Jan. 2, 1968 E. LEINAUER ET AL 3,361,999

MAGNETIC SWITCH OPERATING UNIT

Filed Feb. 2, 1965

FIG. 1

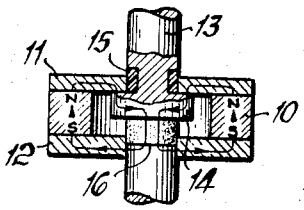



FIG. 2

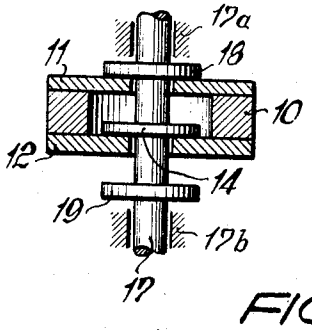



FIG. 4

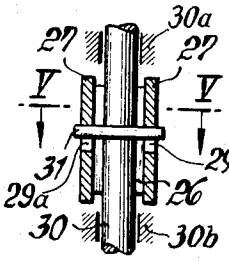



FIG. 6

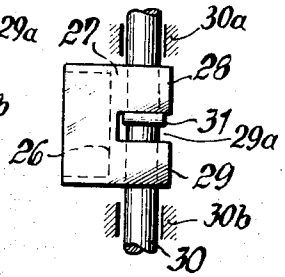



FIG. 3

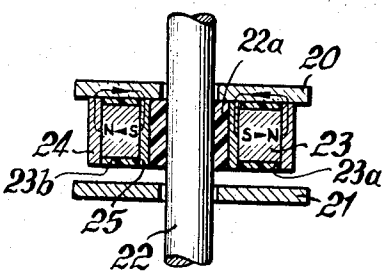



FIG. 5

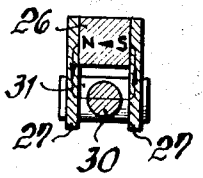



FIG. 8

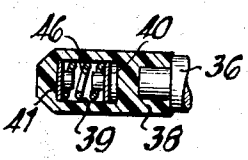
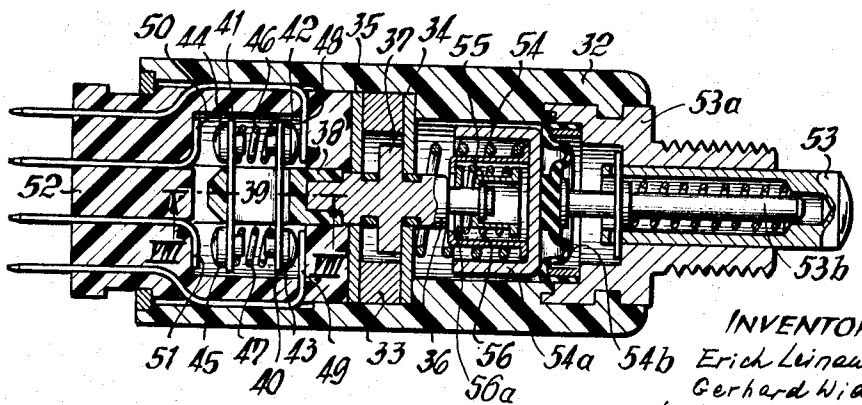



FIG. 7




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# MAGNETIC SWITCH OPERATING UNIT

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13 Claims. (Cl. 335—298)

## ABSTRACT OF THE DISCLOSURE

A movable switch actuating part has a core and paramagnetic abutment means located between two stationary paramagnetic stops so that the magnetic flux of an annular magnet surrounding the core is closed in two end positions of the movable part in which the abutment means abut the stops.

The present invention relates to a magnet assembly or unit which may be utilized in electric snap switches to maintain one or more movable contacts in either of two end positions. Still more particularly, the invention relates to a permanent magnet unit wherein at least a portion of the retaining force needed to keep one or more movable contacts of an electric snap switch in either of two end positions is a magnetic force.

It is an important object of the present invention to provide a magnet unit which consists of a stationary part and a movable part and which is constructed and assembled in such a way that its parts can produce a maximal magnetic force in two different positions of the movable part.

Another object of the invention is to provide a permanent magnet unit of the just outlined characteristics which is capable of automatically moving one or more contacts of an electric snap switch from the one to the other end position or vice versa as soon as such contact or contacts are moved to an intermediate position between the two end positions.

A further object of the invention is to provide a compact, inexpensive and rugged permanent magnet unit which forms a closed magnetic circuit for its permanent magnet in each end position of the movable part and which is capable of exerting a considerable magnetic force to insure retention of one or more movable contacts in desired position.

An additional object of the invention is to provide a permanent magnet unit which can be produced in many sizes and shapes so as to occupy little room in an electric snap switch or in a similar device whose movable part or parts must normally remain in one of two end positions.

Briefly stated, one feature of the present invention resides in the provision of a permanent magnet unit which is particularly useful in electric snap switches wherein it serves as a means for holding one or more movable contacts in either of two end positions. In its elementary form, the permanent magnet unit of our invention comprises a first part which is provided with a pair of spaced stops and a second part having an abutment member located intermediate such stops. One of the two parts is movable with reference to the other part between two positions in each of which the abutment member engages one of the stops, and one part includes a permanent magnet whose circuit is completed in each position of the movable part, i.e., the two parts consist at least in part of paramagnetic material and define a complete path for magnetic force lines from the north pole to the south pole of the permanent magnet whenever the abutment



member engages the one or the other stop. This means that the abutment member is strongly attracted to the corresponding stop and thereby maintains the movable part in the respective position until and unless such movable part is forcibly moved toward the other position.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved permanent magnet unit itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawings, in which:

FIG. 1 is an axial section through a permanent magnet unit which is constructed and assembled in accordance with a first embodiment of our invention;

FIG. 2 is a similar axial section through a slightly modified unit;

FIG. 3 is an axial section through a third unit;

FIG. 4 is a vertical section through a fourth unit;

FIG. 5 is a transverse horizontal section as seen in the direction of arrows from the line V—V of FIG. 4;

FIG. 6 is a side elevational view of the unit shown in FIG. 4;

FIG. 7 is an axial section through an electric snap switch which embodies the unit of FIG. 1; and

FIG. 8 is a fragmentary section as seen in the direction of arrows from the line VIII—VIII of FIG. 7.

Referring to FIG. 1, there is shown a permanent magnet unit comprising a fixed annulus **10** which is a permanent magnet surrounding an air gap. This annulus is magnetized axially and each of its end faces is secured to one of two ring-shaped stops **11**, **12** which consist of iron or another paramagnetic material and constitute conductors for magnetic force lines as indicated by the arrows. The annulus **10** and the stops **11**, **12** together constitute the fixed part of the permanent magnet unit. This unit further comprises a movable part including an elongated core **13** here shown as an iron rod which is slidably received in the central apertures of the stops **11**, **12** and passes through the air gap within the annulus **10**. The core **13** includes an abutment member in the form of an enlarged portion or collar **14** which is located between and normally contacts one of the stops **11**, **12**. As shown, the core **13** is provided with two circumferential grooves each of which receives a sleeve or cylinder **15**, **16** consisting of diamagnetic material. The distance between the sleeves **15**, **16** is selected in such a way that the sleeve **15** is surrounded by the stop **11** when the sleeve **16** is at least partially withdrawn from the stop **12**, or vice versa. It will be noted that the sleeves **15**, **16** are located at the opposite axial ends of and are immediately adjacent to the abutment member **14**. Thus, one can say that the permanent magnet unit shown in FIG. 1 comprises a stationary part including the permanent magnet **10** with two stops **11**, **12**, and a movable part **13** having an abutment member **14** located between the stops **11**, **12** and being shorter than the magnet **10**, the diamagnetic sleeves **15**, **16** being provided to prevent direct contact between the core **13** and one of the stops **11**, **12** when the core is in direct contact with the other stop or vise versa. In this way, there is provided a closed magnetic circuit in each end position of the movable part **13–16**, i.e., when the member **14** abuts against the stop **11** or against the stop **12**. The core **13** constitutes the motion transmitting member of an electric snap switch in which the permanent magnet unit of FIG. 1 is installed in a manner to be described in connection with FIGS. 7 and 8. The sleeves **15**, **16** prevent parasitic flux from that stop which abuts against the member **14** and directly into the core **13** proper, i.e., a parasitic flux which would not pass

through the member 14. The stop 11 attracts the abutment member 14 in the axial position shown in FIG. 1, and the stop 12 will attract this abutment member when the core 13 moves downwardly into the other end position in which the magnetic circuit is completed through the stop 11, core 13, abutment member 14, stop 12 and annulus 10. In the position of FIG. 1, the magnetic circuit is completed through the stop 11, abutment member 14, core 13, stop 12 and annulus 10, i.e., the magnetic force lines need not travel through air gaps but solely through paramagnetic materials regardless of the momentary end position of the abutment member 14. The attraction between the stops 11, 12 and the abutment member 14 is sufficient to insure that the core 13 automatically snaps over to the other end position when it is subjected to the action of an axially oriented pressure large enough to move the abutment member 14 substantially midway or a little more than one-half the distance between the stops 11, 12. In other words, the permanent magnet unit of FIG. 1 may be used in a quick-make and quick-break type of electric snap switch.

FIG. 2 illustrates a modified permanent magnet unit which again comprises a fixed part including an annulus 10 and two stops 11, 12. However, the movable part of this unit comprises a reciprocable core or rod 17 which is guided in fixed bearings 17*a*, 17*b* and extends with clearance through the central apertures of the stops 11, 12 so that the core 17 cannot come in direct contact with the stops. The annular clearances between the periphery of the core 17 and the stops 11, 12 are filled with air which replaces the sleeves 15, 16 of the unit shown in FIG. 1. The core 17 carries three axially spaced abutment members including a median member 14' which is located between and normally abuts against one of the stops 11, 12, an upper abutment member 18 which is outwardly adjacent to the stop 11, and a lower abutment member 19 which is outwardly adjacent to the stop 12. The arrangement is such that the members 18, 14' engage the stops 11, 12 in one end position and the members 14', 19 engage the stops 11, 12 in the other end position of the core 17. In the end position of FIG. 2, the magnetic circuit is completed through the annulus 10, stop 11, member 18, core 17, member 14' and stop 12. Therefore, the core is actually urged to remain in such end position but will automatically assume the other end position when the operator exerts an upwardly directed pressure which moves the abutment member 14' away from the stop 12 and at least slightly toward and nearer to the stop 11. This unit can be used in an electric snap switch with the same advantage as the unit of FIG. 1.

Referring to FIG. 3, there is shown a third permanent magnet unit which differentiates from the units of FIGS. 1 and 2 mainly in that it comprises a two-piece stationary part consisting of spaced plate-like stops 20, 21 which are provided with aligned apertures to receive with at least some clearance the core 22 of a reciprocable part so that the periphery of the core is magnetically insulated from the stops 20, 21 by two sleeves of dielectric material, i.e., air. The stops 20, 21 are disposed in parallel planes and may consist of iron. The core 22 may but need not consist of paramagnetic material; if it does not, its peripheral surface may be slidably guided in the registering apertures of the stops 20, 21. That portion of the core 22 which is located between the stops 20, 21 carries an abutment member including a diamagnetic sleeve 22*a* surrounded by and connected to an annulus 23 received between an inner cylinder 25 and an outer cylinder 24. The cylinder 25 surrounds the sleeve 22*a*. The annulus 23 is a radially magnetized permanent magnet and is shorter than the cylinders 24, 25 so that the end portions of these cylinders extend beyond its end faces. The resulting annular recesses at both axial ends of the annulus 23 are filled in by rings 23*a*, 23*b* of diamagnetic material. The sleeve 22*a* and the rings 23*a*, 23*b* may consist of resin or the like.

In the end position of FIG. 3, the movable part 22–25 is attracted by the stop 20 which is stationary. However, if the core 22 is forced to move downwardly, the movable part will snap over to move the abutment member 22*a*–25 in engagement with the fixed stop 21 and then remains in such end position until the core is forced to move upwardly toward the end position of FIG. 3.

FIGS. 4 to 6 illustrate a fourth permanent magnet unit which comprises a block-shaped permanent magnet 26 of rectangular cross-sectional outline. Two parallel sides of the magnet 26 are adjacent to a pair of plate-like U-shaped stops 27 which consist of paramagnetic material and are located in parallel planes. As best shown in FIG. 6, each of these stops 27 comprises a pair of aligned stop arms 28, 29 which define between themselves a gap 29*a*. The gaps 29*a* are in transverse alignment with each other and accommodate portions of an abutment member 31 provided on a core 30 which is guided in fixed bearings 30*a*, 30*b*. It will be noted that the axis of the core 30 is parallel with one side of the permanent magnet 26 and that this core is movable between two end positions in one of which the member 31 abuts against the arms 28 and in the other of which the member 31 abuts against the arms 29. Since the material of the abutment member 31 is paramagnetic, the circuit of the permanent magnet 26 is closed in each end position of the core 30 so that the core will tend to remain in the momentarily selected end position.

The first part 26–29 of the unit shown in FIGS. 4 to 6 resembles a U-shaped body which straddles the core 30. The core preferably consists of diamagnetic material.

FIG. 7 illustrates an electric snap switch which comprises a cylindrical housing 32 of insulating material. The median portion of the housing 32 accommodates a permanent magnet unit of the type shown in FIG. 1 comprising an annulus 33, two stops 34, 35 and a core 36 having an abutment member 37 located between the stops 34, 35. One end portion of the core 36 is connected with a guide 38 consisting of insulating material and provided with an elongated slot 39 of rectangular cross section, see FIG. 8. This slot 39 accommodates two elongated movable metallic carriers 40, 41 which are slidable in the axial direction of the core 36 and whose end portions extend laterally from the guide 38. The end portions of the carrier 40 are provided with domed contacts 42, 43 and the end portions of the carrier 41 have similar contacts 44, 45. Helical expansion springs 46, 47 operate between the end portions of the carriers 40, 41 to bias them toward the opposite ends of the slot 39. The contacts 42, 43 normally engage two fixed contacts 48, 49, and the contacts 44, 45 are normally spaced from two fixed contacts 50, 51. The fixed contacts 48–51 are embedded in a hardened mass 52 of insulating material which fills one end portion of the housing 32. The tips of the fixed contacts 48–51 extend from the mass 52 and constitute tongues which can be inserted into a socket.

The means for changing the axial position of the core 36 comprises a pushbutton 53 which is coaxial therewith and is slidable in a cylinder 53*a* closing the right-hand end portion of the housing 32. The pushbutton 53 is biased by a helical return spring 54 which operates between the stop 34 and a cupper spring retainer 54*a*, the latter normally abutting against a sealing diaphragm 54*b* which is clamped in the cylinder 53*a* and prevents entry of dust or moisture into the internal chamber of the housing 32. The pushbutton 53 includes a stem 53*b* which is attached to the median portion of the diaphragm 54*b*. When the pushbutton 53 is depressed to penetrate deeper into the cylinder 53*a*, the stem 53*b* deforms the diaphragm 54*b* and causes the retainer 54*a* to move in a direction to the left, as viewed in FIG. 7. The retainer 54*a* entrains a second spring retainer 55 which is slidable on the end portion of the core 36 and which then compresses a weak helical expansion spring 56 so that the

latter bears against a motion transmitting washer **56***a* and changes the axial position of the core **36** in order to move the abutment member **37** away from the stop **34** and toward the stop **35**.

In the first end position of the snap switch which is illustrated in FIG. 7, the springs **54**, **56** are free to expand and the member **37** abuts against the stop **34** whereby the movable contacts **42**, **43** abut against the fixed contacts **48**, **49** but the contacts **44**, **45** remain spaced from the fixed contacts **50**, **51**. The carrier **41** abuts against the wall at the left-hand end of the slot **39** because it is biased by the springs **46**, **47** which at the same time keep the contacts **42**, **43** in engagement with the contacts **48**, **49**.

In order to close the circuit of the fixed contacts **50**, **51**, the user depresses the pushbutton **53** against the bias of the spring **54**. When the pushbutton covers a certain distance, the spring retainer **55** compresses the spring **56** and overcomes the magnetic attraction between the stop **34** and abutment member **37** so that the core **36** begins to move in a direction to the left and snaps over to the other end position on account of the compression of the spring **56**. The movable contacts **44**, **45** now engage the fixed contacts **50**, **51** and the contacts **42**, **43** move away from the contacts **48**, **49**. The springs **46**, **47** then bias the carrier **40** against the right-hand end wall of the slot **39** in the guide **38**.

The bias of the spring **54** is such that the core **36** automatically returns to the end position of FIG. 7 as soon as the pushbutton **53** is released. This means that the circuit of the contacts **50**, **51** remains completed only as long as the pushbutton **53** is depressed by a finger or by a trip.

In some instances, the permanent magnet **10**, **23**, **26** or **33** may be replaced by an electromagnet. All that counts is to provide a body which will insure that the movable contacts are attracted to the corresponding fixed contacts by a magnetic force which reaches a maximum value when the core **13**, **17**, **22**, **30** or **36** assumes one of its end positions and that this core snaps over to the other end position as soon as it moves away from the one end position.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of our contribution to the art and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

**1.** A permanent magnet unit, particularly for use in electric snap switches, comprising a first part including an annular axially magnetized permanent magnet, and a pair of annular stops consisting of paramagnetic material and each adjacent to one axial end of said permanent magnet; and a seuond part comprising an elongated core consisting of paramagnetic material and having an abutment member located intermediate said stops, said core being movable between two end positions in each of which said member abuts against one of said stops, said parts defining a closed magnetic circuit for said permanent magnet in each end position of said core.

**2.** A permanent magnet unit as set forth in claim **1**, wherein said core is in sliding contact with said stops and further comprising a pair of diamagnetic sleeves recessed into said core at the opposite axial ends of said abutment member, one of said sleeves being arranged to insulate said core from one of said stops when the core is in direct contact with the other stop and vice versa.

**3.** A permanent magnet unit, particularly for use in electric snap switches, comprising a first part including an annular axially magnetized permanent magnet and a pair



of annular stops consisting of paramagnetic matreial and each located at one axial end of said permanent magnet; and a second part comprising an elongated paramagnetic core extending with clearance through said first part, a first paramagnetic abutment member located between said stops, and a pair of additional paramagnetic abutment members each outwardly adjacent to one of said stops, said core being movable between two end positions in each of which said first member abuts against one of said stops and one of said additional members abuts against the other stop whereby the stops and said second part define a closed magnetic circuit for said permanent magnet in each end position of said core.

**4.** A permanent magnet unit, particularly for use in electric snap switches, comprising a first part including a pair of spaced annular stops consisting of paramagnetic material; and a second part including a core reciprocably extending through said stops, a radially magnetized annular permanent magnet disposed intermediate said stops and surrounding said core, a first paramagnetic sleeve surrounding said permanent magnet, and a second paramagnetic sleeve surrounded by said permanent magnet and surrounding said core, said sleeves having end portions extending beyond the axial ends of said permanent magnet and said core being rigid with said second sleeve and being movable between two end positions in each of which said sleeves abut against one of said stops to complete a closed magnetic circuit for said permanent magnet.

**5.** A permanent magnet unit as set forth in claim **4**, wherein said second part further comprises an annulus of diamagnetic material connecting said core with said second sleeve and rings of diamagnetic material provided at the axial ends of said permanent magnet between the respective end portions of said sleeves.

**6.** A permanent magnet unit as set forth in claim **5**, wherein said core is a rod consisting of paramagnetic material and wherein said stops are provided with registering apertures through which said rod extends with at least some clearance.

**7.** A permanent magnet unit, particularly for use in electric snap switches, comprising a first part including a pair of spaced parallel plate-like stops consisting of paramagnetic material and a permanent magnet of rectangular outline disposed between and having poles adjacent to said stops, each of said stops having a pair of spaced but aligned arms defining between themselves a gap; and a second part including an elongated core having an abutment member consisting of paramagnetic material and extending into said gaps, said core being movable axially between two end positions in each of which said member abuts against one arm of each stop to complete a closed magnetic circuit for said permanent magnet.

**8.** A permanent magnet unit as set forth in claim **7**, wherein said core is parallel with one side of said parmanent magnet and wherein said first part resembles a U-shaped body which straddles said core.

**9.** A magnetic switch operating unit comprising a stationary part and a switch actuating part movable relative to said stationary part, said movable switch actuating part including a core and paramagnetic annular abutment means on said core, and said stationary part including an annular magnet having two annular paramagnetic stops surrounding said core, said paramagnetic stops cooperating with said paramagnetic abutment means for stopping said movable part in two end positions in which said abutment means abuts said stops, respectively so that the toroid magnetic flux produced by said magnet is closed through said core, said annular abutment means, and one of said annular stops, respectively, in said end positions whereby said movable part is held in either of said end positions.

**10.** A switch operating unit as claimed in claim **9**

wherein said abutment means is a fixed flange on said core; wherein said annular magnet surrounds said core and said abutment means spaced from the same; and wherein said stops are annular paramagnetic discs secured to the ends of said annular magnet surrounding said core and being located on opposite sides of said abutment means so that the same abuts said discs, respectively, in said end positions.

11. A switch operating unit as claimed in claim 10 wherein said abutment means is an abutment flange fixed to said core and located between said annular stop discs.

12. A switch operating unit as claimed in claim 11 wherein said abutment means include a pair of paramagnetic flanges secured to said core outwardly of said annular stop discs and respectively abutting the same in said end positions.



13. A switch operating unit as claimed in claim 10 wherein said annular magnet is magnetized in axial direction so that said annular discs form pole shoes.

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