Dec. 3, 1968 R. L. MARTIN 3,414,852

MAGNETIC LATCHING RELAY

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Fig. 2

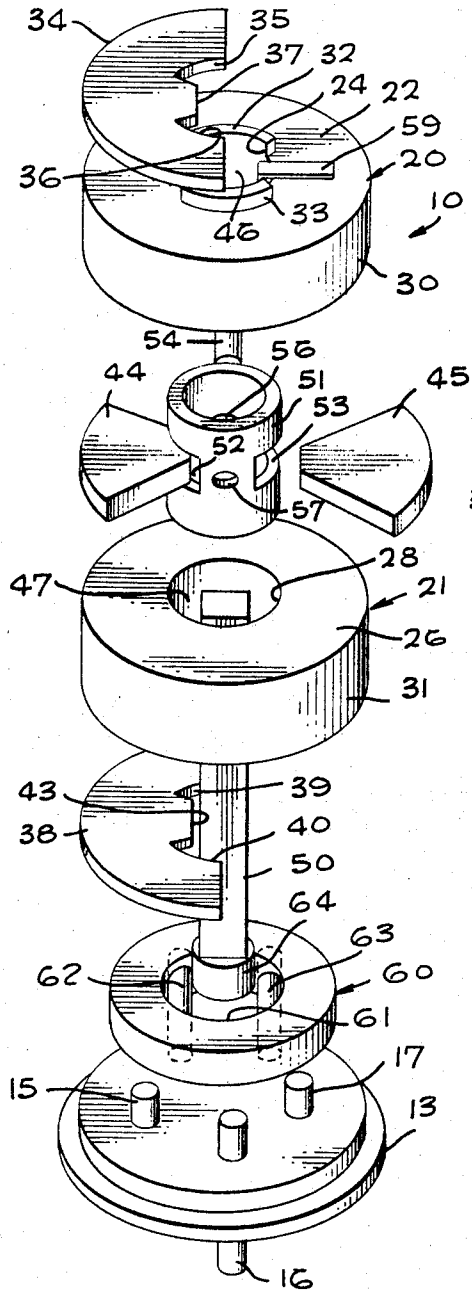


Fig. 1

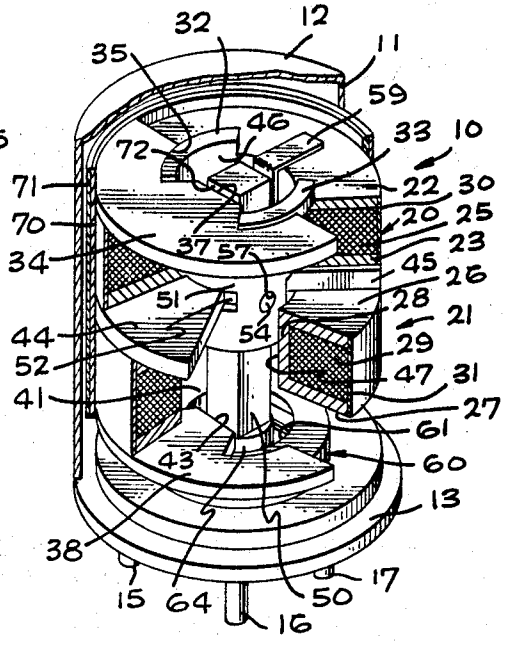
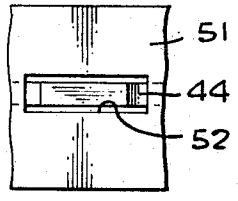


Fig. 8



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Fig. 3

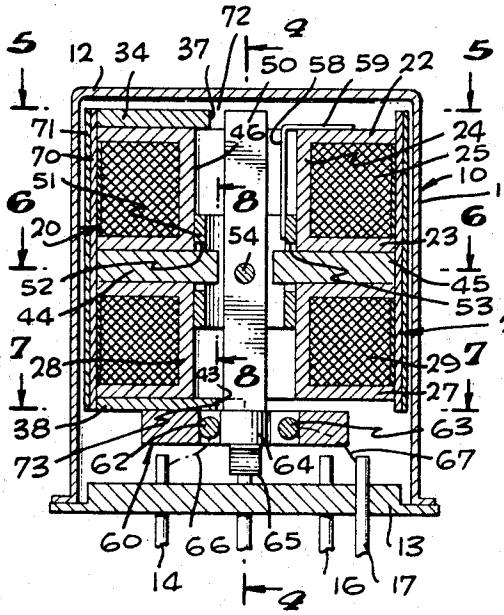


Fig. 4

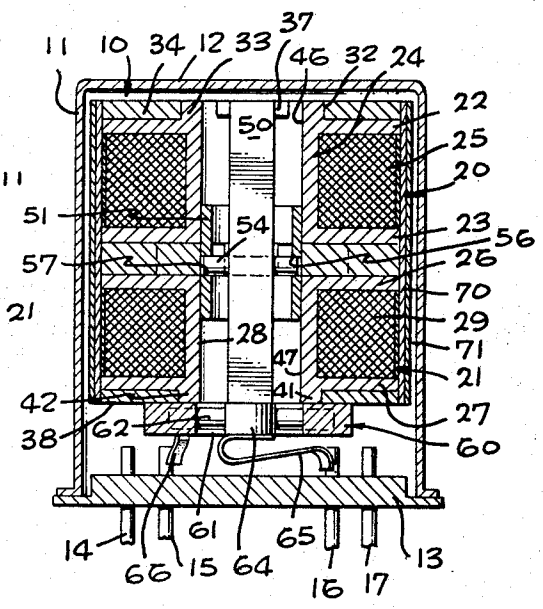


Fig. 5

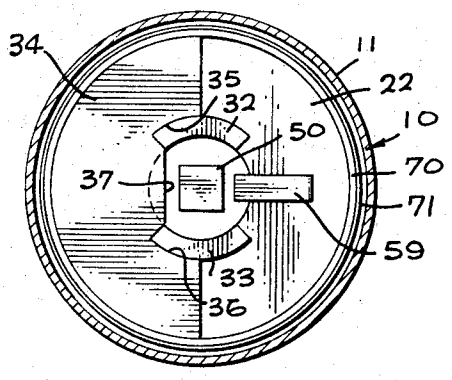
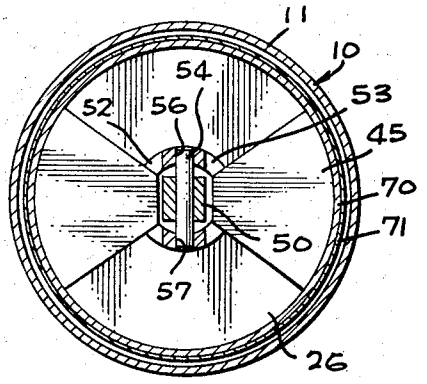


Fig. 6



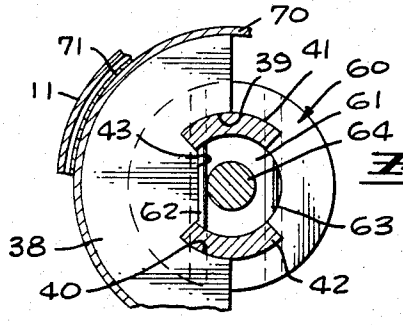


Fig. 7

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United States Patent Office 3,414,852
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3,414,852

MAGNETIC LATCHING RELAY

Robert L. Martin, La Canada, Calif., assignor to Consolidated Electronics Industries Corp., New York, N.Y., a corporation of Delaware

Continuation-in-part of application Ser. No. 513,908, Dec. 13, 1965. This application Apr. 27, 1967, Ser. No. 634,144

7 Claims. (Cl. 335—170)

ABSTRACT OF THE DISCLOSURE

A bi-stable, switching device that is capable of alternately positioning a movable contact against one or another of two fixed contacts. Motion of the movable contact is controlled by energizing one or another of two coils with direct current to position the movable contact against the fixed contact which cooperates with the energized coil, while the other coil remains de-energized. When the movable contact has completed its movement to the fixed contact the coil is de-energized and the movable contact will remain held or latched in the position referred to by the magnetic field induced by the permanent magnet elements where the air gap between the magnet and the movable contact is the smaller. When the latching is to be released, the other coil is energized. This will create a magnetic field stronger than the field created by the permanent magnet and the movable contact will shift to the opposite fixed contact.

The design of micro-miniature equipment has advanced very remarkably in recent years with the calls upon it placed by missile and space vehicle demands. Although technology has evolved many successful micro-miniature relays and switches with acceptable performance characteristics there continue to be other problems to be overcome. One of these is complexity of assemblies which increases the prospect of devices getting out of order. Another is high cost of devices which, especially when somewhat complex, require a considerable amount of careful assembly and adjustment to operate dependably. Other shortcomings include a lack of desirable life span and insufficient degree of precision especially when working with tolerances which need to be measured in a few thousandths of an inch, and frequently less.

Applicant's copending application Ser. No. 513,908, filed Dec. 13, 1965, now Patent No. 3,335,376, of which this is a continuation-in-part, discloses a satisfactory structure suitable for micro-miniature use wherein a dependable procedure is revealed making it possible to construct a switching arrangement with stationary or fixed contacts anchored in position by the initial tooling operation and which makes use of an axially located tiltably mounted armature positively constructed to extremely low tolerances and adapted to operate between the two fixed contacts.

Another of applicant's copending applications Ser. No. 633,289 filed Apr. 24, 1967, discloses a very acceptable method for assembling devices of the character disclosed by appropriate tooling so that no subsequent adjustment is either necessary or possible.

It is among the objects of the invention herein disclosed to provide a new and improved magnetic latching relay of comparable construction readily adapted to subminiature proportions and wherein a movable armature is independent of spring action for its operation.

Another object of the invention is to provide a new and improved magnetic latching relay which makes use of magnetic fields set up by permanent magnets as a latching medium for holding a movable armature in one position or another.

Still another object of the invention is to provide a new and improved magnetic latching relay making use of permanent magnets for the latching operation which employs a relative minimum number of moving parts, which is simple in construction thereby lending itself to a very simple assembly procedure made possible by simple and inexpensive tooling, which is easily varied in size and proportion to meet different demands, capabilities, current load, etc., which is of inexpensive construction and which can be produced from relatively inexpensive materials.

With these and other objects in view, the invention consists of the construction, arrangement, and combination of the various parts of the device, whereby the objects contemplated are attained, as hereinafter set forth, pointed out in the appended claims and illustrated in the accompanying drawings.

In these drawings:

FIGURE 1 is a side perspective view of the device abundantly broken away to show the relationship of the various parts;

FIGURE 2 is an exploded perspective view to better reveal the form, size and relationship of parts;

FIGURE 3 is a longitudinal sectional view through the device showing the armature in a position such that the movable contact is in engagement with one of the fixed contacts;

FIGURE 4 is a longitudinal sectional view on the line 4—4 of FIGURE 3;

FIGURE 5 is a cross-sectional view on the line 5—5 of FIGURE 3;

FIGURE 6 is a cross-sectional view on the line 6—6 of FIGURE 3;

FIGURE 7 is a fragmentary cross-sectional view on the line 7—7 of FIGURE 3; and

FIGURE 8 is a fragmentary longitudinal sectional view on the line 8—8 of FIGURE 3.

In an embodiment of the invention which has been chosen primarily for the purpose of illustrating the principle involved herein there is shown a magnetic latching relay consisting in the main of an operating assembly indicated generally by the reference character **10** lodged within a substantially cylindrical housing **11** having one closed end **12** and having at the opposite end a header **13**. The header serves as a support for a series of pins or soldering posts some of which are shown in FIGURES 1, 2, 3 and 4 identified by the reference characters **14**, **15**, **16**, and **17**. In the device here under consideration two separate coil members **20** and **21** are disclosed each constructed in substantially the same fashion. The coil member **20** consists of opposite annular discs **22** and **23** interconnected by a sleeve **24**, and within which is wound a substantially conventional coil **25**. The coil member **21** is similarly constructed of spaced annular discs **26** and **27** interconnected by means of a sleeve **28** and housing a coil **29**. Appropriate wrappings **30** and **31** surround the coils.

At the inner end of the housing **11** the sleeve **24** projects slightly to form opposite spaced arcuate segments **32** and **33** which serve to position a somewhat arcuate semicircular magnetic plate **34**. There are recesses **35** and **36** which receive respectively the segments **32** and **33** and intermediate the recesses is a pole face **37**.

At the opposite or outer end of the housing **11** is a similar substantially arcuate semicircular magnetic plate **38** comprehending recesses **39** and **40** which receive respective segments **41** and **42** which are extensions of the sleeve **28**. Here also there is a pole face **43** spanning the distance between the two recesses **39** and **40**.

Intermediate the coil members **20** and **21** is a pair of magnetic sectors **44** and **45** which comprise a permanent

magnet member. The magnetic plates **34** and **38** are soft iron magnetic material.

Within the sleeve **24** is a passage **46** which is in axial alignment with a similar passage **47** through the sleeve **28**. For mounting an armature **50** in the combined passages **46**, **47**, there is provided a bushing **51** in which lateral openings **52** and **53**, which admit inner ends of the respective magnetic sectors **44** and **45**, are clearly shown in FIGURES 1, 2, 3 and 6. The armature **50** is pivotedly mounted upon the bushing **51** by means of a pivot pin **54** which rotates in holes **56** and **57**. A positioning strap **58** fastened to the bushing **51** has an end **59** which overlies the disc **22** at the inner end of the housing thereby to hold the bushing in proper position, and accordingly properly position and mount the armature **50**, so that it can reciprocate laterally within the passages **46** and **47**.

A stationary support indicated generally by the reference character **60**, of appropriate dielectric material, is secured in a position adjacent the header **13** by mounting it as shown on the outside face of the magnetic plate **38**. The stationary support **60** is annular in shape as readily appears in FIGURE 2 and is provided with a central opening **61** of ample diameter. Fixed contacts **62** and **63** are anchored in the stationary support **60** in positions extending into the central opening **61**. In the embodiment shown the fixed contacts are substantially cylindrical rods which are embedded initially in position by use of an appropriate fixture which provides a precise spacing between adjacent edges of the contacts. A movable contact **64** is provided on the outer end of the armature **50**, preferably coined to give it a precise dimension and more particularly a precise transverse size measured in the direction between the fixed contacts **62** and **63**, as best seen in FIGURE 3. A flexible pigtail **65** connects the movable contact **64** with one of the pins **16**. Similar pigtails **66** and **67**, suggested schematically in FIGURE 3, connect the movable contacts **62** and **63** with respective pins **15** and **17**. Other pins are provided for attachment of opposite ends of wires from the coils **20** and **21**, not shown in the interest of clarity.

To complete the structure of the operating assembly **10**, there is provided a magnetic sleeve **70** which surrounds the exterior of both of the coil members **20** and **21** and which also overlies outside edges of the magnetic plates **34** and **38** and also the outside edges of the magnetic sectors **44** and **45**. The magnetic sleeve accordingly completes the magnetic paths for the permanent magnet elements and also assists in holding the coil members and related parts in a compact unitary operating assembly. An insulating jacket **71** extends over the entire exterior of the magnetic sleeve.

In operation the permanent magnet elements serve to induce continuous magnetic fields through two closed loop magnetic paths. One path consists of the inner magnetic plate **34**, the adjacent portion of the magnetic sleeve **70**, the magnetic sectors **44** and **45** and the adjacent portion of the armature **50**. The other magnetic path is formed by the outer magnetic plate **38**, the adjacent portion of the magnetic sleeve **70**, the magnetic sectors **44** and **45** and the adjacent portion of the armature **50**. The armature **50** is thus simultaneously attracted to both magnetic plates by magnetic forces of intensities inversely proportioned to air gap distances of respective air gaps **72** and **73**. In the position of adjustment of FIGURE 3 it will be noted that the air gap **72** is larger than the air gap **73**. When the armature **50** has been actuated by energizing the coil **29** the movable contact **64** will be pivoted or swung to a position of engagement with the fixed contact **62** as shown in FIGURES 3 and 7, because the intensity of the magnetic field created by excitation of the coil **29** is substantially greater than any magnetic field generated by the permanent magnetic loops. In this position, however, the attraction of the magnetic plate **38** will be greater than the attraction of the magnetic plate **34** so that when the coil **29** is de-energized the armature **50** will be held or latched in position against the fixed contact **62**.

After the armature has been latched as just described should the coil **25** be energized, the magnetic field thus created will be sufficiently great to overcome the magnetic attraction of the permanent magnetic loops and will cause the armature **50** to pivot counterclockwise in an opposite direction until the movable contact **64** is pulled into engagement with the fixed contact **63**. When this happens the size of the air gaps **72** and **73** will be reversed, the air gap **72** becoming smaller and the air gap **73** becoming larger. Consequently when the coil **25** is de-energized the movable contact **64** will be held or latched in a position of engagement with the fixed contact **63** by reason of the greater attraction of the magnetic loop formed by the magnetic plate **34** in contrast with the weaker magnetic loop of the magnetic plate **38**. This position of course can be immediately changed by re-energizing the coil **29** which will reciprocate motion of the armature **50** and again draw the movable contact **64** into engagement with the fixed contact **62**. The relay may be repeatedly cycled in the manner described by alternately and individually energizing and de-energizing the coils **25** and **29** with direct current.

While the invention has herein been shown and described in what is conceived to be the most practical and preferred embodiment, it is recognized that departures may be made therefrom within the scope of the invention, which is to be accorded the full scope of the claims so as to embrace any and all equivalent devices.

Having described the invention, what is claimed as new in support of Letters Patent is:

1. A magnetic latching relay for an electric circuit comprising an operating assembly having opposite ends, a coil form including a plurality of longitudinally spaced coils located between opposite ends, a permanent magnet member located between said coils, and a magnetic plate on the outer side of each coil, a stationary support in said assembly adjacent one end and a pair of transversely spaced fixed contacts mounted on said support, said coil form having an open axial passage therethrough, an armature in said passage mounted for reciprocating movement in said assembly, whereby opposite ends of said armature are adapted to change their respective positions, one end of said armature having a movable contact located intermediate said fixed contacts, said movable contact when in engagement with one of said fixed contacts upon energization of one of said coils forming air gaps of different distances between opposite ends of said armature and the respective magnetic plates, said different distances being reversed in relative magnitude when the movable contact is in engagement with the other fixed contact upon de-energization of said one coil and energization of the other coil, whereby when one of the coils has been energized the armature is shifted to a corresponding position and latched temporarily by permanent magnetic attraction in said last position after the coil is de-energized.

2. A magnetic latching relay as in claim **1** wherein there is a magnetic sleeve surrounding said coils, said magnetic plate and said permanent magnetic member which completes the magnetic path.

3. A magnetic latching relay as in claim **1** wherein the fixed contacts are anchored in non-adjustable position in said support and the armature is free of engagement with the magnetic plate in all positions of the armature.

4. A magnetic latching relay as in claim **1** wherein the magnetic plates are substantially arcuate in form and have each a central open area surrounding the respective end of the armature.

5. A magnetic latching relay as in claim **1** wherein the permanent magnet member comprises a pair of substantially sector shaped relatively flat elements spaced opposite each other on respectively opposite sides of said passage.

6. A magnetic latching relay as in claim **1** wherein a bushing provides a carrier for said pivotal mounting of

the armature, said bushing being shorter than said passage and having portions on opposite sides of said permanent magnet member engaging said coil form within said passage.

7. A magnetic latching relay as in claim 1 wherein there is a housing surrounding said assembly and a header at one end of the assembly having electric contact posts thereon connected to said respective movable and fixed contacts.

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