

May 10, 1966

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3,250,955

MAGNETICALLY OPERATED SWITCH FOR IGNITION SYSTEM

Filed Nov. 20, 1961

2 Sheets-Sheet 1

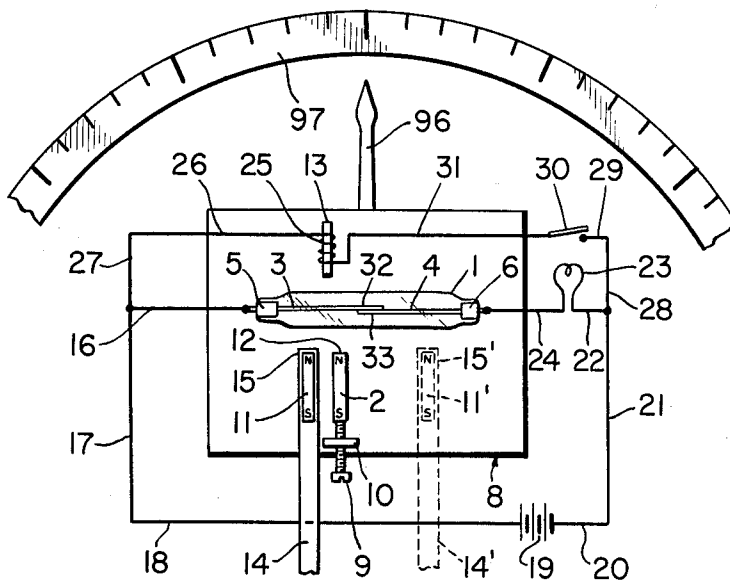


Fig. 7.

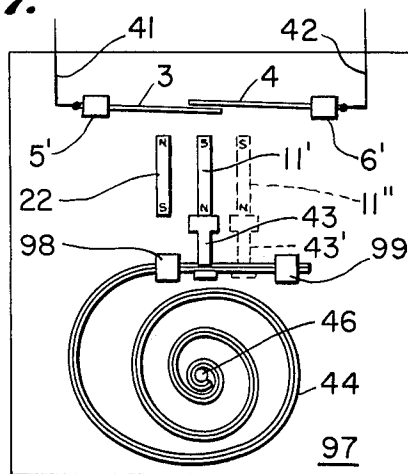


Fig. 2.

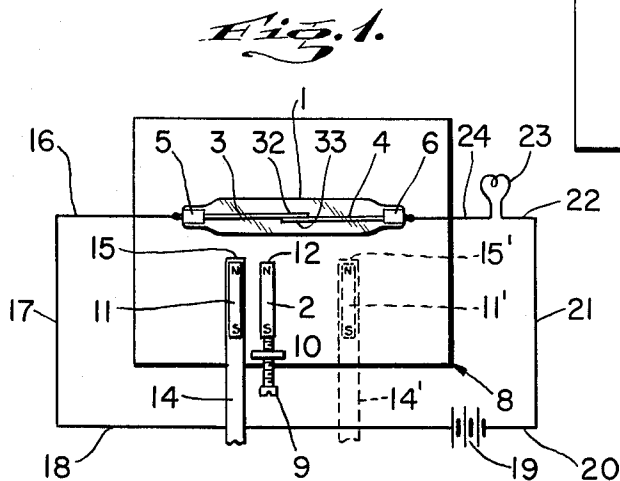


Fig. 1.

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2 Sheets-Sheet 2

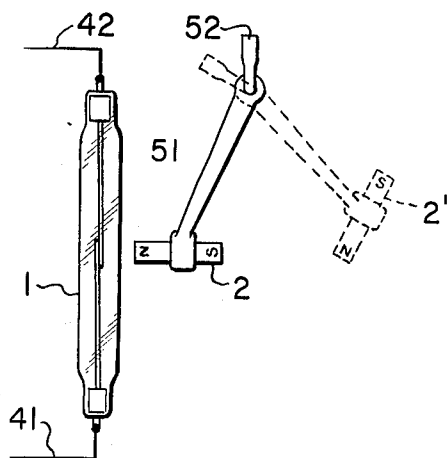


Fig. 3.

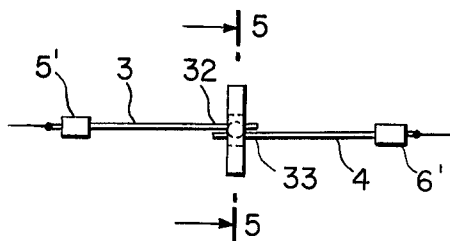


Fig. 4.

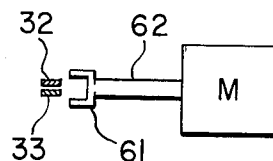


Fig. 5.

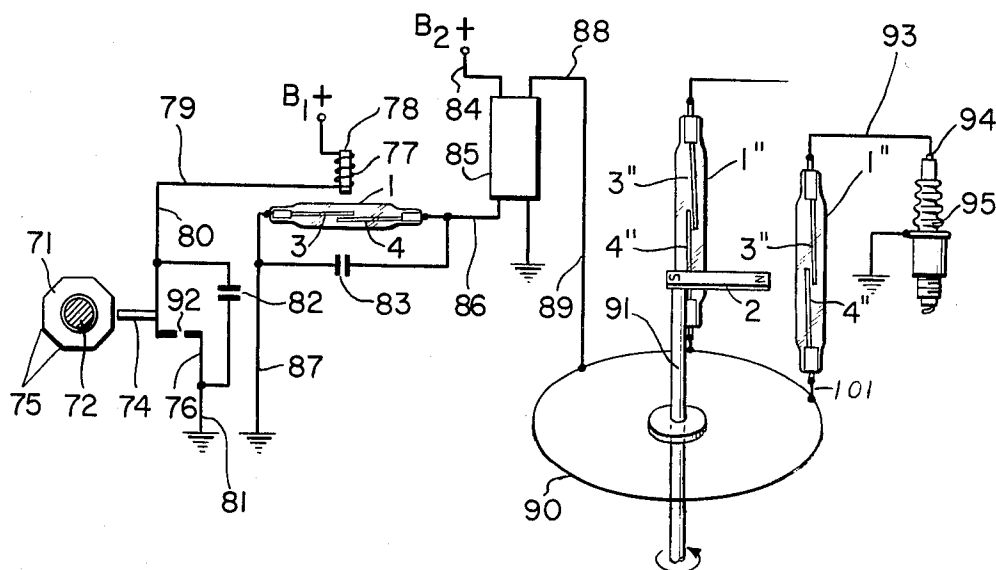


Fig. 6.

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1

3,250,955

MAGNETICALLY OPERATED SWITCH FOR IGNITION SYSTEM

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4 Claims. (Cl. 315-214)

This invention relates to an electrical switch. More particularly this invention relates to an improved proximity switch.

Proximity switches are known in the art. An example is a reed type switch in which electrical contact is made between the reeds by the action of a magnet placed near the switch. In order to maintain the switch in the closed or electrical contact position in the absence of a permanent magnet, a holding relay or a holding circuit of some type is required. In such a case another electrical switch must be thrown or broken in order to deactivate the relay or holding circuit before the reed switch will open. There is, hence, a need for an improved method of operating a reed or proximity switch.

It is, therefore, an object of this invention to provide an improved electrical contact means. Another object of this invention is to provide a novel proximity switch. It is also an object to provide a switch which has a minimum of moving parts. Another object of this invention is to provide an electrical contact switch which can be actuated by the means of a small magnetic field. Still another object is to provide an electrical contact switch which will stay in an electrically closed or open position as desired after the removal of an actuating magnetic field. Still another object of this invention is to provide a switch which can be operated remotely. Still other objects will be apparent from the discussion which follows.

The above and other objects of this invention are accomplished by an electrical contact means comprising in combination a magnet and adjacent thereto a first and a second electrical contact members positioned in a normally spaced-apart relationship wherein at least one of the contact members contains paramagnetic material and is mounted for movement toward the other of said contact members in the presence of a magnetic field of a predetermined strength. The invention will be more readily understood by a description with reference to the accompanying drawings in which:

FIG. 1 is a view of one embodiment of the novel switching means.

FIG. 2 is a view of a thermostatic application of the switch of this invention.

FIG. 3 is a view of another embodiment of this invention.

FIG. 4 is a view of still another embodiment of this invention.

FIG. 5 is a view taken along line 5-5 of FIG. 4.

FIG. 6 is a view of another embodiment of this invention.

FIG. 7 is a view of still another embodiment of this invention.

Like elements in the different figures are designated by the same numeral or the same numeral primed.

In general, this invention comprises of a set of electrical contact members or means 1 and a magnet 2 adjacent thereto. At least one of the contact members in this set contains paramagnetic material. The electrical contact means in FIG. 1 is shown as a reed switch having two electrical contact members 3 and 4 in the form of thin and narrow metal strips containing magnetizable material such as soft iron, for example, but which does not become permanently magnetized. One end of each strip is normally disposed in spaced-apart

2

overlapping relationship as shown in FIG. 2. The other end of each strip is fixedly mounted relative to one another. In FIGS. 1, 3, 6 and 7, the reeds 3 and 4 are shown mounted at points 5 and 6 respectively in a glass envelope. The glass envelope is mounted on a suitable non-magnetic base 8 as of plastic, rubber, ceramic, or other non-magnetic and non-conductive material. In FIG. 2 the electrical contact members 3 and 4 are mounted at points 5' and 6' respectively onto a suitable non-magnetic material, such as Lucite, Bakelite, Vinylite, or ceramic, etc., without a glass envelope. The advantage of having the electrical contact members sealed in a non-magnetic and electrically non-conducting container such as glass or quartz, is that the contact members can then be sealed in the container in a partial or substantially total vacuum which diminishes the possibility of electrical arcing when the overlapping contact members are in a spaced-apart relationship. Alternatively, the envelope can contain an inert gas such as argon, helium, nitrogen, etc.

The magnet 2 is either a permanent magnet as shown in FIG. 1, or an electromagnet and is positioned so that its magnetic attractive force acts or tends to bring the two contact members into electrical contact. In the case of a reed switch as shown in FIG. 1, the magnet 2 is positioned adjacent one of the electrical contact members intermediate its ends. The magnet is positioned in spaced apart relationship relative to the movable paramagnetic material-containing electrical contact member which it actuates, at a distance such that the attractive force due to the magnetic field of the magnet 2 is insufficient to overcome the biasing force which normally holds the electrical contact member 3 in spaced-apart relationship relative to contact member 4. However, the distance is such that when the contact member 3 has been brought into electrical contact with member 4, the attractive force is sufficient to hold the members 3 and 4 in electrical contact. An adjusting screw 9, threaded through flange 10 which is attached to base 8, is either fixedly or rotatively attached to magnet 2. Adjustment of screw 9 relative to flange 10, serves to move the magnet 2 and thereby vary the distance between the magnet and the electrical contact member 3.

The magnet 2 in FIG. 1 has been marked to indicate that its north pole in end 12 is adjacent the electrical contact member while the south pole is further removed therefrom. This, however, is for purposes of illustration and example only, since the north and south pole positions of the magnet can be reversed without affecting the operation of the switch except in the manner described below. The magnet 2 need not be oriented in a perpendicular manner relative to the reed switch or any electrical contact member. The only requirement is that the magnet be so positioned that its magnetic lines of force will act to hold the contact members in electrical contact once such contact has been established, but its lines of force will be insufficient to bring the members into electrical contact when they are in a normally spaced-apart relationship. It is to be understood that an electromagnet can be used in place of a permanent magnet wherever shown in the drawing or mentioned in this writing, it being understood that an electromagnet has the necessary accompanying electrical circuitry which is well known in the art.

An additional attractive force is required to bring the contact members 3 and 4 into electrical contact. This force is supplied by a second, permanent or electromagnet 11 which is at least momentarily positioned so as to reinforce the action due to magnet 2 in bringing the members of the switch into electrical contact. In FIG. 1 the magnetic lines of force of magnet 2, which is positioned

3

adjacent to contact member 3, are reinforced by bringing to the vicinity thereof, a like pole of a second magnet 11. In the reed switch 1, where both contact members 3 and 4 contain paramagnetic material such as soft iron or rhodium, the exact physical location of the like pole of magnet 11 relative to contact member 3 is not critical, so long as the magnetic lines of force passing through the contact members are reinforcing in nature. Magnetic lines of force pass from the like poles adjacent to contact member 3 (which are North poles in FIG. 1), to the member 3. Then, as is well known in magnetic theory, some of the lines of force will pass along member 3 to the end 32 thereof. When the contact members are in spaced-apart relationship, the lines of force pass through the gap between ends 32 and 33 and then continue along member 4. Since the members contain paramagnetic material, the ends 32 and 33 will be drawn together to eliminate the gap and bring about electrical contact.

When an unlike pole of magnet 11 is brought into the vicinity of the contact members, the magnet 11 must be positioned so as to reinforce the lines of force from magnet 2 that pass through the contact members in order that the free ends thereof be brought together. One such location is indicated in dotted outline at 11' except that the N and S poles would be the reverse of that shown in FIG. 1. It will be noted that in this position, magnet 11' is adjacent contact member 4. Hence, magnetic lines of force pass from pole N of magnet 2, through the gap between magnet 2 and contact members 3, along member 3, through the gap between ends 32 and 33 of contact members 3 and 4 (at the area of overlap when the members are not in electrical contact as shown in FIG. 2, for example) along contact member 4, through the gap between contact member 4 and pole S of magnet 11'. Since the contact members contain paramagnetic material, the free, overlapping ends thereof will be drawn together bringing the reeds 3 and 4 into electrical contact with each other as explained above.

In FIG. 1 the magnets are both shown to be positioned on the bottom side of the switch 1. This, however, is for ease of illustration only since either of the two magnets can be placed at any location about the electrical contact member in question, provided that the polarity of the end of the magnet nearest the contact member is as described hereinabove. An example of another position of the second magnet is that shown to be occupied by electromagnet 13 in FIG. 7. The strength and position of the second magnet 13, or 11, or 11' with poles reversed, whether it be an electromagnet or a permanent magnet, are such as to bring members 3 and 4 into electrical contact with one another. The strength of magnet 2 is sufficient to maintain the contact members in electrical contact upon removal or deactivation of the second magnet 13, or 11, or 11' with poles reversed.

Once electrical contact has been established between members 3 and 4, the second magnet can be removed and magnet 2 will hold the members in electrical contact as above. If the second magnet is a permanent magnet, it is physically removed from a position where it can reinforce the attractive force of magnet 2. If the second magnet is an electro-magnet, it need only be deactivated by interrupting the associated electrical circuitry.

To break the electrical contact between members 3 and 4, it is only necessary to remove magnet 2 from the vicinity of the electrical contacts. In the case where magnet 2 is an electromagnet, it can be deactivated without removal. An embodiment of this invention, however, is to place a second magnet adjacent the electrical contact members in a position and orientation such that its magnetic lines of force counteract the attractive force between the free ends 32 and 33 due to the magnetic lines of force of the first magnet 2. When the force due to the second magnet is sufficiently high to counteract at least a part of the force of the first magnet, the electrical contact is broken, since, when the attractive force between the con-

4

tact members due to magnet 2 is substantially nullified, the contact members 3 and 4 return to their neutral positions wherein their free ends are in spaced-apart relationship. The attractive force between members 3 and 4 due to magnet 2 is counteracted by the presence of a magnet of opposite polarity adjacent contact member 3. Thus, a magnet in the position of magnet 11 but with N and S poles reversed would counteract the attractive force between member 3 and 4 due to magnet 2 and the electrical contact between the members would be broken. Since the second magnet can be placed in any radial location about the member under consideration, magnet 13 in FIG. 7 with a South pole adjacent contact member 3 would result in the return of the contact member to an electrically open circuit position since the magnetic lines of force would pass from the N pole of one magnet to the S pole of the other without passing from member 3 to member 4 through the gap between end 32 and 33. Alternatively, the presence of a magnet in the position shown for magnet 11' with the N pole adjacent contact member 4, would result in a separation of the contact members. In the latter case, the magnetic lines of force from magnet 2 would pass through contact member 3 towards contact member 4, while the lines of force from a like pole in magnet 11' would pass through contact member 4 towards contact member 3. Since like poles repel, there would be no attractive lines of force passing from end 32 to end 33 or vice versa to hold the contact members together in the overlapping area. In fact, there would be a repelling force causing the contact members to separate and thus break electrical contact. Like magnets 11 or 13, magnet 11' can be positioned in any radial location around contact member 4.

Magnets 11 can be mounted in or on a suitable non-magnetic holding member 14 for convenience in handling. Thus, magnet 11 can be readily positioned adjacent contact member 3 or contact member 4 by an appropriate movement of the end 15, which holds the magnet. The holder 14 can be handled manually in order to position magnet 11 adjacent the desired contact member.

An embodiment of this invention is to pivotally mount that end of the holding member 14 (not shown), which is opposite the end 15, so that end 15 can readily be shifted from a position adjacent contact member 3 to a position adjacent contact member 4 or vice versa. As explained above, if the poles adjacent the contact members, in magnets 2 and 11 are alike, then a position of magnet 11 adjacent contact member 3 will bring about or sustain electrical contact between the members, while a position of magnet 11 adjacent contact member 4 will bring about or sustain an electrically open circuit condition. If the N and S poles of magnet 11 are reversed so that the ends of the magnets 2 and 11 adjacent the contact members are of unlike polarity, then the presence of magnet 11 adjacent contact member 3 results in a separation of the contact members, while on the other hand, the presence of magnet 11 with the S pole adjacent contact member 4 results in the formation or retention of electrical contact between the members, as explained above.

In FIG. 1, the fixed base 5 of the electrical contact member 3 is connected in series to conductors 16, 17, 18, a source of electrical current 19, conductors 20, 21, 22, a load 23 such as a light bulb, conductor 24, and fixed base 6 of electrical contact member 4. When contact members 3 and 4 are in electrical contact, current flows through the load 23. If the load is a light bulb, the flow of current will be evidenced by a lighting up of the bulb. When the electrical contact between members 3 and 4 is broken, the light will go out.

In FIG. 7, the coil 25 which actuates electromagnet 13 is connected in series with conductors 26, 27, 17, 18, source of current 19, conductors 20, 21, 28, 29, contact switch 30 and conductor 31. The source of power for electromagnet 13 is shown as battery 19 for convenience

of illustration only, and is not limiting since the electromagnet can have a separate power supply.

To illustrate the operation of the above described switch, consider the case where the electrical contact points 32 and 33 (free ends of members 3 and 4 respectively) are initially in a spaced apart relationship, that is the switch 1 is open. Magnet 2 is positioned adjacent member 3 in a manner and at a distance such that the magnetic attraction between ends 32 and 33 due to the line of force passing from contact member 3 to contact member 4 is not sufficient to pull member 3 toward member 4, but is nevertheless sufficient to hold the members in contact once such contact has been established. An operator next manipulates holder 14 having magnet 11 mounted in the end thereof, so as to either (1) bring a pole of magnet 11, which is alike to the pole in end 12 of magnet 2, adjacent to member 3 or (2) bring a pole of magnet 11, which is the magnetic opposite of the pole in end 12 of magnet 2, adjacent to member 4. Then, as explained above ends 32 and 33 of members 3 and 4 will make electrical contact and light 23 lights up. Holder 14 is next removed from vicinity of contact members 3 and 4. Magnet 2 holds member 3 in electrical contact with member 4 and current continues to flow through light bulb 23. It is to be noted that the source of current can be 110 volt line current available in any home or industrial structure, and bulb 23 can be an ordinary light bulb or an electroluminescent light which, for example, can be mounted over the switch 1 and magnet 2. In the latter case, the switch 1 can be actuated by bringing magnet 11 to the vicinity of the proper member 3 or 4 but on the side of the electroluminescent light panel further removed from the switch 1. To break the electrical contact between ends 32 and 33, and thereby extinguish the light, a magnetic pole in end 15 of the holder 14, unlike the pole in end 12 of magnet 2, is brought adjacent to member 3. Alternatively, a magnetic pole in end 15 of the holder 14, having the same polarity as the end 12 of magnet 2, is brought adjacent to member 4 and the electrical contact between members 3 and 4 is broken.

In the embodiment shown in FIG. 7, switch 30 is closed so as to cause the electromagnet to be actuated in a manner such that the magnetic pole thereof adjacent member 3 will be of opposite polarity to the pole in end 12 of magnet 2. The attractive force due to lines of force from magnet 2 between members 3 and 4 are thus counteracted and members 3 and 4 returns to their normal spring-biased position, breaking contact between ends 32 and 33. As a consequence thereof, the light goes out. It is to be understood that the electromagnet can be positioned adjacent member 3 or adjacent member 4, and with a selection of the proper polarity at its ends as discussed above, electrical contact between ends 32 and 33 can be interrupted. A permanent magnet positioned in place of the electromagnet functions in the same manner to interrupt the electrical contact.

The strength of the second magnet (magnet 11 or 13), is such that when used to close the switch, its lines of force when added to the lines of force of the first magnet (magnet 2) that pass from one contact member to the other, the combined lines of force result in an attractive force between the contact members sufficient to bring the movable ends into electrical contact. When the second magnet is used to break electrical contact between the contact members, it is brought sufficiently close to the appropriate contact member to counteract the attractive force between the contact members due to the first magnet. However, the second magnet is not so strong nor is it brought so closely to the contact members that its lines of force, though opposed to those of the first magnet, would be sufficient in themselves to hold the contact members in electrical contact. The size and strength of either the first or the second magnet depends on the

biasing force that keeps the contact members in a normally spaced-apart relationship and the distance that the magnet is positioned from the contact members. In the case of a reed switch of the type shown in FIG. 1 in which the reeds, made of rhodium, are sealed in a glass envelope in an atmosphere of nitrogen at a pressure of substantially 25 ± 5 p.s.i.g.; having a pull in characteristic of about 64-150 amp. turns, and a drop out of 40-60% of pull in, it is found that a rod-shaped magnet 1 inch long and $\frac{3}{16}$ inch in diameter, made of alnico, positioned at a distance of from about $\frac{1}{4}$ inch to about $\frac{5}{16}$ inch from one of the reeds, will not by itself bring about electrical contact between the reeds contact members. A second magnet of substantially equal magnetic strength of the first magnet (magnets of from $\frac{1}{4}$ to 10 times or more of the strength of the first magnet work equally well) when employed as explained above, can result in either the making or breaking of electrical contact between the reeds.

A plurality of switches and accompanying lights of the type shown in FIG. 1 can be set up to illuminate sections of an instruction chart. The holder 14 can be used by an instructor to close selected ones of the plurality of switches and thus illuminate, with either conventional or electroluminescent lights, selected sections of the chart. Deactivating electromagnets 13 for each switch 1 as shown in FIG. 7, can be connected to a common switch so that the closing of the common switch by the instructor causes an electromagnet 13 to be actuated in each of the plurality of switch units, extinguishing all the lights simultaneously. In like manner, actuating magnet 11 for each switch can be an electromagnet connected to a common switch for closing electrical contacts 32 and 33 in each of the plurality of switches and thus illuminating all the lights. Electromagnet 13 can serve the last described function by merely having its polarity reversed.

An embodiment of this invention is to adjust magnet 2 in FIG. 7 to such a position relative to electrical contact member 3 that the attraction between members 3 and 4 due to the lines of force from magnet 2, when reinforced by the magnetic lines of force in the earth's field, will be sufficient to bring contact member 3 into electrical contact with member 4. The electrical contact can then be broken by activating magnet 13 with the proper end polarity. Upon deactivating the electromagnet, electrical contact will again be established if the earth's magnetic lines of force continue to reinforce the lines of force due to magnet 2. It will be readily seen that this provides a new form of compass. When the North seeking pole of the magnet 2 is in end 12 and its magnetic lines of force passing through members 3 and 4 are reinforced by the lines of force of the earth's magnetic field, the north seeking end of magnet 2 will be pointing substantially in a southerly direction. A pointer 96 can be attached to base 8 so as to point in a southerly direction when the contact members are aligned in an east-west direction and end 12 of magnet 2 is pointing in a southerly direction. When the base 8 is rotated so that the north-seeking end of the magnet 2 is pointing in a northerly direction, the attractive force between the contact members due to the lines of force from magnet 2 will not be reinforced by the earth's magnetic field and contact between points 32 and 33 will remain broken after temporary activation of magnet 13. Now, when a light 23 is in the circuit of which the switch is a part, the light will go on after each breaking of the circuit when pointer 96 is pointing in a southerly direction and will remain extinguished after each breaking of the circuit by magnet 13 when the pointer 96 is pointing in a northerly direction. When fixed scale 97 is associated with rotating base 8, observations can be made as to the point on the scale indicated by pointer 96 at which the light (a) goes on following each circuit breaking by the use of magnet 13, and (b) stays out after the circuit is broken with the aid of magnet 13. In indication of true south can then be

made by determining the mid-point between (a) and (b). The scale 97 can completely surround the rotating base 8. It is to be noted that if the polarity of magnet 2 is reversed, the light will go on and off for each deactivation and activation of magnet 13 when the pointer 96 is pointing in a northerly direction.

FIG. 2 illustrates another embodiment of this invention in which a proximity switch 1' has its metal strips 3 and 4 fixedly mounted on their terminal ends 5' and 6' respectively to a suitable non-magnetic base 97. The terminal leads 41 and 42 are connected to the base mountings 5' and 6' and lead to equipment to be actuated such as a heating unit, not shown. The magnet 2 is fixedly mounted on a non-magnetic arm 43 such as for example Lucite, Bakelite, ebonite, etc. The arm is connected to a temperature responsive means 44 which, in FIG. 2, is illustrated as a bi-metallic spring which has its first end 45 connected to the arm 43 and its second end 46 mounted on base 97. Guide means 98 and 99 are mounted on base 97 and serve to guide end 45 of the temperature responsive means as it moves with variation in temperature. The latter means serves to move the magnet from a position adjacent member 3 to a position adjacent member 4 and vice versa. The magnet 11' of FIG. 2 is shown to have its south pole nearer the contact members of the switch. Therefore, when magnet 11' is adjacent contact member 3, the switch will be open, and when magnet 11' is adjacent to contact member 4, the switch will be closed. It is in this manner that the temperature responsive member is used to control the switch 1 through the magnet to which it is operatively connected. Although the magnets in FIG. 2 are illustrated as permanent magnets this embodiment operates in the same manner when one or both of the magnets are electromagnets.

As illustrated in FIG. 2, the contact members 3 and 4 need not be enclosed in a glass envelope. The contact members and magnet(s) that are mounted on a base in this invention are mounted by any suitable means such as clamps which can be of non-magnetic material or they can be mounted in depressions in the base and held in place by plastic, cement, mortar, plaster of Paris, etc. Alternatively, the contact members and magnet(s) can be encapsulated in plastic such as phenolic resin, acrylic resins, alkyd resins, Bakelite, Lucite, phenol formaldehyde resins, polyethylene, etc.

Another embodiment of this invention is to replace the temperature responsive means with manual control means for moving the south pole of magnet 11' from one position to another. This embodiment then provides a simple electrical switch, as for example an electrical wall switch.

FIG. 3 illustrates still another embodiment of this invention in which the combination of a proximity switch 1 and a magnet 2 is used as an ordinary electrical switch. The magnet 2 is connected to one end of an arm 51 having its other end pivotally mounted so that the magnet 2 can be moved toward the switch 1 or retracted from it. The retracted position of magnet 2 is shown in dotted outline as 2'. A turn knob 52 is operatively connected to arm 51 to facilitate manual movement of magnet 2 toward, and away from, the switch 1. When the magnet 2 is brought sufficiently close to switch 1, the electrical contact members will be brought together, and when the magnet is removed from the vicinity of the switch, as, for example, the position indicated in dotted outline, the electrical contact members return to their normal spaced-apart position, thereby breaking the electrical contact. Preferably the magnet is positioned so as to be adjacent electrical contact member 3, when it is moved near to switch 1, so as to attract member 3, toward electrical contact 4 or to permit the magnetic lines of force to pass from member 3 to member 4 and draw the free ends together. The embodiment shown in FIG. 3 is used as an

ordinary light switch, for example. The magnet 2 can, of course, be replaced by an electromagnet.

Another embodiment of this invention is illustrated in FIG. 4 in which a magnet 61 is manipulated in a plane substantially parallel to the plane of movement of the electrical contact members 3 and 4. The midpoint between the north and south poles of the magnet being substantially opposite the free ends 32 and 33 of the electrical contact members 3 and 4. The magnet 61 is mounted for rotation by shaft 62. When the line joining the north and south poles of the magnet 61 is substantially parallel with the direction of motion of the electrical contact members, the contact members are in their normal, spaced-apart position. When the magnet 61 is rotated by shaft 62, the contact members 3 and 4 will be in spaced-apart relationship when a line joining the north and south poles of the magnet is substantially parallel to the direction of motion of the members and will be in electrical contact when the line joining the poles of the magnet is perpendicular to the direction of motion. Thus, the switch will repeatedly open and close as the magnet is rotated.

In FIG. 5 is shown a section view taken along line 5—5 of FIG. 4. The rotatable shaft 62 is connected to a motor M which can be an internal combustion engine or an electrical motor drawing power from an electrical source, not shown. In one operation rotation of the magnet 61 at 15,000 r.p.m. for a period of 28 hours, causing a counting circuit, not shown, connected across mounting points 5' and 6' to record 50,400,000 cycles of the making and breaking of the circuit by the switch members without failure.

FIG. 6 illustrates an adaption of this invention to an ignition system for an internal combustion engine. The rotor 71, mounted for rotation on central shaft 72, actuates contact member 73 through connecting arm 74. Each time one of the cam shoulders 75 passes arm 74, contact member 72 is moved into electrical contact with member 76. An electrical current then flows from the source of potential B₁, through the winding 77 of electromagnet or relay 78, conductors 79 and 80, electrical contact members 73 and 76 and conductor 81 to ground. When the electromagnet 78 is actuated the contact members 3 and 4 of the switch 1 are closed. Once the cam shoulder 75 is past the arm 74 the contact between members 73 and 76 is broken thereby deactivating electromagnet 78 and the electrical contact in switch 1 is broken. Capacitor 82 is connected across contact members 73 and 76 in order to prevent sparking when electrical contact between the latter is broken. Capacitor 83 serves the same purpose across switch 1.

When electrical contact is made between members 3 and 4 of switch 1, current flows from a source of potential B₂ through conductor 84, a primary coil in coil 85, conductor 86, contact members 4 and 3 of switch 1 and conductor 87 to ground. The flow of current from the source of power through the primary of coil 85 causes a current to flow through the secondary induction coil of coil 85 and through conductors 88, 89 and 90. Common conductor 90 has a plurality of switches 1'' connected thereto by means of conductors 101 leading to one of the electrical contact members in each switch. A magnet 2 is mounted on the end of a rotatable shaft 91 with the plurality of switches 1'' disposed in a circle around the rotatable shaft. The shaft 91 is rotated by an actuating source, not shown. The plurality of switches 1'' are so positioned about the rotating magnet 2 that the magnet will bring about electrical contact between the members 3'' and 4'' of each switch successively. In an alternate embodiment, each of the switches 1 and 1'' can have a magnet adjacent to one of the contact members as in FIG. 1, together with means for deactivation. Only one switch at a time has electrical contact between members 3'' and 4'' as one end of the rotating magnet 2 passes in the vicinity thereof. The closing of a predetermined switch 1'' is co-ordinated with the closing of contact members 73

and 76 of switch 92 by a given one of the cam shoulders 75. One of the contact members of each of the switches 1" is connected to the common conduit 90 and the other contact member is connected by conductor 93 to an electrode 94 in a spark plug 95. The other electrode of the spark plug is connected to ground. The system shown in FIG. 6 has two improved embodiments. The switch 92 takes the place of the distributor points in the ignition system of an automobile, for example. The current that flows from electrical potential B₁ is just sufficient to cause excessive sparking between the contact points in switch 92. Consequently, switch 92 will not deteriorate as rapidly as the distributor points now used in an automobile and will not have to be replaced as often. In fact, switch 92 can be made to last substantially the lifetime of the automobile. A heavier current will flow through switch 1 from the source B₂. However, this also will not be sufficient to cause as rapid a degeneration of the contact points 3 and 4 as is presently the case in an automobile ignition system. Even though replacement of switch 1 may be necessary periodically, retiming of the engine will not be necessary as is now the case when points are replaced. This results in a saving of both time and money. The rotating magnet 2 will close a selected one of the switches 1" just prior to the closing of switch 1 by the electromagnet 78 and will keep it closed as it rotates past it until switch 1 has opened again. Thus the high potential required for the spark plug 95 will only see one spark gap and that is the one in the spark plug, so that no other contact points will be subjected to a high potential spark. The switch 1" together with the rotating magnet 2 will replace the rotor and distributor in an ignition system. Presently a spark is required to traverse the space between the rotor and spark plug contact members in a distributor system of an automobile. Deterioration also occurs on these components and periodic replacement of parts is necessary. Since the electrical contact in each one of the plurality of switches 1" will be closed when the current from the coil is initiated, no spark burning of switch contact points is encountered. Satisfactory operation of an automobile is obtained with the use of the invention described above in conjunction with FIG. 6.

The novel switching means of this invention can be used in computer circuits wherein data processing is accomplished with the aid of on-off switching means. The switching means of this invention, utilizing a permanent magnet for magnet 2, are insensitive to power failure. The switching means is substantially unaffected by changes in temperature or radiation from radioactive sources. The simplicity of the component parts and low maintenance requirements make the switching means economically attractive.

Although this invention has been described and illustrated with reference to a magnet having one of its magnetic poles nearer to an electrical contact member, than the other of its poles, this is not to be taken as a limitation of the angle made by a line joining the north and south poles of a magnet with a plane in which the electrical contact member lies. For example, magnet 2 in FIG. 1, whether it be a permanent magnet or an electrical magnet, can be placed in a position which is parallel to one of the electrical reeds 3 or 4. If the magnetic lines of force of the magnet are of sufficient strength, the reeds 3 and 4 will come into electrical contact. This is the case in connection with the description relating to FIGS. 4 and 5. A preferred embodiment is to use a first magnet of insufficient magnetic lines of force to bring the reeds into electrical contact so that a second magnet is necessary to accomplish this. An especially preferred embodiment of this invention is to position the first magnet so that both of its magnetic poles are to one side of the area where the reeds or other contact members come into electrical contact. For example, in FIG. 1, both magnetic poles of the first magnet 2 are to one side of a plane taken substantially normal to the contact members and placed so

as to substantially bisect the overlapping area of the two contact members. A switch of this invention in which the first magnet is parallel to the contact members of a reed switch, operates as well as a switch in which the magnet is substantially at right angles to the longitudinal axis of the contact members. The second magnet also performs satisfactorily when it is moved in the vicinity of the contact members and of the first magnet in a manner such that the line joining the north and south poles of the second magnet is likewise parallel to the longitudinal axis of the reed contact members. The only requirement is that the magnetic lines of force of the two magnets be reinforcing in order to bring the electrical contact members together, or opposing in order to permit the biasing or restoring force of the individual contact members to bring about a separation of the members and thus an opening of the switch.

Although the present invention has been described and illustrated in detail, the same is to be taken by way of illustration only and not by way of limitation, the spirit and scope of this invention being limited only by the appended claims.

I claim:

1. In combination

a switch comprising a first and second contact members containing paramagnetic material said contact members being of elongated strip design, each of said contact members having a first free end and a second fixed end, said first ends of said contact members being normally in overlapping spaced-apart relationship, and said second end of each of said contact members being fixedly mounted,

an electromagnet positioned adjacent one of said contact members of a first one of said switches,

a means for intermittently actuating said electromagnet, a load comprising a voltage multiplying means and a source of potential, said load and said source of potential being connected in series with said electrical contact members,

a second one of said switches,

a use means connected in series with said voltage multiplying means through said second one of said switches, and

a rotating magnet for intermittently making and breaking electrical contact between the free ends of said second one of said switches, said second switch being closed prior to said first switch and remaining closed until after the opening of said first switch.

2. The combination of claim 1 wherein said use means comprises a plurality of individual use means, and said second switch means comprises a plurality of individual switches,

and wherein said rotating magnet means intermittently makes and breaks electrical contact in each one of said plurality of switches successively.

3. In an ignition system for internal combustion engines having an induction coil which has a primary coil and a secondary induction coil, the combination comprising:

a plurality of individual electrical switch means, each comprising a first and second contact member containing paramagnetic material, said contact members being of elongated strip design, each of said contact members having a first free end and a second fixed end, said first free ends of said contact members being normally in overlapping spaced-apart relationship, and said second end of each of said contact members being fixedly mounted;

a plurality of individual use means, each said use means connected in series with said secondary induction coil through a different one of said electrical switch means;

a magnetic actuating means for intermittently closing the contacts of said electrical switch means at predetermined intervals;

wherein the contacts of one of said electrical switch means are closed prior to the passage of current through said secondary induction coil thereby eliminating arcing across the contacts of said electrical switch means; and

wherein said magnetic actuating means is a rotating magnet means in which said magnet passes in close proximity to each of said electrical switch means successively, thereby closing and opening the contacts intermittently of each said electrical switch means in succession.

4. In an ignition system for internal combustion engines having an induction coil which has a primary coil and a secondary induction coil, the combination comprising:

- a first electrical circuit comprising a first source of potential; and
- a first electrical switch means connected in series with said first source of potential and said primary coil, a second electrical circuit comprising a second source of potential;
- an electromagnet positioned adjacent said first electrical switch means;
- a second electrical switch means connected in series with said second source of potential and said electromagnet; and
- a first actuating means for intermittently opening and closing the electrical contacts of said second electrical switch means, thereby permitting current to flow intermittently from said second source of potential so as to intermittently actuate said electromagnet and close the contacts of said first electrical switch means, thus permitting current to flow from said first source of potential through said primary coil;
- a third electrical circuit comprising a plurality of individual third electrical switch means wherein said first electrical switch means and each of said plurality of individual third electrical switch means comprises a first and second contact members containing paramagnetic material, said contact members being of elongated strip design, each of said contact members having a first free end and a second fixed end, said first free ends of said contact members being normally in overlapping spaced-apart relationship, and said second end of each of said contact members being fixedly mounted;
- a plurality of individual use means each said use means being connected to said secondary induction coil through a different one of said plurality of individual third electrical switch means; and

a magnetic second actuating means for intermittently closing and opening the contacts of said third electrical switch means; and

wherein the contacts of one of said plurality of individual third electrical switch means are closed prior to the closing of the electrical contacts in said second electrical switch means, thereby preventing arcing across the contact terminals of said third electrical switch means; and

wherein said magnetic second actuating means comprises a rotating magnet means which passes in close proximity to each of said individual third electrical switch means in succession, thereby causing the contacts to close and open intermittently in each of said switch means in succession.

References Cited by the Examiner

UNITED STATES PATENTS

2,240,847	5/1941	Hildebrecht	200—87
2,289,830	7/1942	Ellwood	200—87
2,478,672	8/1949	Smits	315—226
2,770,697	11/1956	Kellett	200—87.3
2,781,412	2/1957	Mike	200—19
2,803,720	8/1957	Mason	200—87.3
2,877,361	3/1959	Chase	200—87.3
2,901,672	8/1959	Lauer	315—226
2,902,558	9/1959	Peek	200—87
2,907,846	10/1959	Wilhelm	200—87
2,929,895	3/1960	Shebanow	200—87
2,931,021	3/1960	Brown	340—282
2,973,414	2/1961	Bossemeyer	200—56
2,999,915	9/1961	Pfleiderer et al.	200—87
3,012,116	12/1961	Boylan et al.	200—87
3,046,370	7/1962	Adams et al.	200—87

FOREIGN PATENTS

1,182,298 6/1957 France.

OTHER REFERENCES

German printed application, Weitzel, 1,095,360, Dec. 22, 1960.

IBM Technical Disclosure, page 19, titled Toggle Switch, vol. 4, No. 11, dated April 1962.

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