Sept. 15, 1970 W. P. GARDINER 3,529,269

MAGNETIC SWITCH

Filed Aug. 1, 1966

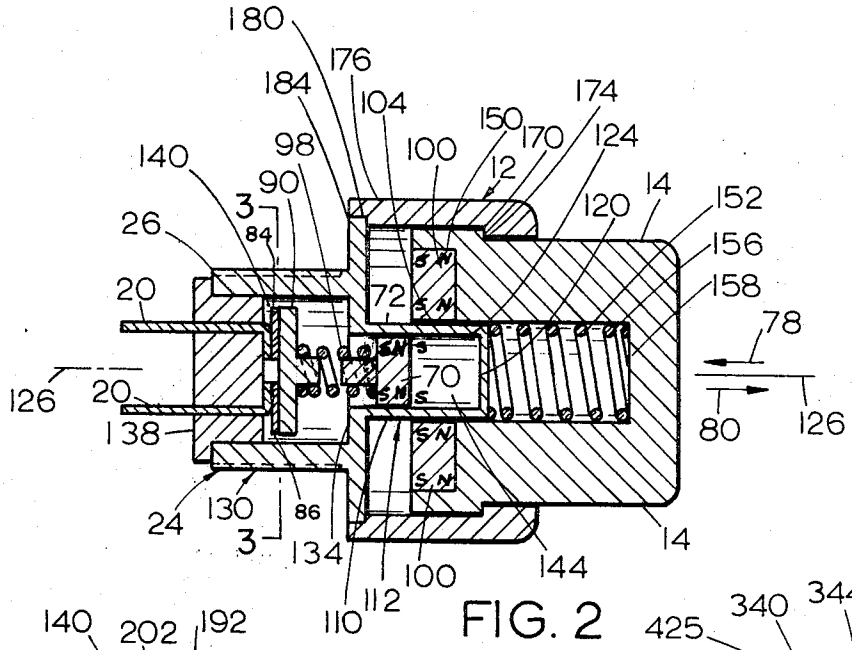


FIG. 2

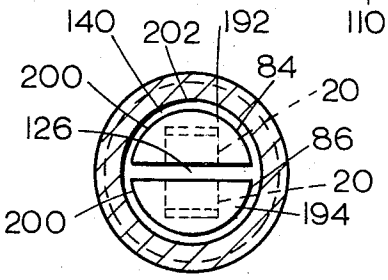


FIG. 3

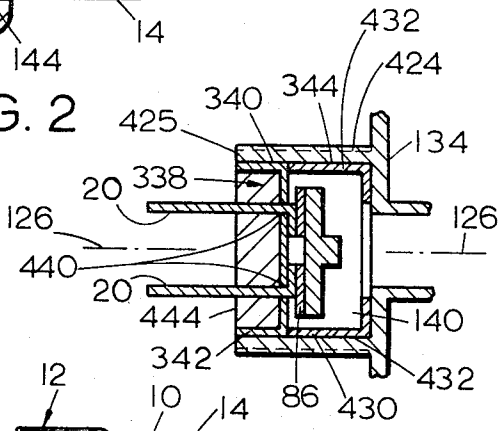


FIG. 5

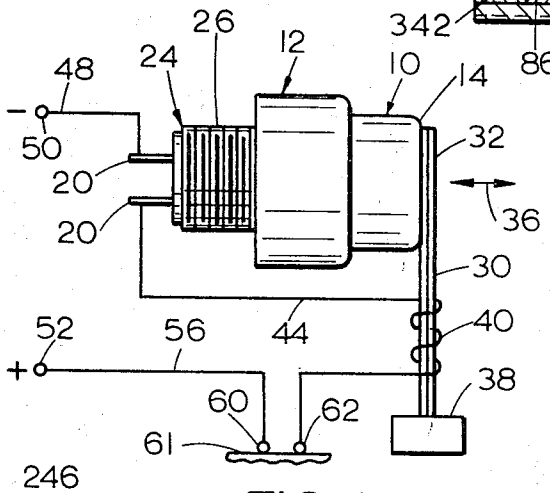


FIG. 1

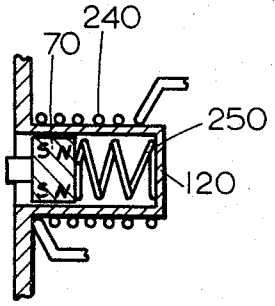


FIG. 6

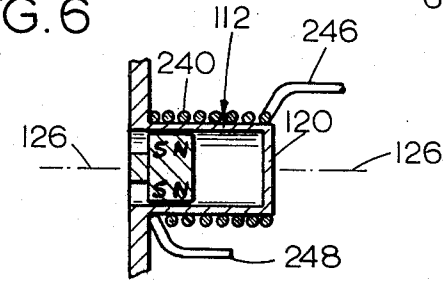


FIG. 4

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MAGNETIC SWITCH

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Int. Cl. H01h 9/22
U.S. Cl. 335—207 12 Claims

ABSTRACT OF THE DISCLOSURE

A panel mountable magnetic switch of the type having an inner magnet and contact area enclosed in a sealed housing with a magnet outside the housing controlling the magnet inside in which the housing has a threaded exterior at one end for insertion into a panel so that the leads are on one side of the panel and actuating means for the control of the outer magnet are on the outer side of the panel.

In the prior, art attempts have been made to construct a successful switch of this type, and of particular interest is the German patent to Zuckschwerdt, issued in December of 1962, Pat. No. 1,141,000. My experiments have shown that when a switch is constructed as in Zuckschwerdt with the inner magnet rigidly attached to the moving contact, then when the moving contact strikes the stationary contacts, the amount of bouncing is so great as to cause a very serious impairment in the effectiveness and life of the switch with each bounce of the switch. When the moving contact bounces, it is caused by magnetism to again strike the moving contacts and to bounce again. These motions are repeated causing many bouncings each of a lesser distance from the stationary contacts.

With each of these bouncings, there is both an opening and closing of the switch with accompanying arcing. Such a switch has a much shorter life. And its inability to close and remain substantially closed makes it impractical.

It is my belief that it is for this reason that switches of this type have not been successfully produced in the great commercial quantities that one would expect in view of the explosion-proof, dust-proof, and moisture-proof possibilities that such a sealed switch could give the world.

The U.S. Pat. No. 3,273,091, issued Sept. 13, 1966, to N. B. Wales, Jr. is titled, Hermetically-Sealed Manually-Actuated Magnetic Snap Switch. This Wales patent also shows the absence of means for preventing bouncing, as its moving magnet does not have a spring attached to it. Although FIG. 7 of the Wales patent shows leaf springs supporting contacts, these springs are not mounted on a reciprocating magnet and they are not stated in the Wales patent to be for the purpose of preventing bouncing.

The U.S. Pat. No. 3,025,372, issued Mar. 13, 1962 to Louis Benson, and titled, Reciprocating Type Actuating Means, shows in its FIG. 1 a reciprocating magnet to which moving contacts are attached by means of "resilient material such as foam rubber." The use of resilient material is stated in the Benson patent, column 2, lines 49–51, as being "optional expedients to be utilized if relatively noiseless operation is desired." It is evident from Benson's patent that this foam rubber was intended to be only for reducing noise and is not of a composition designed or intended for reducing bounce with its attendant arcing as in my invention.

Further in the Benson patent and in column 2, lines 57–59, it is stated: "The contact bridging plate may also take the form of a resilient member itself, in the form of a metallic spring, though not shown as such."

Presumably here again Benson had no appreciation of the problem of bouncing and intended to use a spring or resilient member in substitution for the foam rubber for the mere purpose of relative noiseless operation.

Additionally, the Benson mention of a metallic spring is stated in a form indicating that the metallic spring is used in substitution for the movable contact which he calls the contact bridging plate. This means that Benson did not have in mind placing a spring between a contact bridging plate itself and the magnet, as is a separate difference from the question of using a resilient spring to prevent bouncing.

An object of the invention is to provide a switch which can be manufactured in a practical form more economically than the switch described in my earlier co-pending patent application, Ser. No. 507,966, filed Nov. 15, 1965, entitled, Switch With Magnetically Controlled Inner Rotating and Reciprocating Elements, which is now Pat. No. 3,402,376, issued Sept. 17, 1968.

Still another object is to provide such a switch with the housing so structurally arranged that its threaded portion is on the same end as its leads and on the opposite end from its push-button whereby the switch can be mounted on a panel by emplacement into the panel from the forward side of the panel, so as to speed and simplify installation in equipment with crowded panels.

Still another object is to provide, in a switch as described, the feature of a spring between the moving contact and the inner magnet for minimizing bouncing upon contact closure.

Yet another object is to provide, in a switch as described, an arrangement of parts providing the switch with a more compact structure.

Still another object is to provide a relay in which a coil disposed on the outside of the enclosure can influence movement of an inner magnetically attracted element in each of two directions as current is reversed in the coil, with the inner element closing a switch.

A further object is to provide a relay as described in which the energizing of the coil moves the inner element in one direction and the de-energizing of the coil permits the inner element to be returned in an opposite direction by a spring.

A further object is to provide a thermostatically controlled switch in which a heating coil around a bimetallic element causes the bimetallic element to bend when the coil is energized, the bimetallic element actuating the plunger on the switch.

A further object is to provide a switch in which the contact leads are mounted in a cuplike member for gaining a perfection of alignment, and a still further object is to provide the switch with a wall lining element facilitating proper emplacement of the cuplike member, the wall lining element further insulating the contact area from a conductive housing.

SUMMARY OF THE INVENTION

An electrical switch of a type having a reciprocating inner magnet carrying a moving contact in which the contact is connected to the inner magnet by means of a spring having a resiliency selected for the purpose of reducing bouncing of the moving contact and the attendant arcing, the switch having an externally threaded housing portion on the same end as its leads to facilitate mounting from one side of a panel. The externally threaded housing portion forms a part of an enclosure having therein the contacts. An inner magnet receiving enclosure housing portion opens upon and forms an integral part of the externally threaded housing portion for leak-proof construction and for economy by eliminating the step of assembly that would be necessary if these two housing portions were

separate whereby it would be necessary to attach them together.

FIG. 1 shows a circuit breaker employing the switch of this invention.

FIG. 2 is a vertical section taken through the switch of FIG. 1.

FIG. 3 is a sectional view taken along the line 3—3 of FIG. 2.

FIG. 4 shows a modification of the right-hand portion of the switch of FIG. 2 in which the push-button and its retainer housing are replaced by a coil.

FIG. 5 is a modification of the left-hand side of FIG. 2 with right-hand side portions broken away.

FIG. 6 is a modification of a right-hand side of the switch of FIG. 2 with the left-hand side broken away, with a coil replacing the push-button and a push-button retainer housing, the modification utilizing a spring.

Referring to FIG. 1, an electrically controlled thermally operated switch assembly is there shown and generally indicated at **10** having a switch generally indicated at **12**. The switch **12** has a plunger **14** at one end and has a pair of leads **20** protruding from its other end and has an enclosure or threaded bearing housing **24** having a threaded area **26** disposed inwardly of the leads **20**.

A bimetallic element **30** is mounted in a position so that one of its ends **32** is free to move in each of two directions as indicated by a double arrow **36** in accordance with thermal conditions around the element **30**, the opposite end of the element **30** being attached to a suitable mounting **38**.

An electrical coil **40** is disposed around the bimetallic element **30** between the switch **12** and mounting **38** so that heat from the coil **40** will cause the bimetallic element **30** to bend. One end of the coil **40** is shown at **44** connected to one of the leads **20**.

The other lead **20** is connected by a wire **48** to one terminal **50** of a source of power. The other terminal **52** of the same source of power is connected by a wire **56** to a terminal **60** of an imaginary element to be controlled, the other terminal **62** of that element being connected by a wire **64** to the opposite side of the coil **40**.

In operation, the switch is normally closed whereby energy is reaching the imaginary element at the terminals **60** and **62**. The flow of energy will continue until sufficient heat is built up in the coil **40** to cause the bimetallic element **30** to move toward the opposite end of the switch depressing the plunger, as causes the switch to open as later described. The opening of the switch then breaks the flow of energy allowing the coil **40** to cool. This permits the bimetallic element **30** to move in an opposite direction permitting the plunger to move out from the switch as causes the switch to close once again.

The imaginary element **61** connected to the terminals **60** and **62** can be a motor, for example, and when the current through the coil **40** is sufficiently strong, the coil **40** will heat, causing the plunger **14** to be depressed and the switch to open.

As thus described, the thermally operated switch assembly **10** functions as a most effective circuit breaker.

Referring to FIG. 2, the switch **12** will be seen to have an inner element **70** of magnetically attracted material, preferably a permanent magnet. The magnet **70** is surrounded by a frame **72** on which the inner element **70** is mounted in a manner for moving in each of two opposite directions **78** and **80**, toward and away from two stationary swtich contact means or switch contacts **84** and **86**, which latter are disposed adjacent but spaced from each other.

A moving contact **90** is disposed between the inner element **70** and the stationary contacts **84** and **86**. The inner magnetic element **70** is connected to the moving contact **90** by a spring assembly **98** which is adapted to reduce bouncing when the moving contact **90** strikes the stationary contacts **84** and **86** because of the resiliency of the spring **98** which tends to compress permitting the inner magnetic element **70** to move independently of the moving contact **90** in a direction toward the stationary contacts **84** after the moving contact **90** has engaged the contacts **84** and **86**.

The switch further has an external element **100** spaced from the inner element **70** and having a magnetic interattraction with the inner element, as can be accomplished by having the external element **100** in the form of a permanent magnet of annular shape having a central opening **104** of cylindrical shape closely but slidably fitting the cylindrical exterior wall **110** of an inner magnet receiving housing portion **112** which latter has an end wall **120** closing the end of the housing portion **112** which is opposite the moving contact **90**.

The interior of the housing portion **112** is preferably also provided with a cylindrical wall **124** and the inner magnet **70** preferably has a cylindrical exterior.

All parts described as cylindrical have a common axis **126** extending through the center of the switch.

An enclosure **130** which can also be called a housing **130** is formed of a moving contact housing portion **24** having an exterior provided with threads **26**, the housing portion **24** being cylindrical on its inner and outer sides and symmetrical about the axis **126**.

The enclosure housing **130** further has a connecting portion **134** of annular shape and which interconnects the housing portion **112** with the housing portion **24** in a manner which is airtight and watertight, the entire housing **130** further having a lead-carrying end closure portion **138** which closes the outer end of the housing portion **24** and by forming a part of the total enclosure **130** tends to create a completely enclosed interior having a floating contact chamber **140** and a inner magnet chamber **144**, the chambers **140** and **144** being interconnected. The leads **20** are embedded in the lead-carrying housing portion **138** and are attached to the stationary contacts **84** and **86** respectively, whereby the latter the exposed on the inner side of the enclosure **130** where they are engageable by the moving contact **90**. The outer ends of the leads **20** extend outwardly of the lead-carrying housing member **138**.

The outer magnet **100** is fixed to and mounted in the plunger **14**, being received in a recess **150** on the inner side thereof and the plunger **14** has a spring-receiving recess **152** of a lesser diameter than the recess **150**, the recess **152** extending into the plunger **14** from its inner side and being for the purpose of receiving a coiled compression spring **156** which latter engages an end wall **158** of the spring-receiving recess **152** and also engages the end wall **120** of the inner magnet housing **112** so that the plunger **14** is constantly urged in an outer direction and in the direction of the arrow **80**.

The plunger **14** is limited in its movement in the direction of the arrow **80** by the engagement of a shoulder **170** on the plunger **14** with a shoulder **174** which extends inwardly from the end of a plunger retaining housing generally indicated at **176** which is opposite the contact **90**, the shoulder **174** extending toward the axis **126** beyond the outer side of the shoulder **170** which latter has a larger diameter and size than the remainder of the plunger **14** so that the plunger **14** is effectively retained by the plunger retaining housing **176** from moving excessively in the direction of the arrow **80**.

The housing portion **176** is suitably fixed by a tight fit or other means at **180** to the housing or envelope **130** at a flange portion thereof or external shoulder providing means **184** which extends annularly outwardly from the housing portion **24** in the direction normal to the axis **126**.

The plunger **14** is free to move a sufficient distance between the shoulder **174** and the housing portion **184** for moving the magnet **100** in the direction of the arrows **78** and **80** sufficiently to cause the inner magnet **70** to move back and forth in the direction of the arrows **78** and **80**. The inner magnet **70** thus moves sufficiently for

causing the moving contact **90** to press against and to separate from the stationary contacts **84** and **86**.

As best seen in FIG. 3, the stationary contacts **84** and **86** are preferably provided with surfaces **192** and **194** which face the moving contact **90**, which latter surfaces are preferably of approximately semi-cylindrical shape for providing arcuate edges **200** which are spaced from but which are coaxial with the cylindrical interior **202** of the stationary contact chamber **140**, the curve surfaces **200** being sections of a circle arranged about the axis **126**.

The stationary contacts **84** and **86** are each not completely semi-circular, however, as they are spaced apart, each being spaced from the axis **126**. It is desirable that the contacts **84** present a maximum area of surface for engagement by the moving contact **90** consistent with an adequate spacing apart of the contact surface connected to the one lead from the contact surface connected to the other lead **20**.

Referring to FIG. 4, a modification of the switch is there shown in which the plunger **14** is not used and its retainer housing **176** is not used and even the outer magnet **100** is not used, being replaced by an electrical coil **240** which closely surrounds the housing **112** coaxially with the axis **126** of the switch, whereby when a current is passed through the ends **246** and **248** of the coil **240** in one direction, the inner magnet **70** is caused to move toward the contacts **84** and **86** and when the current through the coil **240** is reversed, the inner magnet **70** is caused to move away from the contacts **84** and **86**.

Referring now to FIG. 6, a similar modification is shown in which similar parts will be given similar numbers, but in which a coiled compression spring **250** for inner magnet return is disposed between the inner magnet **70** and the housing wall **120** for causing the inner magnet **70** to be urged toward the contacts, while in operation the current energizing the coil **240** tends to influence the inner magnet **70** causing it to move away from the stationary contacts.

Referring to FIG. 5, there will be seen a modification of the left-hand portion of the switch in which the lead-carrying member is given the numeral **338** to indicate that it is a modification of the lead-carrying member **138**, in which the member **338** is formed in two main portions, a first portion being a cuplike lead carrying member **340** having a cylindrical outer portion **342** snugly received in and sealed to the inner wall **344** of the threaded housing portion **424**, which latter is a number chosen to signify that it is a modification of the housing portion **24** of the switch of FIG. 2.

The inner wall **344** is cylindrical and is centered about the axis **126**, and it will be seen that the outer cylindrical portion **342** of the lead carrying member **340** extends a partial distance inwardly from the outer end **425** of the housing portion **424** toward the housing portion **130**.

The remaining space along the inner wall **344** and between the lead carrying member **340** and the housing portion **134** is occupied by a liner **430** which has a cylindrical outer portion **432** of a sufficient size such that during assembly, the positioning of the liner **432** in the housing portion **424** before the insertion of the lead carrying member **340**, will cause the lead carrying member **340** to be ideally positioned for the proper positioning of the stationary contacts.

The liner **432** is of electrical insulating material and its tight engagement against the cuplike member **340** tends to prevent arcing from reaching the housing portion **424** which can, therefore, be safely made of electrically conductive material.

The housing portion **424** and the housing portion **134** and also the housing portion **112** and end wall **120** are all preferably integrally made of aluminum, whereby they are integrally formed of this material which is not magnetically attracted whereby it will not disturb the action of the magnet.

Lug-carrying member **338** has its cup-shaped portion or member **340** provided with openings **440** therethrough through which the leads **20** extend. The inside of the cup-shaped member **340** is filled with a material **444** which is adapted to seal the leads **20** to the cup-shaped member **340** holding them firmly in place with respect thereto and completing the enclosure of the moving contact chamber **140**.

As best seen in FIG. 2, the south poles of the magnets **70** and **100** both face the contacts **84**, **86**, and **90**, whereas the opposite side of each of the magnets is the north pole. This has been found to have the effect of reducing the arcing because the south pole has a beneficial effect upon the contact area.

Referring to FIG. 2, it will be seen in operation that whenever the plunger is outward, as shown, the south pole of the outer magnet **100** will be repulsing the south pole of the inner magnet and the north pole of the outer magnet will simultaneously repulse the north pole of the inner magnet causing the inner magnet to be forced in the direction of the arrow **78** for pressing the moving contact **90** against the stationary contacts **84** and **86**.

The repulsion described is sufficient to overcome the amount of attraction there is between the south pole of the outer magnet and the north pole of the inner magnet.

When the plunger is pushed inwardly in the direction of the arrow **78**, the outer magnet **100** will move until it engages the housing portion **184** at which time the south pole of the outer magnet is farther to the left than the south pole of the inner magnet whereupon repulsion begins to drive the inner magnet to the right in the direction of the arrow **80** opening the switch and the inner magnet **70** continues to move to the right until it engages the end wall **120** remaining in this position as long as the button **14** is sufficiently pressed inwardly. When the operator lets go of button **14**, the spring **156** will cause it to move to the right until it has reached the position shown in FIG. 2 whereupon it once again drives the inner magnet to the left for again closing the switch.

The contacts described can be defined also as a first contact means comprising a pair of separate contact means **84** and **86**, insulated from each other, and a second or bridging contact means **90**.

The flange portion **184**, as earlier stated, can also be called an external shoulder providing means **184** attached to one of the housings and disposed a substantial distance from each end of both of the housings on the exterior of the switch for engaging a panel, not shown, on the opposite side of the panel from the threads in the threaded area **26**.

The inner magnet receiving housing portion **112** can be called a second portion of the sealed housing and the first portion of the sealed housing is formed of the sealed housing portion which receives the contacts and which is formed of the parts of the sealed housing which are between the flange **184** and including the lead end of the sealed housing formed by the lead-carrying closure portion **138**. The second portion of the sealed housing is of susbtantially lesser size than the size of the first portion of the sealed housing as seen linearly of the line of reciprocation of the inner magnet **70**, and the outer magnet **100** extends inwardly toward the path of reciprocation of the inner magnet **70** beyond the inner side of the first portion of the sealed housing for helping to provide a compact arrangement.

I claim:

1. A panel mountable magnetic switch comprising: a sealed housing, an inner magnet disposed inside said housing, a first contact means comprising a pair of separate contact means in said sealed housing, means in said sealed housing insulating said pair of contact means from each other, a second contact means comprising a bridging contact means in said housing, said inner magnet

reciprocating in each of two opposite directions toward and away from one of said first and second contact means, means mounting the other of said first and second contact means on said inner magnet and between said inner magnet and said one of said contact means, said housing surrounding said inner magnet and said contact means, and an external magnet means disposed outside of said sealed housing and reciprocating in said two directions for magnetically causing said reciprocating movements of said inner magnet, a pair of leads having outer ends disposed outside of said housing at one of the ends of said housing, means electrically attaching said pair of leads one to each of said pair of contact means, said external magnet means being actuable for reciprocation toward and away from said one of said first and second contact means along a line of reciprocation, an outer housing disposed outside of said sealed housing and attached to said sealed housing and disposed on a plurality of those sides of the area of reciprocation of said outer magnet which sides are disposed laterally of said line of reciprocation, said switch having a threaded substantially cylindrical surface on the exterior of one of said housings, movable external magnet actuating means disposed on the other end of said sealed housing from the lead end thereof and connected to said external magnet for mechanically controlling said reciprocating movements of said external magnet, said actuating means being disposed partly in said outer housing and partly projecting through that end of said outer housing which is opposite said leads, and shoulder-providing means providing an external shoulder attached to one of said housings and disposed a substantial distance from each end of both of said housings and disposed on the exterior of said switch, said external shoulder extending laterally of said line of reciprocation to at least one side of said housing beyond said threaded exterior, said external shoulder facing at least part of said threads, whereby said switch can be mounted on a panel with one end of said threads on one side of the panel, its actuating means on the outside of said panel and its leads on the inner side of the panel and with its external shoulder means engaging that side of the panel which is opposite said end of said threads.

2. The combination of claim **1** in which said sealed housing has a first portion containing said contacts and a second portion containing said inner magnet, said second portion of said sealed housing being of substantially lesser size than the size of said first portion as seen linearly of said line of reciprocation, and said outer magnet means extending inwardly toward the path of reciprocation of said inner magnet beyond the inner side of said first portion of said sealed housing for helping to provide a compact arrangement.

3. The combination of claim **1** further including actuating means mounting means of which said outer housing forms a part, said actuating means mounting means further comprising means attached to said outer housing and operably correlated with said outer magnet actuating means to movably mount said actuating means on said sealed housing.

4. The combination of claim **1** in which said outer housing is attached to said sealed housing partially by a flange attached to said sealed housing and extending from said sealed housing laterally of said line of reciprocation, said flange defining said shoulder providing means.

5. The combination of claim **4** in which said threads are on said inner housing.

6. The combination of claim **1** in which said threads are on the inner one of said housings.

7. The combination of claim **1** in which said mounting means comprises a compression spring.

8. The combination of claim **1** in which actuating means is a plunger having an exposed surface disposed opposite the lead end of said sealed housing, said plunger reciprocating in each of said two directions, a spring engageable with said plunger for urging said plunger in a direction away from said one contact means, and means comprising said outer housing for attaching said plunger to said sealed housing in a manner for the said reciprocattion of said plunger.

9. The combination of claim **8** in which said plunger has a recess on that side thereof which faces said moving contact, said spring being disposed in said recess.

10. The combination of claim **8** in which said plunger has a recess on that side thereof which faces said moving contact, said spring being disposed in said recess, said plunger being slidably received on the adjacent end of said sealed housing for reciprocating with respect thereto.

11. The combination of claim **1** in which said leads are mounted in a lead-carrying member, said lead-carrying member forming an end wall of said sealed housing on said one end thereof, said lead-carrying member being attached to but not integral with the remainder of said sealed housing.

12. The combination of claim **11** in which said lead-carrying member is cuplike on that side thereof which faces away from said contacts.

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U.S. Cl. X.R.

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