Nov. 1, 1955 E. C. WITTKE 2,722,581

SENSITIVE RELAY WITH MAGNETIC TOGGLE

Filed April 4, 1952 2 Sheets-Sheet 1

FIG.1.

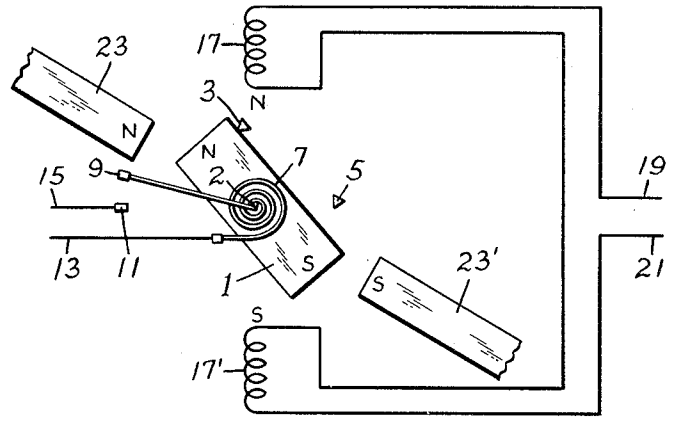


FIG.2.

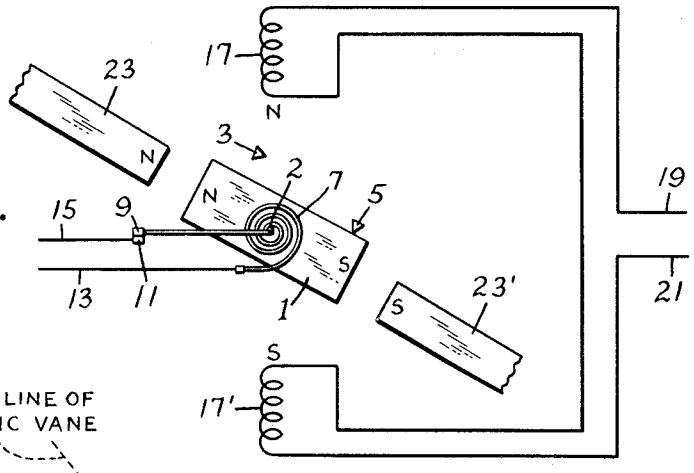
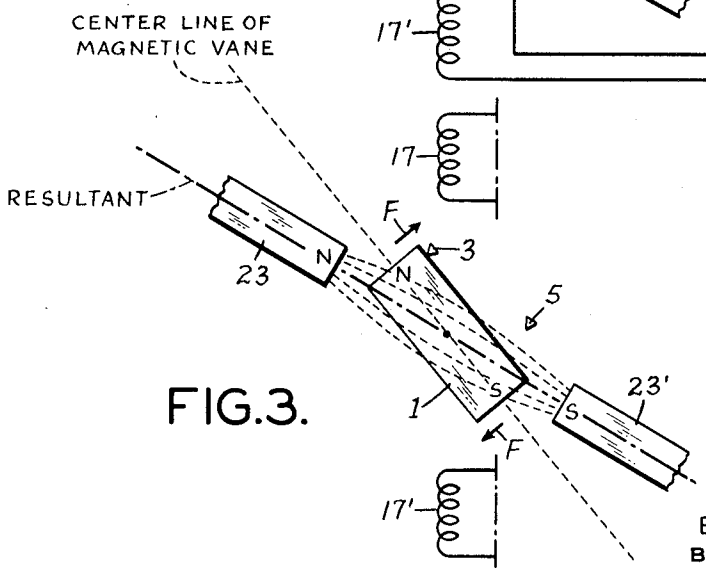


FIG.3.



INVENTOR.
ERNEST C. WITTKE
BY
ATTORNEY.

Nov. 1, 1955 E. C. WITTKE 2,722,581

SENSITIVE RELAY WITH-MAGNETIC TOGGLE

Filed April 4, 1952 2 Sheets-Sheet 2

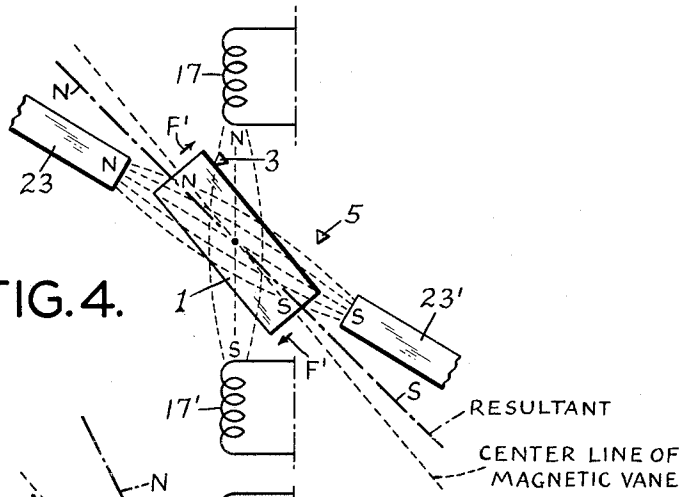


FIG. 4.

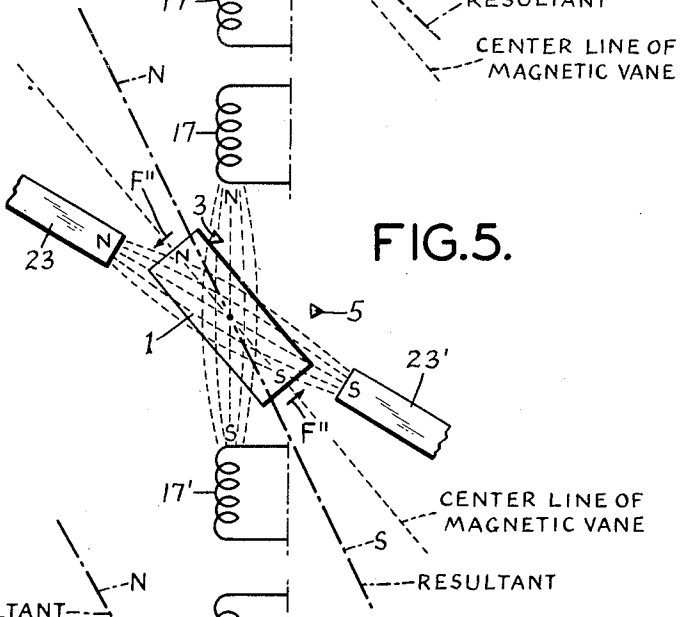


FIG. 5.

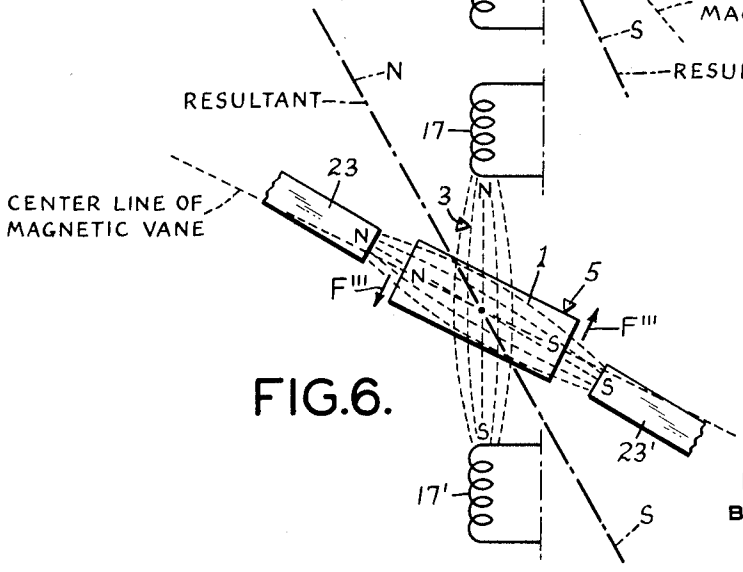


FIG. 6.

INVENTOR.
ERNEST C. WITTKE
BY
ATTORNEY.

United States Patent Office 2,722,581 Patented Nov. 1, 1955

2,722,581

SENSITIVE RELAY WITH MAGNETIC TOGGLE

Ernest Carl Wittke, Bayside, N. Y., assignor to Combustion Engineering, Inc., New York, N. Y., a corporation of Delaware

Application April 4, 1952, Serial No. 280,537

11 Claims. (Cl. 200—93)

My invention relates generally to instrument type relays and has specific reference to such a relay with means for insuring a positive contact without chatter.

Instrument type relays have a very sensitive meter movement which is adapted to respond to small electrical currents such as those available from thermocouples, magnetic inductance pickups and the like.

The power that can be developed from such small currents is itself necessarily exceedingly small resulting in a small force available to maintain the contacts of the relay in engagement. Because of this it has long been a serious problem to obtain a satisfactory electrical connection between the relay contacts under ordinary operating conditions. When the contacts are closed with insufficient force to establish good electrical contact a point of high resistance is established which may result in excessive temperature at this point causing said contacts to become welded together. Furthermore with but a very small force maintaining said contacts in engagement considerable chattering will occur during make and break operations and also incident to any mechanical vibration of the relay.

Various arrangements have been devised in the past in an attempt to overcome the aforementioned difficulties and produce an instrument type relay which will operate satisfactorily with the small currents available for such purpose. However, all of the prior art devices of which I am aware have had one or more drawbacks making them unsatisfactory for general use as an instrument type relay. They either employ intricate cams, levers, and/or ratchets which generally have to be manually reset or they have additional magnetic devices which require manual manipulation in order to open the contacts of the relay once they are closed. Many of these devices are exceedingly cumbersome and expensive for the result which they are designed to accomplish.

It is therefore the object of my invention to provide an instrument type relay that is free of the aforementioned difficulties, extremely compact, highly efficient and relatively cheap to manufacture.

A further object is to provide a completely automatic instrument type relay having an additional magnetic means associated therewith in such a manner as to provide sure and positive operation of the relay contacts without chattering.

Other and further objects and advantages will become apparent as the description hereof proceeds.

With the aforementioned objects in view my invention comprises an arrangement, construction and combination of the elements of a relay in such a manner as to attain the results desired as hereinafter set forth in the following detailed description of the illustrative embodiment depicted in the accompanying drawings wherein:

Figure 1 is a diagrammatic representation in the nature of a plan view of a relay employing my inventive concept;

Figure 2 is a view similar to Fig. 1 with the relay moved to the closed position;

Figure 3 is a diagrammatic view of the magnetic elements of the relay showing the effective resultant field relative to the center line of the rotatable vane when no current is flowing through the field coils;

Figure 4 is a view similar to Fig. 3 showing the effective resultant field when a small current is flowing through the field coils;

Figure 5 is a view similar to Figs. 3 and 4 showing the resultant field with an increased current flowing through the field coils;

Figure 6 is a view similar to Fig. 5 showing the magnetic vane moved to its switch closing position.

The device to be benefitted

Referring to the drawings and more particularly to Figs. 1 and 2, numeral **1** designates an elongated generally rectangular magnetic vane rotatably mounted about an axis **2** perpendicular to the surface thereof and extending centrally therethrough. A plurality of stops **3** and **5** are arranged to limit the rotational movement of said vane within predetermined limits. Hair spring **7** has one end secured to a fixed frame member (not shown) and the other end secured to vane **1** in a manner to urge said vane in a clockwise direction into engagement with stop **3**.

Also secured to said vane is movable contact **9** of an electrical switch, said contact being arranged to engage stationary contact **11** when said vane is rotated in a counterclockwise direction to its extreme position where it engages stop **5** and to be separated from said stationary contact **11** when said vane is moved in a clockwise direction to its extreme portion where it engages stop **3**. In order to eliminate any effect upon vane **1** due to connecting movable contact **9** into an electrical circuit, hair spring **7** is utilized as the electrical connection for said movable contact; said hair spring **7** being secured at one end to said contact and at the other end to lead **13** of a suitable work circuit of which lead **15**, secured to contact **11**, also forms a portion.

Field coils **17**, **17'** are connected by leads **19** and **21** to a suitable detecting device (not shown) such as a thermocouple, magnetic inductance pickup or the like. Said coils **17**, **17'** are positioned adjacent the end of magnetic vane **1** but laterally displaced from the longitudinal center line thereof when said vane occupies a first position wherein contacts **9**, **11** are open and the vane is in engagement with stop **3** as shown in Figs. 1, 3, 4 and 5. The wiring of coils **17**, **17'** is such that the flow of current therethrough in response to activation of the aforementioned detecting device produces a magnetic field the poles of which are adjacent like poles of said magnetic vane **1** as shown in the drawings where N designates a north magnetic pole and S designates a south magnetic pole. Thus, since like poles repel, the magnetic field created by field coils **17**, **17'** tends to rotate said magnetic vane in a counterclockwise direction as viewed in Fig. 1 from said first to a second position wherein contacts **9**, **11** are closed and said vane is in engagement with stop **5** (Figs. 2 and 6).

One meter-type electrical instrument utilizing a permanent magnet rotor in the manner here shown and described is more fully disclosed by U. S. Patent 2,473,939, issued June 21, 1949, to W. B. M. Clark for "Polarized Electromagnet."

The improvement of my invention

In accordance with my invention permanent magnetic members **23**, **23'** are also disposed adjacent the ends of said magnetic vane **1**. In the illustrative arrangement shown these members **23**, **23'** are located on the opposite side of the longitudinal center line of the vane from said field coils **17**, **17'** when said vane is in the first or open-contact position in engagement with stop **3** (Figs. 1, 3, 4 and 5) and on the same side of said longitudinal center line when said vane is in the second or closed-contact

position in engagement with stop 5 (Figs. 2 and 6). Depending on the location of stop 5, other relationships are possible.

As in the case of field coils 17, 17', the poles of magnetic members 23, 23' are positioned adjacent like poles of said magnetic vane 1 as indicated on the drawings by the N and S designations of magnetic poles. Thus, when vane 1 occupies the "first" position in engagement with stop 3 (contacts 9, 11 then open) said magnetic members 23, 23' are effective to urge said vane in a clockwise direction to maintain the vane in engagement with said stop 3; while when vane 1 occupies the "second" position in engagement with stop 5 (contacts 9, 11 then closed) said magnetic member 23, 23' are effective to urge said vane in a counterclockwise direction to maintain said vane in engagement with said stop 5.

In order to facilitate explanation of my improved device, the magnetic lines of force represented in Fig. 3 as dotted lines bridging the gap between the north (N) and (S) south pole of permanent magnetic members 23, 23' and in Figs. 4, 5 and 6 as bridging the gap between the poles created by current flowing through field coils 17, 17' as well as the gap between magnetic members 23, 23' are intended to indicate the respective strengths of the individual fields of these two pairs of magnetic elements. The dot dash line depicted in Figs. 3, 4, 5 and 6, which is labeled "Resultant," indicates the effective resultant magnetic field formed by the combination of the aforesaid individual fields.

How improved relay operates

My invention thus provides a magnetic toggle comprised of the added permanent magnet members 23 and 23' which are coordinated with the conventional elements of the relay in the unique manner just described. The operation of the so-improved relay will best be understood by referring to Figs. 3 to 6, inclusive. With coils 17, 17' and magnetic elements 23, 23' disposed as shown in the drawings, with like magnetic poles adjacent each other, an effective resultant magnetic field is created somewhere between the individual fields of said coils and said magnetic elements respectively, depending upon the strength of the individual fields, which resultant field is effectively of greater strength than either of said individual fields. However, with no current flowing through field coils 17, 17', as represented by Fig. 3, the magnetic field developed across the gap of magnetic members 23, 23' is the sole field acting on vane 1, wherefore the effective resultant field coincides with and is of equal strength to the field produced by said magnetic members 23, 23' as clearly indicated in said Fig. 3. Under these circumstances the rotative force, illustrated as F in Fig. 3, acting on magnetic vane 1 due to said magnetic field urges said vane in a clockwise direction into engagement with stop 3.

As the current is raised from zero in coils 17, 17' the effective resultant magnetic field is rotated in a clockwise direction. Fig. 4 shows the position of said resultant field when the current flowing through coils 17, 17' is insufficient to effect a counterclockwise rotation of magnetic vane 1. It will be observed that under these conditions the effective resultant field has not been rotated past the longitudinal center line of magnetic vane 1. Therefore the magnetic force (indicated as F' in Fig. 4) tending to rotate said magnetic vane, although greatly reduced from that present under the conditions depicted in Fig. 3, still urges said magnetic vane in a clockwise direction into engagement with stop 3.

However, as the current flowing through coils 17, 17' continues to increase, the effective resultant field is further rotated in a clockwise direction and at a predetermined point passes the longitudinal center line of magnetic vane 1 (which may be designated "dead center"), at which time the direction of the rotative force acting on magnetic vane 1 is reversed causing said vane to quickly rotate its full distance of travel in the counterclockwise direction to the switch closing position in engagement with stop 5. This result is best shown in Figs. 5 and 6 wherein F'' and F''', respectively, represent the aforementioned rotative force acting on said vane.

Once said vane 1 starts to move in a counterclockwise direction it will continue this movement until contacts 9—11 are closed and stop 5 is engaged since the moment acting on said vane to produce said counterclockwise rotation increases more rapidly than the spring-produced moment (from element 7) opposing said rotation. This is due to the fact that as the vane moves in a counterclockwise direction it is approaching a position where the longitudinal axis of said vane is normal to the effective resultant magnetic field causing the movement of said vane and since the component of the force of said resultant magnetic field acting to urge said vane in a counterclockwise direction is greatest when the longitudinal axis of said vane is normal to said resultant field it follows that said force component is increased as this relationship is approached. This is evidenced in the drawings by vectorially representing F''' (Fig. 5) as being greater force than F'' (Fig. 4) with the same current flowing through coils 17, 17'.

It will be noted that when magnetic vane 1 is in engagement with stop 5 the effect of the magnetic field produced by magnetic members 23, 23' is such as to urge said vane into continued engagement with said stop 5. However, the force thus produced by said magnetic members 23, 23' is, of itself, insufficient to overcome the force of hair spring 7 urging said vane in a clockwise direction. Therefore when the current in coils 17, 17' falls below a predetermined value, at which point the force tending to maintain magnetic vane 1 in engagement with stop 5 is insufficient to overcome the force of said spring, said magnetic vane will quickly rotate in a clockwise or contact-opening direction into engagement with stop 3.

Once said clockwise rotation is initiated by spring 7 it will continue at an increasing rate until vane 1 contacts said stop 3. This is due to a reversal of the effect hereinbefore described with respect to the counterclockwise rotation of said vane; i. e., as the vane moves in a clockwise direction the angularity between the longitudinal axis of the vane and the effective resultant magnetic field decreases, wherefore the force component produced by said effective resultant magnetic field and which acts normal to said longitudinal axis to urge said vane in a counterclockwise direction is also decreased. After said vane has moved a predetermined distance in said clockwise direction the longitudinal axis of magnetic vane 1 will override the effective resultant field produced by field coils 17, 17' and magnetic members 23, 23', whereupon the direction of the rotative force upon said vane produced by said effective field will reverse thereby aiding spring 7 in returning vane 1 to its switch opening position in engagement with stop 3.

The amount of current flowing through field coils 17, 17' that is required to operate the improved relay can be varied within wide limits since said current is dependent upon the number of windings in said coil, the strength of the magneitc field produced by magnetic members 23, 23' and the strength of spring 7.

It will thus be seen that I have provided an instrument type magnetic relay which will make and break without chattering and which has an effective force pressing the contacts of the relay (here shown at 9, 11) into engagement, when said relay is in the closed position, that is greater than the force capable of being developed solely by the small current which motivates the actuation of said relay.

While I have shown and described a preferred embodiment of my magnetic toggle improvement it is to be understood that such is merely illustrative and not restrictive and that variations and modifications may be made therein without departing from the spirit and scope of the invention. I therefore do not wish to be limited to the

precise details set forth but desire to avail myself of such changes and alterations as fall within the purview of my invention.

What I claim is:

1. In a relay of the type described, a pivotally mounted polarized magnetic vane, switch means associated with said vane and arranged to be open when said vane is in a first position and closed when said vane is in a second position, means biasing said vane to one of said positions, field coil means disposed adjacent said vane in a manner so that the poles of the magnetic field created by current flowing through said field coil means in a predetermined direction are adjacent like poles of said vane and laterally displaced therefrom in such a manner as to urge said vane when in said one position for rotation to the other of said positions, additional magnetic means positioned adjacent said vane with the poles thereof disposed adjacent like poles of said vane but laterally and outwardly displaced therefrom in such a manner as to urge said vane when in said one position for rotation to said one position.

2. In a relay of the type described, a pivotally mounted polarized magnetic vane, switch means associated with said vane and arranged to be open when said vane is in a first position and closed when said vane is in a second position, stop means for limiting the movement of said vane to within a range defined by said two positions, means biasing said vane to one of said positions, coil means disposed adjacent said vane in a manner so that the poles of the magnetic field created by current flowing through said coil means in a predetermined direction are adjacent like poles of said vane and laterally displaced therefrom when said vane is in said one position so as to urge said vane for movement from said one to the other of said positions, and permanent magnetic means also associated with said vane with the poles thereof disposed adjacent like poles of said vane but laterally and outwardly displaced therefrom in such a manner as to urge said vane when in said one position for rotation in said one position.

3. An instrument type electrical relay comprising a substantially rectangular polarized magnetic vane rotatable about a centrally disposed transverse axis, said vane having electrical switch means operatively associated therewith and being adapted to rotate from a first position where said switch is open to a second position where said switch is closed; means biasing said vane to said first or open-switch position; stop means for limiting the rotational movement of said vane to within a range defined by said two positions; field coil means disposed adjacent said vane in a manner so that the poles of the magnetic field created by current flowing therethrough in a predetermined direction are adjacent like poles of said magnetic vane and displaced laterally of the longitudinal center line of said vane in a manner to urge said vane from said first or switch-open position to said second or closed-switch position; and permanent magnetic means associated with said vane, the poles of said magnetic means being disposed adjacent like poles of said vane but located on opposite sides of the longitudinal center line of said vane from the poles created by said field coil when said vane is in said first position whereby said magnetic means opposes initial rotation of said vane from said first or open-contact position.

4. An instrument type electrical relay comprising a substantially rectangular polarized magnetic vane rotatable about a centrally disposed transverse axis, said vane having electrical switch means operatively associated therewith and being adapted to rotate from a first position where said switch is open to a second position where said switch is closed; spring means biasing said vane to said first position and forming one of the electrical leads for said switch; stop means for limiting the rotational movement of said vane to within a range defined by said two positions; field coil means disposed adjacent said vane in a manner so that the poles of the magnetic field created by current flowing therethrough in a predetermined direction are adjacent like poles of said magnetic vane and displaced laterally of the longitudinal center line of said vane in a manner to urge said vane from said first or open-switch position to said second or closed-switch position; and permanent magnetic means associated with said vane, the poles of said magnetic means being disposed adjacent like poles of said vane but located on opposite sides of the longitudinal center line of said vane from the poles created by said field coil when said vane is in said first position and on the same side of said longitudinal center line when said vane is in said second position whereby said magnetic means opposes initial rotation of said vane from said first or open-switch position but once rotation has advanced beyond a given intermediate point then aids further rotation of the vane into said second or closed-switch position.

5. An instrument type electrical relay comprising an elongated polarized magnetic vane rotatable in a predetermined plane about a centrally disposed transverse axis; switch means having a movable contact connected to said vane and arranged to be open when said vane is in a first position and closed when said vane is in a second position; means biasing said vane to said first or open-contact position; field coil means disposed adjacent said vane so that the poles of the magnetic field created by current flowing therethrough in a predetermined direction are located in said predetermined plane and are adjacent like poles of said magnetic vane but displaced laterally of the longitudinal axis thereof in a manner to urge said vane from said first to said second or closed-contact position; and additional magnetic means associated with said vane comprising permanent magnetic members with poles positioned in said predetermined plane adjacent like poles of said magnetic vane, said permanent magnetic members being fixedly disposed at a location where the effect of the magnetic field thereof is to oppose the rotation of said vane from said first to said second position when said vane occupies said first or open-contact position and from said second to said first position when said vane occupies said second or closed-contact position.

6. An instrument type electrical relay comprising a rotatably mounted polarized magnetic vane having electrical switch means operatively associated therewith, said vane being adapted to rotate from a first position where said switch is open to a second position where said switch is closed, first magnetic means positioned adjacent said vane in a manner so that the poles of the magnetic field created thereby are adjacent like poles of the vane and laterally displaced therefrom in such a manner as to urge the vane when in one of said positions for rotation to the other position, second magnetic means positioned adjacent said vane so that the poles of the magnetic field created thereby are adjacent like poles of the vane and laterally and outwardly displaced therefrom in such a manner as to oppose rotation of the vane to the other of said positions when in said one position, the magnitude of the magnetic field of said first magnetic means which acts upon said vane being variable and being related to said second magnetic means so that upon exceeding a predetermined value the resultant force acting upon said vane will effect rotation of said vane from said first to said second position.

7. In an instrument type electrical relay a polarized magnetic vane rotatable about a transverse axis, means limiting the angular movement of the vane to and from first and second positions spaced a predetermined angular distance apart, a first polarized magnetic means of variable magnitude positioned adjacent an end of the vane with like poles of the magnetic means and the vane being adjacent, said magnetic means being displaced laterally of said vane when it is in one of its extreme positions in a manner so that the repulsion force of said adjacent like poles urges the vane from said one to the other of said positions, additional polarized magnetic means

positioned adjacent an end of the vane with like poles of this magnetic means and the vane being adjacent, the second mentioned magnetic means being displaced laterally and outwardly of said vane when it is in its one position in a manner so the repulsion force of said adjacent like poles urges the vane toward said one position.

8. Apparatus as defined in claim 7 wherein the first mentioned magnetic means comprises a coil and the second mentioned magnetic means comprises a permanent magnet.

9. An apparatus as defined in claim 7 wherein the second mentioned magnetic means is laterally displaced with respect to the vane when the vane is in its other position opposite to its lateral displacement with respect to the vane when the vane is in its one position.

10. In a relay of the type described a pivotally mounted polarized magnetic vane, switch means associated with said vane and arranged to be open when said vane is in a first position and closed when said vane is in a second position, field coil means disposed adjacent said vane in a manner so that the coil means generates upon energization a magnetic field directed at an angle to the magnetic field of the vane with like poles of said fields being adjacent so as to create a turning force on the vane to urge said vane to said second position when in said one position, additional magnetic means adjacent said

vane and generating a magnetic field directed at an angle to the magnetic field of the vane with like poles of these fields being adjacent so as to create a turning force on the vane to urge said vane to said one position when in said one position.

11. A relay as defined in claim 10 wherein the magnetic field of the additional magnetic means is directed at an angle to the magnetic field of the vane when the vane is in said second position so as to create a turning force tending to urge said vane to said second position.

References Cited in the file of this patent

UNITED STATES PATENTS

1,675,919	Babcock	July 3, 1928
1,743,478	Pratt	Jan. 14, 1930
1,818,170	Stalder	Aug. 11, 1931
1,837,188	Keller	Dec. 22, 1931
1,901,443	Garvin	Mar. 14, 1933
1,951,409	Havenner et al.	Mar. 20, 1934
2,254,411	Ashworth et al.	Sept. 2, 1941
2,298,573	Little	Oct. 13, 1942
2,437,726	Davis	Mar. 16, 1948

FOREIGN PATENTS

118,575	Australia	May 31, 1944