

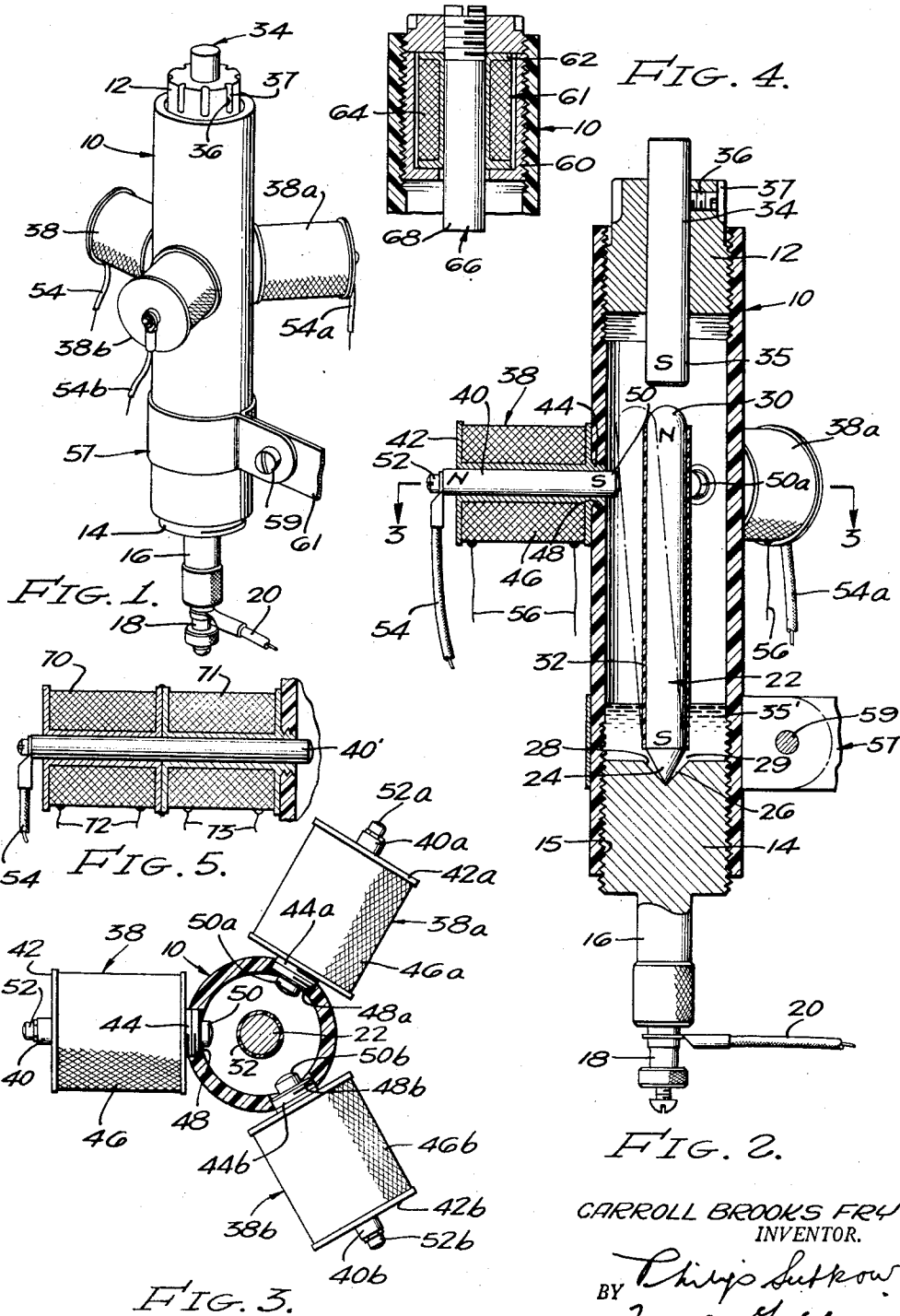
Feb. 2, 1960

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2,923,792

MAGNETIC SWITCH

Filed Sept. 22, 1958



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2,923,792

MAGNETIC SWITCH

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Application September 22, 1958, Serial No. 762,353

18 Claims. (Cl. 200—93)

This invention relates to a magnetic relay or switch structure and is particularly concerned with a selective switch mechanism.

It is an object of the invention to provide a switch which can be selectively actuated to close any one of a plurality of electrical circuits.

It is another object of the invention to design a substantially frictionless magnetic bridge relay responsive to high frequency applications.

Yet another object is to afford a switch having a novel magnetic locking means.

Still another object is the provision of a versatile, sensitive magnetic switch which is operable by small currents, and whose sensitivity can be readily adjusted.

Still other objects and advantages of the invention will be apparent hereinafter.

The above objects are accomplished in whole or in part according to the invention by providing a switch which comprises an insulating tube having a conductive base member mounted in the lower end of said tube and an elongated magnetizable conductive member, one end of said conductive member being pivotally mounted on said base member for free movement of the opposite end of said elongated member from side to side of said insulating tube. The lower end of the base member carries a terminal on the exterior of the base member. At least one electro-magnet is mounted on the exterior of said tube adjacent the free end of said elongated member, said electro-magnet having a central magnetically permeable armature, one end of the armature protruding through the insulating tube and forming a contact within and adjacent the wall of said tube, with a terminal at the opposite outer end of said armature. The movable end of said elongated member is attracted toward and into engagement with said contact when the electro-magnet is energized, to close the switch between said terminals.

By mounting the elongated member at its lower end so that there is practically no resistance to pivotal movement of the upper end of said member, the upper end of said member is highly sensitive and responsive to energization of an electro-magnet positioned on said tube, and requires relatively small energizing currents in such electro-magnets for operation of said member. Said magnetizable elongated member may be the armature of an electro-magnet, but in preferred practice said elongated member is in the form of a permanently magnetized rod or arm. Said elongated member can be conductive so that when it engages an inwardly protruding contact adjacent a side of the tube, it can close a circuit from said contact through the elongated member and base member to the external terminal thereon. Where the elongated member is a permanent magnet according to a preferred embodiment, a conductive outer sheath is mounted on said rod. The conductive sheath is electrically connected to the conductive base member by some conductive means which presents substantially no interference with the free pivotal motion of the rod when an electro-magnet

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mounted on the side of the tube is energized. For this purpose, and as an additional feature of the invention a small body of mercury is placed in the tube in contact with the base member and said conductive sheath.

I have further provided as an additional feature of the invention an aid to guiding the freely movable end of the elongated member during its movement from one position to another in said tube. Such means is in the form of a magnet, either an electro-magnet or a permanent magnetic bar, preferably the latter. This magnetic means is preferably positioned axially within the upper portion of the insulating tube, above and spaced from the upper end of the aforementioned pivoting elongated member. The spacing between the upper end of said pivoting elongated member and the upper magnetic means is made adjustable to facilitate adjustment of the sensitivity of the instrument.

In a preferred embodiment a plurality of electro-magnets having magnetically permeable central armatures are mounted at spaced locations about the periphery of the insulated tube at a position adjacent the movable end of the pivoting magnetic rod. These electro-magnets are preferably mounted so that the longitudinal axes of the central armatures thereof are in a plane substantially normal to the axis of the insulated tube. One end of each of these armatures protrudes a short adjustable distance into the insulated tube, forming a contact for the conductive sheath on the rod, as aforementioned.

The pivoting magnetic rod in one position thereof may be in engagement with an inwardly protruding contact of the armature of one of said electro-magnets, closing an external circuit through the sheath on the magnetic rod and the armature of said electro-magnet. When this electro-magnet is de-energized, or its polarity is reversed to repel the magnetic rod, and one of the other electro-magnets is energized to assume a polarity to attract the magnetic rod, the rod is urged away from the first electro-magnet into engagement with the inwardly protruding contact and the armature of the newly energized electro-magnet. This opens the first mentioned circuit and closes a second circuit through the sheath on the magnetic rod and the armature of the second energized electro-magnet.

The electro-magnets mounted on the tube each can be designed sufficiently strong to move the pivoting rod the complete distance from one position thereof into contact with said electro-magnet when it is energized. However this is facilitated by provision of the aforementioned magnetic means preferably positioned above the movable rod. Thus, when the rod disengages from the armature of one electro-magnet, the magnetic attraction of the magnetic bar or other magnetic means mounted above the movable magnetic rod and axially within the insulating tube, attracts the upper end of the rod, and on reaching an intermediate position within the insulating tube, the magnetic attraction of the energized electro-magnet is sufficient to urge the rod the remaining distance toward its magnetized armature. The strength of the energized electro-magnet, and the distance between the upper end of the magnetic rod and the magnetic means mounted directly above it, are such that when the rod is pivoting from one electro-magnet to an energized electro-magnet mounted on the tube, there is practically continuous movement of the upper end of the rod from its initial position to its rest position in contact with the newly energized electro-magnet, and the force of attraction between the rod and the overhead magnetic means is sufficient to guide the movement of the rod substantially without interrupting movement of the upper end of the rod and preventing engagement of the rod with, or movement of the rod along, the wall of the insulated tube intermediate the electro-magnets.

By selectively energizing individually different ones of the electromagnets peripherally positioned about the insulated tube, different circuits can be closed selectively. When more than one of said electromagnets is energized, the free swivelling end of the magnetizable or magnetic rod in the tube can take an intermediate position within the insulating tube without making contact, e.g. through its outer sheath, with any of the electromagnet armatures, and none of the circuits will be closed or activated. Hence the device can function to selectively open or close any one of a plurality of electrical circuits.

The invention will be more fully understood in the following description of certain embodiments taken in connection with the accompanying drawing wherein:

Fig. 1 is an elevational perspective view of a switch according to the invention;

Fig. 2 is a vertical section, shown partly in elevation, of the switch of Fig. 1;

Fig. 3 is a section taken on line 3—3 of Fig. 2;

Fig. 4 is a modification of a detail of the device of Figs. 1 to 3; and

Fig. 5 is a detail showing another modification.

Referring to Figs. 1 to 3 of the drawing, numeral 10 represents an outer insulating tube made of any suitable insulating material such as plastics, ceramics and the like, closed at its upper end by a threadably engaging plug 12 formed of non-magnetic material, and closed at its lower end by a base member 14 threadably engaging tube 10, as indicated at 15. Member 14 is formed of a conducting material carrying an integral depending support 16 to which is connected a terminal 18 having an electrical lead 20 attached thereto.

Mounted within the tube 10 is a rod 22 composed of any suitable permanent magnetic material such as "Alnico." The rod is formed with a conical point 24 at its lower end which rests in a depression 26 formed in the upper surface of 14. The depression 26 has an upwardly sloping side 28 at a greater angle to the vertical than the conical surface of the point 24 of the rod, thus affording sufficient clearance at 29 between the sides 28 of the depression and the side of the conical point, to permit the upper free end 30 of the rod 22 to swivel or pivot within the tube, for example, from a central position as shown in full lines in Fig. 2 to a position adjacent the side wall of tube 10, as indicated by phantom lines in Fig. 2, and as further described below. Snugly positioned about the rod 22 is a conductive metallic sheath or sleeve 32 which extends from the lower end of the rod just above the conical point 24, to the upper end of the rod. The lower portion of the interior of tube 10 is filled with a conductive liquid such as mercury, indicated at 35' so that the lower portion of rod 22 and sheath 32 are immersed in the pool of mercury. The mercury forms a conductor between the conductive sheath 32 and the conductive base 14. The amount of mercury employed is preferably such that the point 24 of the rod rests in the depression 26 and does not float above member 14.

Positioned centrally in the plug 12 along the axis of tube 10 is a permanent magnet 34 in the form of a bar, the lower end 35 of which is disposed closely adjacent to but spaced from the upper end of rod 22. Bar 34 is held in position by one or more adjusting screws 36 which can be disposed in grooves 37 about the periphery of the upper end of plug 12. Bar 34 is slidable in plug 12 for adjustment of the distance between the adjacent ends of bar 34 and rod 22. The magnetic rod 22 and bar 34 are arranged so that their adjacent ends are of opposite polarity, that is, one is a North pole and the other a South pole, or vice versa, as indicated in Fig. 2, so that rod 22 may be held or attracted toward its axial position as shown in Fig. 2, by the attracting magnetic forces between the adjacent ends 30 and 35 of members 22 and 34.

Positioned about the outer periphery of tube 10 ad-

jacent the upper end of rod 22, and spaced equidistantly from each other, are three electromagnets 38, 38a and 38b all constructed in identical manner. One of these electromagnets 38 will be described, the corresponding parts of the electromagnets 38a and 38b being identical and being indicated by like part numbers but including the letters "a" and "b" respectively. The longitudinal axes of all of the electromagnets are in a plane normal or perpendicular to the axis of tube 10.

Electromagnet 38 has a central conductive magnetically permeable armature 40 which carries a spool 42 on which is wound a wire coil 46. The inner end of the spool 42 carries an externally threaded flange 44 which engages with internal threads formed in an aperture 48 in the wall of tube 10 for supporting the electromagnet. The armature 40 protrudes a short distance through aperture 48, forming a contact 50 for the conductive sheath 32 of rod 22. The extent of protrusion of armature 40 and contact 50 into the tube 10 can be adjusted by turning spool 42 and flange 44 in the threaded aperture 48 the desired amount. The contact 50 may be coated or plated with a highly conductive material such as silver. The opposite end of the armature carries a contact 52 to which is connected an electrical lead 54. The electromagnet 38 is energized by a source of potential (not shown) through leads 56 connected to opposite ends of the coil 46. Leads 20 and 54 are connected in a first circuit, leads 54a and 20 in a second circuit and leads 20 and 54b in a third circuit. The switch is supported by a metal band 57 clamped about the tube 10 and held in position by a fastener 59, the outwardly extending end 61 of the band being supported in any suitable manner.

Assume the upper end 30 of the rod 22 is in engagement with contact 50a of electromagnet 38a. When electromagnet 38a is de-energized or its polarity is reversed, and one of the other electromagnets, say 38, is energized, the armature 40 thereof is magnetized and the contact 50 assumes magnetic polarity opposite to that of the adjacent end 30 of rod 22, e.g. contact 50 becomes a South pole while the end 30 of rod 22 is a North pole, as indicated in Fig. 2. The magnetic attraction of the end 35 of bar 34 first urges the end 30 of rod 22 inwardly toward the center of the tube 10. Such movement may be aided by the repelling force of the armature 40a of electromagnet 38a where the polarity of this electromagnet has been reversed, i.e. the polarity of contact 50a has been made the same as that of the end 30 of rod 22. But when the rod end 30 reaches an intermediate position, the magnetic force between 50 and 30 becomes greater than that between 35 and 30, causing the rod 22 and the sheath carried thereby to swivel to the phantom line position shown in Fig. 2, wherein the upper end 30 of rod 22 engages the contact 50.

It will be understood that the path of movement of the rod 22 from contact 50a to contact 50 is arcuate, and the rod may or may not pass through the axis of the tube 10, or the path of movement of rod end 30 may be in substantially a straight line between contact 50a and 50, dependent upon the magnetic force of the magnet 34, which in turn depends on the distance between members 22 and 34. However, magnet 34 aids in guiding and moving rod end 30 from a de-energized electromagnet, or from one whose polarity is reversed to make it the same as rod end 30, to an energized electromagnet without striking or sliding along the inner surface of insulating tube 10. It will also be understood that the electromagnets are placed with respect to the longitudinal extent of rod 22 so that the end portion 30 of rod 22 extends but a short distance above the contacts 50, 50a and 50b of the electromagnets. This permits the requirement of a minimum of magnetization attraction for movement of the rod end 30 to the contacts 50, 50a and 50b of the respective electromagnet armatures. The

position of rod 22 with respect to the contacts 50, 50a and 50b of the respective electromagnets can be vertically adjusted by adjustment of base member 14 in the tube 10.

When the sheath 32 of rod 22 engages contact 50, the circuit including leads 20 and 54 is closed through conductive members 16, 14, the body of mercury 35', sheath 32, and conductive members 30 and 40.

It is a feature of the invention structure that when the sheath 32 of rod 22 is in engagement with a contact, say 50, to close the circuit as described above, the electromagnet may be de-energized and the rod and sheath 32 will remain in engagement with contact 50, maintaining the circuit closed, thus acting as a magnetic lock. This is because rod 22 is a permanent magnet and will maintain itself attached to the permeable armature 40 of the electromagnet 38 even though armature 40 is no longer polarized, as by de-energizing the electromagnet. Hence, it is apparent that only a momentary energizing of electromagnet 38 is required to flip the rod 22 into position so that the sheath 32 is engaged with contact 50 to close the aforementioned circuit through armature 40, and thereafter the rod 22 will remain magnetically locked in this position until another electromagnet is energized.

However, if it is desired that the switch not have such a magnetic locking action, the distance between the adjacent ends 30 and 35 of arm 22 and of magnetic bar 34 can be adjusted, and the strength of magnet 34 can be designed such that when sheath 32 of rod 22 is in contact with a magnet such as 38, and the electromagnet is de-energized, the rod 22 will pivot to a central axial position as shown in Fig. 2 and remain in this position until one of the electromagnets is energized. Further, if desired, by adjusting bar 34 so that the lower end 35 makes contact with the upper end 30 of rod 22, the rod 22 will remain locked in this position and will not move even though one of the electromagnets 38, 38a or 38b is energized, due to the very high magnetic force of attraction between 35 and 30 under these conditions.

It will be noted that the pivotal movement of rod 22 is practically frictionless. That is, as a result of the central pivotal point contact between the conical point 24 on the lower end of rod 22 and the depression 26 in member 14, and the use of relatively small amount of liquid conductor such as mercury surrounding the lower end of rod 22, the system may be made relatively frictionless. Hence, the switch described above is highly sensitive and can be operated by small currents, and is responsive to high frequency application. The frequency of rod 22 can also be increased by decreasing the mass of the rod. However, if desired, by increasing the amount of mercury, the rod 22 can be damped so that it will assume an axial position in tube 10, as seen in Fig. 2, due to the force of attraction between 30 and 35, without undue vibration or over-shooting of the axial position.

If two electromagnets, say 38 and 38a are energized simultaneously, the upper end 30 of rod 22 may swivel to a position between and out of engagement with contacts 50 and 50a of said electromagnets, and will not close either the circuit including leads 20 and 54, or the circuit including leads 20 and 54a. If one of these electromagnets, say 38, is then de-energized, the rod 22 will swivel to the armature 40a of the other electromagnet 38a, to cause engagement between sheath 32 and the contact 50a to close the circuit including leads 20 and 54a. If all three electromagnets 38, 38a and 38b are energized simultaneously, the rod 22 will take a neutral axial position as shown in full lines in Fig. 2, and all three circuits will remain open. The presence of magnetic bar 34 aids in causing the rod 22 to assume an axial position under these conditions, and will prevent rod 22 from falling against the sides of tube 10.

Instead of employing a permanent magnet 34 I can

employ instead an electromagnet having a vertically adjustable armature. Thus, as shown in Fig. 4, in place of plug 12 and magnet 34 of Fig. 1, a retainer 60 can be threadably secured in the upper end of tube 10, said retainer carrying an electromagnet 61 comprising a spool 62 having wound thereon a wire coil 64. Passing centrally through the spool 64 and in threaded engagement therewith is a permeable magnetic armature 66 which is disposed centrally in tube 10, the end 68 of the armature being spaced above the end 30 of rod 22. Armature 66 is adjustable to change the distance between 68 and 30 as desired.

The electromagnet 61 operates in the same manner as bar magnet 34 when the coil 64 of the electromagnet is energized.

When it is desired that a circuit not be closed by switch arm 22 unless two or more external circuits are closed, two or more coils, for example 70 and 71 as shown in Fig. 5, may be wound on one armature, say 40, and the magnetic force required to cause rod 22 to engage the contact 50 on armature 40, can be made such that the magnetomotive force for this purpose is only obtained when both coils 70 and 71 are energized simultaneously by external circuits through leads 70 and 73 respectively. Hence, only under the latter conditions will the circuit via leads 20 and 54 be energized. If only coil 70 or only coil 71 is energized, the magnetomotive force between armature pole 50 and rod 22 will not be sufficient to cause the rod 22 to pivot and engage contact 50. Hence, it is seen that by means of the modification of my switch illustrated in Fig. 5, a single circuit can be controlled by two or more external circuits.

It will be understood that I can employ any desired number of electromagnets 38, say one, two, five or six, instead of the three shown in Fig. 2, permitting selective closing of one of the corresponding number of circuits thus provided.

Also, I can connect the conductive sheath 32 to the conductive base member 14 by means other than a conductive fluid such as mercury. Thus, for example, I can connect an electrical lead between such sheath and member 14, so that the electrical lead provides a minimum of interference for the movement of the upper end of 22 to and from contacts 50, 50a or 50b as above described.

Further, if desired, where rod 22 is sufficiently conductive I can omit the conductive sheath 32 and the body of mercury 35'.

From the foregoing, it is seen that I have provided a novel, versatile switch structure or relay which can be selectively actuated to close a predetermined one of a number of individual circuits, while the other circuits are maintained open.

While I have described particular embodiments of my invention for the purpose of illustration, it should be understood that various modifications and adaptations thereof may be made within the spirit of the invention as set forth in the appended claims.

I claim:

1. A switch which comprises an insulating tube, a conductive base member mounted in the lower end of said tube, a terminal connected to said base member, a permanent magnetic elongated conductive member, one end of said conductive member being pivotally mounted on said base member for free movement of the opposite end of said elongated member from side to side of said insulating tube, at least one electromagnet mounted on said tube adjacent said free end of said elongated member, said electromagnet having a central magnetically permeable armature, one end of said armature protruding through said insulating tube and forming a contact within and adjacent the wall of said tube, and a terminal at the opposite end of said armature, said movable end of said elongated member being attracted toward and into en-

gagement with said contact when said electromagnet is energized, to close the switch between said terminals.

2. A switch as defined in claim 1, wherein said elongated magnetizable member is a permanent magnetic rod, and including a conductive sheath positioned about said rod, and means electrically connecting said sheath and said base member.

3. A switch as defined in claim 2, said last mentioned means comprising a body of mercury in said tube in contact with said sheath and said base member.

4. A switch as defined in claim 2, including magnetic means mounted in said tube adjacent the freely movable end of said rod, said magnetic means being spaced from the walls of said tube.

5. A switch as defined in claim 1, including magnetic means mounted in said tube adjacent the freely movable end of said elongated member, said magnetic means being spaced from the walls of said tube.

6. A device as defined in claim 1, including a plurality of said electromagnets positioned about the periphery of said tube adjacent the freely movable end of said elongated member.

7. A device as defined in claim 4, including a plurality of said electromagnets positioned about the periphery of said tube adjacent the freely movable end of said elongated member.

8. A switch as defined in claim 1, said base member having a conical depression in the upper surface thereof, said one end of said elongated member having a conical point resting in said depression.

9. A switch which comprises an insulating tube, a conductive base member mounted in the lower end of said tube, an electrical terminal connected to said base member, a permanent magnetic rod positioned in said tube, at least one end of said rod being movable, a conductive sheath about said rod, means electrically connecting said sheath and said base member, permanent magnetic means mounted in said tube, and spaced from the walls thereof, said magnetic means magnetically attracting the free end of said rod positioned in said tube, an electromagnet mounted on said tube adjacent said free end of said rod, a central magnetically permeable armature in said electromagnet, one end of said armature protruding through said insulating tube and forming a contact within and adjacent the wall of said tube, a terminal at the opposite end of said armature, said movable end of said rod being attracted toward said contact when said electromagnet is energized, to cause engagement of said sheath with said contact and to close the switch between said terminals.

10. A switch which comprises an insulating tube, a conductive base member mounted in the lower end of said tube, an electrical terminal connected to said base member, a permanent magnetic rod having one end in contact with and mounted on said base member, the opposite end of said rod being freely movable, a conductive sheath about said rod, a body of mercury in said tube in contact with said sheath and said base member, magnetic means mounted in said tube and magnetically attracting the movable end of said rod, said magnetic means being mounted axially in said tube, an electromagnet mounted on said tube adjacent said movable end of said rod, a central magnetically permeable armature in said electromagnet, one end of said armature protruding through said insulating tube, and forming a contact within and adjacent to the wall of said tube, an electrical terminal at the opposite end of said armature, said movable end of said rod being attracted toward said contact when said electromagnet is energized, to cause engagement of said sheath with said contact and to close the switch between said terminals.

11. A switch which comprises an insulated tube, a conductive base member mounted in the lower end of said tube, a first electrical terminal connected to said base member, a permanent magnetic rod positioned in

said tube, at least one end of said rod being freely movable, a conductive sheath about said rod, means electrically connecting said sheath and said base member, magnetic means mounted in said tube and spaced from the walls thereof, said magnetic means magnetically attracting the movable end of said rod, said rod being axially positioned in said tube, a plurality of electromagnets positioned about the periphery of said tube adjacent the said movable end of said rod, a central magnetically permeable armature in each of said electromagnets, the inner end of said armatures each protruding through said magnetic tube and forming a plurality of spaced contacts within and adjacent the wall of said tube, a second terminal at the opposite end of each of said armatures, said movable end of said rod being attracted selectively toward one of said contacts when its electromagnet is energized, to cause engagement of said sheath with said one of said contacts, and to close the switch between said first terminal and one of said second terminals.

12. A switch which comprises an insulating tube, a conductive base member mounted in the lower end of said tube, a first electrical terminal connected to said base member, a permanent magnetic rod having one end in contact with and mounted on said base member, the opposite end of said rod being freely movable, a conductive sheath about said rod, a body of mercury in said tube in contact with said tube and said base member, permanent magnetic means mounted in said tube and magnetically attracting the movable end of said rod, said permanent magnetic means being axially positioned in said tube, a plurality of electromagnets positioned about the periphery of said tube adjacent the said movable end of said rod, a central magnetically permeable armature in each of said electromagnets, the inner ends of said armatures protruding through said insulating tube and forming a plurality of spaced contacts within and adjacent the wall of said tube, a second terminal at the opposite end of each of said armatures, said movable end of said rod being attracted selectively toward one of said contacts when its electromagnet is energized, to cause engagement of said sheath with said one of said contacts and to close the switch between said first terminal and one of said second terminals.

13. A switch which comprises an insulating tube, a conductive base member mounted in the lower end of said tube, an electrical terminal connected to said base member, a depression in the upper surface of said base member on the axis of said tube, a permanent magnetic rod having one end positioned in said depression, the opposite end of said rod being freely movable, a conductive sheath about said rod, a body of mercury in said tube in contact with said sheath and said base member, a permanent bar magnet mounted axially in said tube adjacent but spaced from the movable end of said rod, said bar magnet magnetically attracting the movable end of said rod, a plurality of electromagnets positioned about the periphery of said tube adjacent the movable end of said rod, a central magnetically permeable armature in each of said electromagnets, the inner ends of said armatures each protruding through said insulating tube and forming a plurality of spaced contacts within and adjacent the wall of said tube, the longitudinal axes of said permeable armatures being in a plane substantially normal to the axis of said tube, a second terminal at the opposite end of each of said armatures, said movable end of said rod adapted to be swiveled about the opposite end of said rod, selectively toward one of said contacts when its electromagnet is energized, to cause engagement of said sheath with said one of said contacts to close the switch between said first terminal and said second terminal of said last mentioned electromagnet.

14. A switch as defined in claim 1, said electromagnet

having a plurality of coils wound thereon, each of said coils being energized by a separate circuit.

15. A switch which comprises a housing, a conductive base member mounted in the lower portion of said housing, an electrical terminal connected to said base member, an elongated magnetic conductive member positioned in said housing, one end of said magnetic member being movable, means electrically connecting said magnetic member and said base member, an electromagnet mounted on said housing adjacent the movable end of said magnetic member, a central magnetically permeable armature in said electromagnet, one end of said armature forming a contact, a terminal at the opposite end of said armature, magnetic means mounted in said housing adjacent the movable end of said magnetic conductive member and in axial alignment therewith, said magnetic means operating independently of said electromagnet, said movable end of said magnetic conductive member being attracted toward and into engagement with said contact when said electromagnet is energized to close the switch between said terminals.

16. A switch which comprises an insulating tube, a conductive base member mounted in the lower end of said tube, an electrical terminal connected to said base member, a permanent magnetic rod positioned in said tube, at least one end of said rod being movable, a conductive sheath about said rod, means electrically con-

necting said sheath and said base member, magnetic means mounted in said tube, and spaced from the walls thereof, said magnetic means magnetically attracting the free end of said rod positioned in said tube, an electromagnet mounted on said tube adjacent said free end of said rod, a central magnetically permeable armature in said electromagnet, one end of said armature protruding through said insulating tube and forming a contact within and adjacent the wall of said tube, a terminal at the opposite end of said armature, said movable end of said rod being attracted toward said contact when said electromagnet is energized, to cause engagement of said sheath with said contact and to close the switch between said terminals.

17. A switch as defined in claim 16, wherein said magnetic means is adjustable with respect to the free end of said rod.

18. A switch as defined in claim 16, wherein said magnetic means is an electromagnet.

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