and if desired the detent **82** could be located to provide for angularly displacing the indicating element a few degrees when the operative electromagnet is deenergized.

A modified pole and auxiliary detent arrangement is shown in FIG. **15** in which the cores **83**, **84** of the pair of electromagnets are spaced further apart to reduce their magnetic interaction and are specially formed to coact with a pair of elongated detents **85** which are spaced substantially 90° apart and with their forward longitudinal ends adjacent the indicating element **20**. The forward ends or pole faces of the cores **83**, **84** are positioned aside the detents **85** and radially outwardly of the forward ends of the detents such that each detent **85** functions to reduce the air gap between the pole faces of the core and permanent magnet **30** and to thereby increase the magnetic influence of the corresponding electromagnet on the permanent magnet **30**, to reduce the influence of the cores **83**, **84** of the electromagnets on the detent positions of the indicating element **20**, and to increase the spacing tolerance between the pole faces of the electromagnet and permanent magnet. Also the detents **85** provide for angularly shifting the indicating element **20** a few degrees when the electromagnet is deenergized as in the embodiments shown in FIG. **9** and **10**.

The offset detents **70**, **82** or **85** provide for preventing rotational hangup of the indicating element when the electromagnetic field is reversed. Alternatively a magnetic shunt **90** could be provided between the cores of the electromagnets as shown by broken lines in FIG. **9** to provide a weak secondary field with the "inactive" electromagnet which would provide for altering the primary magnetic field sufficiently to avoid hangup. The secondary field could alternatively be provided electrically by the provision of an additional coil on each electromagnet which is connected to be energized when the other electromagnet is energized, or the coils of the electromagnets could be interconnected through suitable resistors (not shown). Hangup could also be avoided by providing a momentary magnetic pulse in the inactive coil when the active coil is energized, for example by the circuit shown in broken lines in FIG. **4** in which the connectors **45** and **46** of the pair of coils are interconnected through suitable capacitors.

Referring to FIG. **13** the indicating elements could be modified to include additional "passive" permanent magnets **30'** identical to the permanent magnets **30** and which function to magnetically balance the end indicating elements so as to diminish or substantially eliminate the magnetic influence of adjacent indicating elements and therefore to reduce the magnetic force required to position each indicating element.

The indicating elements **20** are discretely marked for example with discrete areas of black on a white background, to provide character portions on their display faces as shown in FIGS. **5–7** such that the indicating elements are collectively adapted to present each of the digits 0–9 by selectively angularly positioning each of the indicating elements with their corresponding pair of electromagnets. A predetermined, meaningful and unified figure or other character can therefore be set forth by positioning the indicator elements to present their appropriate display faces. Also suitable circuitry, for example a simple diode matrix could be provided for selectively energizing the electromagnets of a single indicator or of a bank of two or more indicators for selectively presenting each of the available displays, or the electromagnets could have a series of "coded" windings for selectively presenting each of the available displays.

The indicator of the present invention therefore provides a readable and compact indicating device which is capable of presenting each of a plurality of available characters or displays such as the sequence of digits of 1–9 and which is adapted to be mounted in a bank to provide for example a multiple order numerical readout.

As will be apparent to persons skilled in the art, various modifications and adaptations of the structure above described will become readily apparent without departure from the spirit and scope of the invention, the scope of which is defined in the appended claims.

I claim:

1. In an indicator having a rotatable indicating element, and a pair of electromagnets with salient poles and operating coils for selectively angularly positioning the indicating element in each of a plurality of angular operating positions, the improvement wherein the indicator comprises circuit means interconnecting the operating coils of the electromagnets to provide a momentary secondary magnetic field with one of the pair of electromagnets when the other electromagnet is energized, the circuit means including capacitance means interconnecting the operating coils of the electromagnets.

* * * * *