Feb. 2, 1960

H. E. CORBITT ET AL

SEALED POLARIZED RELAY

2,923,791

Filed Nov. 29, 1956

2 Sheets-Sheet 1

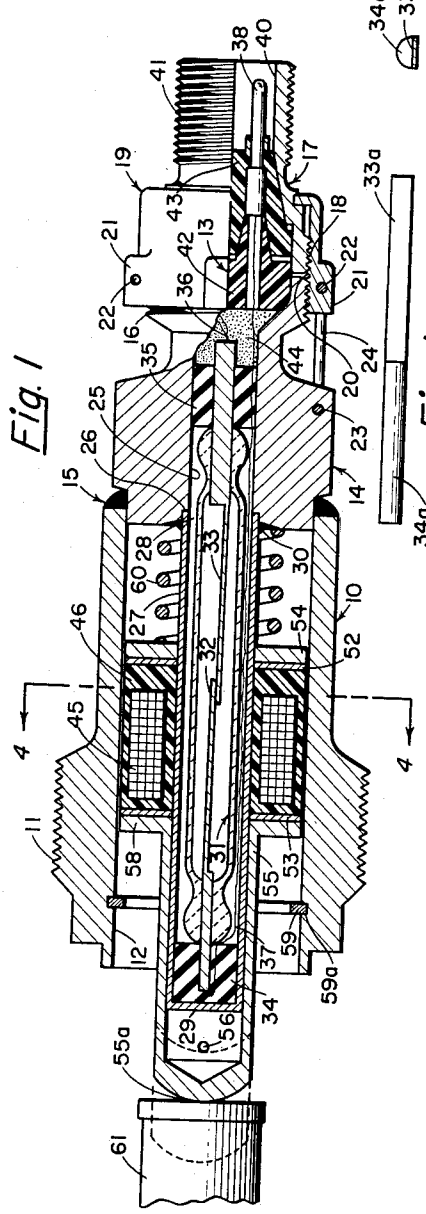


Fig. 1

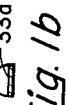


Fig. 1b



Fig. 1c



Fig. 1a

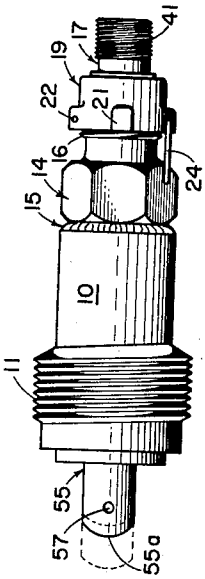


Fig. 2

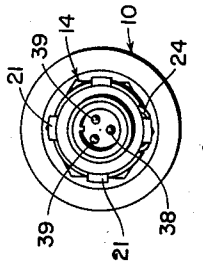


Fig. 3

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2 Sheets-Sheet 2

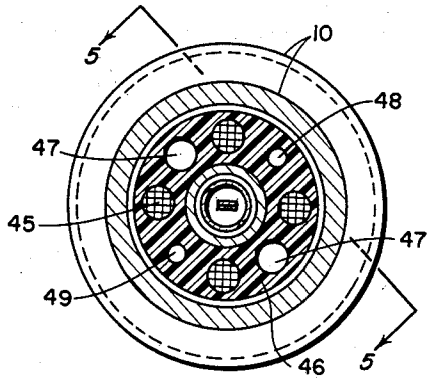


Fig. 4

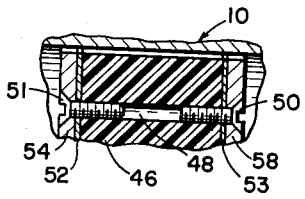


Fig. 5

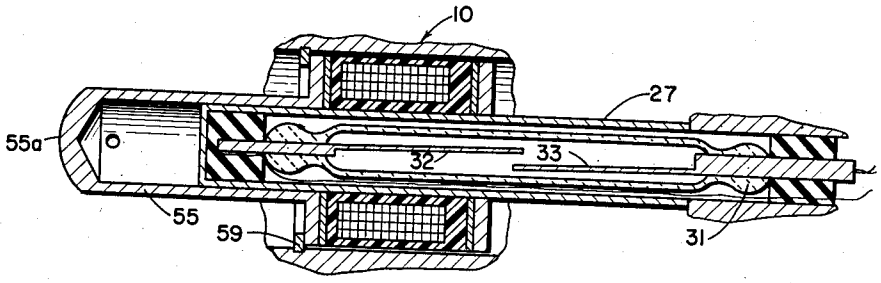


Fig. 6

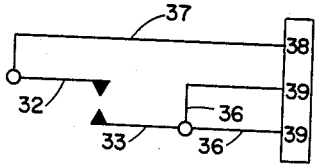


Fig. 7

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SEALED POLARIZED RELAY

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Application November 29, 1956, Serial No. 625,061

6 Claims. (Cl. 200—87)

This invention relates to electrical switches and more particularly to magnetically-operated switches.

An object of this invention is to provide a switch of this type wherein the switch contacts are protected from liquids or gases which might have a deleterious effect.

The invention is carried out by provision of resilient permeable switch contact elements within an enclosed envelope which is placed in operating relation with magnets in a magnetic circuit.

A feature of the invention resides in means for moving the magnets in relation to the permeable switch elements, in response to a pressure or force which is to actuate the switch.

In a preferred arrangement the magnets are moved along the outside of the envelope containing the switch elements.

The foregoing and other features of the invention will be better understood from the following detailed description and the accompanying drawings, of which:

Fig. 1 is an enlarged view partly in cross section of a switch according to this invention, shown in its actuated position;

Fig. 1*a* is a top view of an element used in the switch of Fig. 1;

Fig. 1*b* is an end view of the element of Fig. 1*a*;

Fig. 1*c* is an enlarged top view of fragments of a pair of elements according to Figs. 1*a* and 1*b*, as used in the switch of Fig. 1;

Fig. 2 is a side view of the switch of Fig. 1, shown true size;

Fig. 3 is an end view of the switch of Fig. 1 and Fig. 2;

Fig. 4 is a cross-section view taken at line 4—4 of Fig. 1;

Fig. 5 is a cross-section view of a fragment taken at line 5—5 in Fig. 4;

Fig. 6 is a fragmentary side view in cross section of parts in Fig. 1 showing the related position of parts when the switch of Fig. 1 is unactuated; and

Fig. 7 is a schematic wiring diagram for the switch of Figs. 1 to 7.

In Figs. 1 and 2 there is shown an assembled switch having a body **10** which is adapted to be attached within a threaded hole in a chamber subjected to pressure, by means of exterior threads **11** on the body **10**. The body is hollow, having an internal area **12** which is concentric around the center line **13** of the assembled switch. A housing **14** fits on one end into the unthreaded end of the body and is welded at **15** to the body **10**. The housing **14** has exterior threads **16** on the other end. A connector cap **17** of the same diameter as the threaded end of the housing also has exterior threads **18** of the same size as the housing threads. A connector **19** attaches the connector cap to the housing by means of internal connector threads **20**. The connector is provided with a number of connector lugs **21** each having a wire hole **22**. The housing **14** also has a wire hole **23**. The connector **19** may be tightened down and held in place by a lock wire **24** which goes through the housing wire hole **23** and the

nearest lug wire hole **22**. The housing **14** has an internal chamber **25** which is concentric around the center line **13** of the assembled switch. The housing end within the body is drilled and countersunk at **26** concentric around the center line **13**. A non-magnetic tube **27**, which may be of metal, having an open end **28** and a closed end **29** is attached to the housing by inserting the open end **28** into the drilled and countersunk body portion **26** and welding the two together at **30** in the countersunk portion.

Within the tube **27** and the housing chamber **25** there is mounted an electric switch which is enclosed in a sealed insulating tube **31** which may be of glass or the like, and is preferably evacuated of air or gas. The switch is of a type available commercially such as is obtainable from the Revere Corp. of America. The switch has two cantilever electrically contacting elements **32** and **33** shown separately in Figs. 1*a* and 1*b*, each sealed through one of the ends of the tube **31**. These elements each have a resilient flat portion **33***a* at the right (in Fig. 1*a*) and a substantially rigid mounting portion **34***a* of semi-circular cross section at the left (in Fig. 1*a*). The portion **34***a* is part of the element which is sealed through the tube. Flat portion **33***a* bends easily when it is affected by magnetic forces. The cantilever strips are of high magnetic permeability and low retentivity and each extends from its respective end of the tube to a position just beyond the tube center, so that the free ends of the strips overlap. The strips **32** and **33**, as shown in Fig. 1*c*, each have a wide surface of their rectangular cross section directed toward one another so that when they bend at their resilient portions the flat surfaces directed toward each other will move toward or away from the opposite facing flat surface of the other strip.

The overlapping ends of the strips located near the tube center are preferably gold plated so that they give good electrical contact with each other even after repeated use. The ends of the cantilever strips sealed through the evacuated tube **31**, protrude to some extent outside the tube. The protruding portion of strip **32** within the closed end **29** of the tube **27** is embedded in a shock-absorbing mount **34** of rubber or similar material. The protruding portion of the cantilever strip **33** extends centrally into the housing chamber **25** where it is centrally supported by a similar mount **35**. A part of cantilever strip **33** extends beyond the mount **35** and has attached to it a pair of lead wires **36**. A similar lead wire **37** extends from the protruding end of cantilever strip **32** along the outside of the glass tube through the housing chamber **25** and connects to a prong **38**.

A wiring diagram is shown in Fig. 7 having switch contacts **33** and **32**, wiring **36** and **37** and prongs **38** and **39** identified by like numbers as in Fig. 1. Lead wires **36** connect to a pair of prongs **39** which are shown in the end view in Fig. 3 but are not shown in Fig. 1. The prong **38** and the prongs **39** are located in a hollow prong chamber **40**. There are three prongs so that connection may be made to a three-prong plug, although a three-prong plug is not essential to the invention. The outside of the connector cap is provided with threads at **41** which may be used if desired to receive an internally threaded cap or the like which may fit over a prong receptacle so that tight electrical contact may be maintained when a connection is made to the prongs. The prongs are attached to a prong base **42** which should be of non-conductive material. Each prong is attached to the base **42** by a cone-shaped portion of the base. A non-conductive prong cap **43** fits over the three cone-shaped portions of the prong base and keeps the prongs positioned from one another. The prong base **42** and prong cap **43** are shaped to fit the internal surfaces of the housing **14** and the connector cap **17** respectively so that the assembly may be tightened. An adhesive **44** fills portions of the housing chamber **25**

between the switch mount **35** and the prong base **42** so that the lead wires are insulated from one another.

An assembly of permanent magnets **45** are surrounded by a solid molding compound which is formed into a cylinder **46**. There are shown four such magnets, although it will be understod that some other number could be used. The four permanent type magnets **45** are of similar shape, lie longitudinally in the cylinder **46** and are concentrically located around the assembly axis **13** with all of their like poles facing in the same direction. The magnet assembly comprises the magnets **45**, the moulded cylinder **46**, two washers **52** and **53** located on each end of the cylinder **46**, an inner washer **54** and a hollow plunger **55**. The plunger **55** slides over the closed end **29** of the tube **27**. The outer end of the plunger **55** has a contact surface **55***a* by which the plunger may be pushed forward into the body **10** and around the tube **27**. The outer end of the plunger is provided with two vent holes **56** and **57**, one of which is shown in Fig. 1 and the other is shown in Fig. 2. The plunger inner end, which extends into the body **10**, has a flanged base **58** which is of the same diameter as the washers **52**, **53** and **54** and the cylinder **46**. The five members **58**, **52**, **53**, **54** and **46**, which have the same diameter, are shown adjacent to one another in Fig. 5. Each of these parts is provided with aligned tapped holes **48** and **49** and the aligned pair of vent holes **47** shown in Fig. 4. The pair of vent holes **47** in the various parts are kept aligned by the screws **50** and **51** inserted from opposite ends in tapped hole **48**, as shown in Fig. 5, and two similar screws which are located in tapped hole **49** but are not here shown in any view. The four screws in the two tapped holes **48** and **49** not only align the vent holes **47** but they also make a single connected unit of the members **58**, **52**, **53**, **54** and **46** which shall be referred to as the magnet assembly. The magnet assembly is shown in Fig. 4 where the vent holes **47** through the molding compound and the tapped holes **48** and **49** are shown. The screws are inserted in the tapped holes to align the vent holes **47** in the various parts of the magnet assembly.

Located to the right of the magnet assembly and adjacent to it, is a coil spring **60** which pushes against the magnet assembly by contact on the washer **54**. A snap ring **59** in a groove **59***a*, within the hollow area **12** of the body **10**, limits outward movement of the magnet assembly when the plunger flange **58** contacts the snap ring **59**. The snap ring **59** is a split ring which may be inserted in the groove **59***a* through spaces smaller than the groove due to the contractability at its split portion. The plunger flange **58**, which is positioned by the snap ring **59** and the spring **60** is normally kept in contact with the snap ring by means of the spring **60** which is located between the end of the housing **14** and the washer **54**.

To use the switch, it is threaded by threads **11** into the wall of the chamber or tank which is to operate it. Such a chamber, for example, may be a propellant tank for a rocket; although it will be understood that the switch is not limited to such use. If the chamber or tank contain acid, such as is frequently the case in a propellant tank, the metal parts of the switch which are in contact with fluids in the chamber interior may be of an acid-resistant metal and the molded cylinder **46** may be of a non-metallic acid-resistant compound such as the commercial products Kel-F or Teflon, which are resistant to acid or its equivalent. Electrical connection is made to the switch at the prongs **38** and **39**.

In the normal unactuated switch position, the magnets are withdrawn to the left from the position around the vicinity of the gold-plated ends of the contacts **32** and **33**, as shown in Fig. 6. This is the normal unactuated position in which the magnet assembly plunger **58** is kept in contact with snap ring **59** by compression spring **60** (see Fig. 1). The righthand end of the magnets are of the same polarity, for example north poles, and in the unactuated position of a switch, shown in Fig. 6, the strips **32** and **33** of high permeability and low retentivity will then have north poles induced in their ends by the concentrically located magnets. The like polarity is induced in the two strips because magnetic lines of flux tend to take the path through the strips which are of a high permeability. With the strip contact ends largely removed from between the concentric magnets the resilient portions of each strip bend away from one another causing the strip contact ends of like polarity to separate since they repel one another.

The switch can be operated by mechanical pressure of a piston **61** or float, or the like, in the tank or chamber; which moves in response to the quantity or condition of fluid in the chamber. The piston **61** contacts the plunger contact surfaces **55***a* and pushes the plunger **55** and the concentric magnet assembly of which it is a part, longitudinally toward the spring **60** along the tube **27** on all sides of the tube. The plunger flange **58** moves away from the limiting snap ring **59** and the compression spring on the opposite side of the magnet assembly is compressed between the washer **54** and the end of the housing **14**.

This actuated condition of the switch is shown in Fig. 1. The righthand ends of the permanent magnets are around the overlapping contact ends of strips **32** and **33** and in this position the magnetic flux paths concentrate themselves in the highly permeable strips. In Fig. 1, flux emanates from the righthand poles, for example, the north poles, of the permanent magnets and enters the strip **32** on its free contact end which makes its free contact end of south polarity. In the same position of the switch flux from the north polarity poles of the permanent magnets makes the attachment end of strip **33** a south pole and passes through the strip **33** to its free end which becomes of north polarity. The south polarity of the contact end of strip **32** and the north polarity of the contact end of strip **33** causes the contact ends to attract one another. The strips **32** and **33** bend toward one another along their resilient portions and the contact ends of strips **32** and **33** make electrical contact on their gold-plated ends to close the switch.

Removing mechanical pressure from contact surface **55***a* again causes the compression spring to expand and return the magnet assembly and therefore the switch contacts to their unactuated position as shown in Fig. 6.

The magnet assembly vent holes **47** permit equalizing of pressures on the two sides of the magnet assembly as the magnet assembly is moved either to the right or to the left. The magnet assembly movement is then affected only by the piston actuation and the compression spring and not in any way by unbalanced pressures.

The vent holes **56** and **57** in the plunger **55** also permit equalizing of pressure inside and outside the slidable plunger as it is moved.

The switch of the present invention has a number of advantages. It is completely self-contained and may be readily replaced by disconnecting electrical leads attached to its prong receptacle and turning its threaded body out of a chamber when the chamber is empty. The switch will not leak under pressure since the switch has internal areas between its parts which are pressure proof because the switch parts in correspondence with the pressure chamber are soldered or welded together. The switch assembly is rugged and can withstand the mechanical shock of a piston or the like, since the part hit by the piston in no way causes mechanical shock to the relatively delicate electrical switch contacts because there is only a magnetic energy linkage between mechanical and electrical parts. The electrical switch contacts are effectively sealed against fumes and liquid by its own construction and by being sealed in the tube. The parts not sealed from fumes and liquid are parts which can conveniently be composed of materials which are substantially acid resistant, such as the acid resistant molding compound of the magnet assembly cylinder. The shock resistant mounts of the vacuum tube type switch protect

the relatively delicate switch contacts from vibration and shock. The switch operates effectively over a wide temperature range, for example from —65° F. to +160° F.

The concentric arrangement of the permanent magnets provides a strong and uniform concentric field pattern which concentrates itself in the high permeability cantilever strips of the switch, and produces strong magnetic forces required to operate the switch contacts effectively with good electrical contact.

We do not desire that our invention be limited to the particular embodiment shown, but only in accordance with the scope of the following claims.

We claim:

1. An electric switch assembly comprising a tubular envelope having a longitudinal axis, switch contacts within said envelope, said switch contacts comprising electrically conducting flexible overlapping reeds of magnetic material adapted to contact each other, a hollow plunger having at least part of the envelope within it, means for sliding said plunger over said envelope in a direction colinear with said longitudinal axis, a plurality of permanent magnets, and means attached to the plunger holding said permanent magnets in spaced positions around the circumference of the envelope, whereby movement of the plunger moves the magnets in relation to the overlapped reeds to operate the switch.

2. An electric switch according to claim 1 in which a spring is arranged in relation to the plunger to urge it in one direction along said axis, and means is provided for moving the plunger against the force of said spring in the opposite direction along said axis.

3. An electric switch according to claim 2 in which the means attached to the plunger holding said permanent magnets comprises molding compound.

4. An electric switch assembly comprising a housing having a cylindrical portion closed at one end and open at its other end, a tubular envelope within said cylindrical portion and co-axial with the longitudinal axis thereof, switch contacts within said envelope, said contacts comprising electrically conducting flexible overlapping reeds of magnetic material adapted to contact each other, a tubular plunger fitted over the end of said envelope adjacent the open end of said housing, an annular means attached to said plunger and fitted between the inner cylindrical wall of said housing and the outer tubular wall of said envelope and slidable between said inner and outer walls in the direction of said longitudinal axis, and magnet means supported by said annular means, whereby movement of the plunger moves said magnet means in relation to the overlapping reeds to operate the switch.

5. An electric switch assembly according to claim 4 in which a compression spring placed between said annular means and the closed end of said housing urges the plunger in the direction away from said closed housing end, and a stop means is fastened to said housing at the opposite side of said annular means from said spring to limit the movement of said plunger.

6. A switch according to claim 4 in which vent means is placed in the end of the plunger remote from the annular means communicating from the atmosphere to the inside of the plunger and vent means is provided through the annular means communicating between the atmosphere and the region within the housing between the annular means and the closed end of the housing.

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