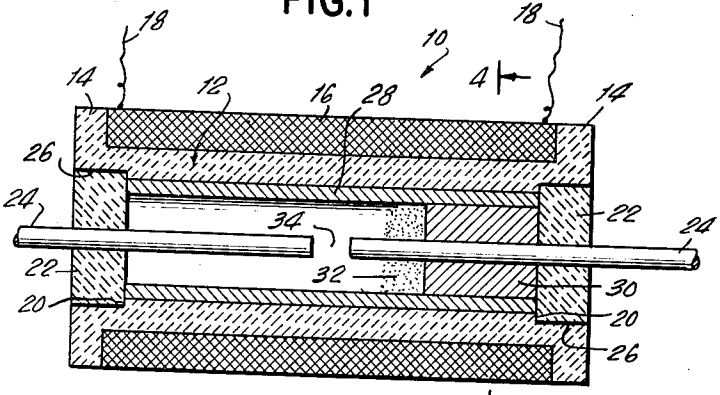
Aug. 10, 1965 A. D. DEUTSCHMAN 3,200,216

MAGNETIC PARTICLE SWITCH PROVIDED WITH QUICK DISCONNECT

Filed March 1, 1962

FIG. 1



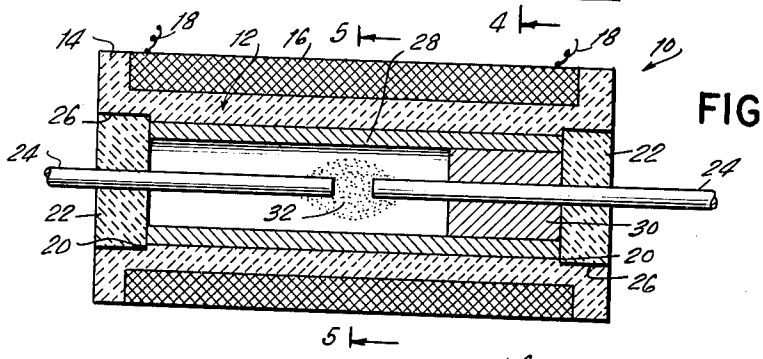


FIG. 2

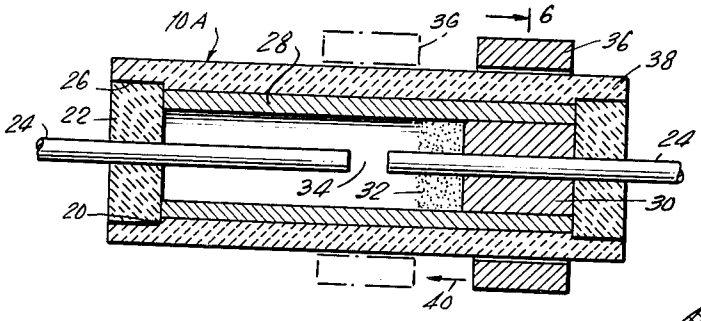
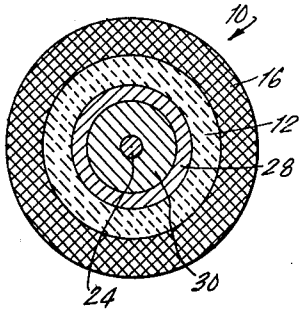


FIG. 3

FIG. 4



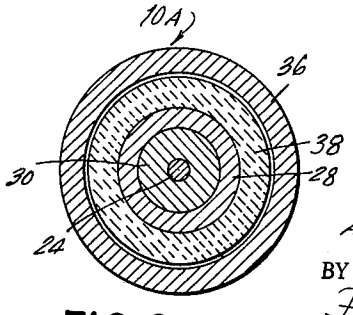
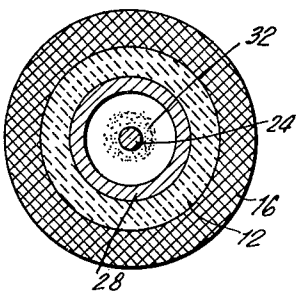


FIG. 6

FIG. 5



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3,200,216
MAGNETIC PARTICLE SWITCH PROVIDED WITH QUICK DISCONNECT

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1 Claim. (Cl. 200—87)

The present invention relates in general to electrical switching apparatus and, in particular, to a magnetic switch or relay.

The present invention relates to an enclosed type of switch which is provided with a pair of spaced electrical terminals which, when the switch is energized, are bridged by a quantity of conducting particles to complete the circuit through the switch. A disadvantage of prior art switches of the described type resides in the fact that the time required to discontinue the flow of current through the switch or relay is relatively long due to the fact that time is required for the particles which bridge the gap to be removed therefrom as a result of the removal of a magnetic field which originally caused the particles to bridge the gap.

In view of the foregoing, it is an object of the present invention to provide a switch or relay of the described type which eliminates the disadvantages of prior art switches of this type.

It is another object of the present invention to provide a switch or relay of the described type in which there is a substantially sharp and instantaneous discontinuance of current flow therethrough when the magnetic field which causes the particles to bridge the gap is discontinued or removed.

Another object of the present invention is to provide a switch or relay of the described type which is highly efficient in operation and which nevertheless can be manufactured and sold at a relatively low cost.

A further object of the present invention is to provide a switch or relay of the described type which will have a relatively long life and which has no moving parts, other than the conducting particles.

Other and further objects and advantages of the present invention will be readily apparent to one skilled in the art from a consideration of the following specification taken in connection with the appended drawing.

In the drawing which illustrates the best mode presently contemplated for carrying out the invention:

FIGURE 1 is a longitudinal sectional view taken through a switch or relay pursuant to the present invention with the switch being shown in the open or de-energized condition thereof;

FIGURE 2 is a view similar to FIGURE 1 and illustrates the switch or relay in the energized or current conducting condition thereof;

FIGURE 3 is a view similar to FIGURE 1 and illustrates another embodiment;

FIGURE 4 is a sectional view taken on the line 4—4 of FIGURE 1;

FIGURE 5 is a sectional view taken on the line 5—5 of FIGURE 2; and

FIGURE 6 is a sectional view taken on the line 6—6 of FIGURE 3.

Referring now to FIGURES 1, 2, 4 and 5 of the drawings in detail, there is shown a magnetic switch or relay 10 pursuant to the present invention. As here shown, the relay 10 comprises a cylindrical hollow housing or coil bobbin 12 which is formed of a suitable insulating material, preferably a suitable ceramic, and is provided with the end flanges 14—14. A field coil 16 is wound about the bobbin 12, being retained within the end flanges 14 thereof and being provided with the leads 18—18. At each end thereof, the bobbin 12 is provided with a cut-away portion which defines a seat 20. An insert or plug 22 is seated or inserted in each of the seats 20. The inserts 22 are formed of a suitable material, preferably a suitable ceramic or insulating material and each has mounted therein, as here shown, a conductor or lead 24. The leads 24 may be formed of any suitable material, such as for example, the material known as "Kovar." While in the present embodiment one lead 24 is shown inserted in each of the end plugs 22, it will be understood that it is within the scope of the present invention to provide a plurality of leads in each of the plugs 22 when it is desired to provide a multiple pole switch relay in lieu of a single pole switch or relay as shown in the drawings. It is also within the scope of the present invention to provide a Kovar ring about the circumference of each of the plugs 22. Further in this connection, the switch or relay 10 is a hermetically-sealed unit and in this connection a suitable metallic seal is provided on the circumferential periphery of each of the plugs 22, as indicated at 26 so as to hermetically seal the open interior of the bobbin 12 into which the leads 24 extend. In order to improve the magnetic qualities of the device 10, a tube 28 formed of suitable magnetic or magnetically permeable material is provided at the inner diameter of the bobbin 12. Pursuant to an important aspect of the present invention, a permanent magnet 30 is provided within the tube 28 in abutment with one of the end plugs 22, here shown as the end plug at the right end of the device 10 viewing FIGURE 1, the associated lead 24 extending through the permanent magnet 30, the function of which will presently appear. Within the tube 28 there is provided, within the interior of the bobbin 12, metallic particles or filings 32, preferably formed of soft iron, and preferably coated with a suitable conductive material, such as for example, silver or copper.

FIGURE 1 illustrates the condition of the device 10 when the field coil 16 is de-energized. It will be noted that in said condition of the device 10, the magnetizable particles 32 are attracted by the permanent magnet 30 so that they are completely removed from the gap between the spaced confronting ends of the companion leads 24. Consequently, it will be apparent that the switch or relay 10 is de-energized and that there can be no flow of current through a circuit to which the leads 24 are connected. However, when current is applied to the field coil 16 through the leads 18, a magnetic field will be developed or result therefrom, which field will, it is understood, be stronger than the field or magnetic course provided by the permanent magnet 30. The magnetic field resulting from the energization of the field coil 16, and reinforced by the magnetizable tube 28 will cause the metallic particles 32 to be moved from the influence of the permanent magnet 30 so as to be arranged between and across the gap 34, thereby filling the gap as illustrated in FIGURE 2, which shows the device 10 in its condition when current is applied to the field coil 16. With the gap 34 bridged by the metallic particles 32, it will be apparent that the leads 24 are electrically connected to each other, so that the circuit to which the leads 24 may be connected will now be completed for the flow of current therethrough so as to energize the particular circuit, for example and not by way of limitation, a motor controlled circuit. If it is desired to increase the current carrying capacity of the device 10, it is merely necessary to increase the amount of current being supplied to the field coil 18. By increasing the current flow through the field coil 18, the magnetic flux generated thereby is increased and consequently the metallic particles 32 become more closely packed together so as to decrease the resistance to current flow therethrough. Therefore, as the field current is increased and the resistance to current flow through the particles 32 is decreased, a greater amount of current

the current flow through the field coil 16, the magnetic field created thereby will collapse so that the particles 32 bridging the gap 34 will fall away therefrom. Pursuant to the previously described feature of the present invention, it will be understood that with the discontinuance of the magnetic field provided by the field coil 16, the sole magnetic field remaining within the bobbin 12 is that created or provided by the permanent magnet 30. Consequently, when the magnetic field of the field coil 16 is discontinued, the magnetic field of the permanent magnet 30, which, as previously indicated, is not as great or as strong as the electromagnetic field of coil 16, will nevertheless be effective to immediately attract the iron particles from their bridging condition to the condition thereof illustrated in FIGURE 1. This provides a more effective control upon discontinuance of the energization of the field coil 16 in view of the fact that it provides a much faster and more efficient termination of current flow through the leads 24 or a sharper break in the flow of current through the leads 24 than was previously possible with devices of the general type to which the present invention relates.

Referring now to FIGURES 3 and 6, there is shown another embodiment of the invention. While the device illustrated in FIGURES 1 and 2 operates completely automatically in response to the energization of the field coil 16, the device 10A illustrated in FIGURES 3 and 6 provides for a mechanical switch operation. In the device 10A the field coil 16 is eliminated and in lieu thereof a circular permanent magnet 36 is mounted for slidable movement along the external surface of the cylindrical hollow housing 38, which in all respects, is similar to the bobbin 12 except that it is not provided with the end flanges 14. In all other respects, the construction of the device 10A is similar to the construction of the device 10 and similar parts are indicated by similar reference numerals. In the de-energized condition of the switch 10A, the permanent magnet 36 is disposed in the full-line position thereof as illustrated in FIGURE 3, in which it will be noted that it is removed laterally from a position encompassing the gap 34. It will be understood that the magnetic field created by the permanent magnet 36 is greater than the magnetic field created by the permanent magnet 30 so that when the permanent magnet 36 is moved to the left, viewing FIGURE 3 as indicated by arrows 40 to the broken line position thereof, the magnetic field thereof is concentrated at the gap 34 so as to attract or draw the metallic particles 32 from their position in abutment with a permanent magnet 30 to a position in which they bridge the gap 34 in the same manner as shown in FIGURE 2. If it is desired to increase the current carrying capacity of the device 10A, it is merely necessary to provide a permanent magnet 36 which develops a stronger magnetic field. When it is desired to open the switch so as to interrupt the current flow through the leads 24, the magnet 36 is moved from its broken line to its full line position shown in FIGURE 3. When this occurs, the permanent magnet 30 is effective as in the device 10 to provide a sharp and immediate discontinuance or break in the current flow through the leads 24 by causing an immediate removal of the particles 32 from their bridging position across gap 34 to the position thereof as shown in FIGURE 3.

In view of the foregoing, it will be apparent that there has been disclosed a highly novel electromagnetic relay or switch or a mechanical switch which is relatively small in physical size but which nevertheless can provide an effective control of current flow therethrough and which also provides an immediate discontinuance or break in the current flow when the energizing force is removed. Since

there are no moving parts in the device 10 and merely an externally movable permanent magnet in the device 10A, both devices will have a relatively long useful life. Moreover, due to the arrangement of the end plugs 22 and the seal 26, it will be noted that the interior of the device which contains the particles 32 is readily hermetically sealed and moreover it will be apparent that the complete device itself can be hermetically sealed in a relatively simple and inexpensive manner. Moreover, the current carrying capacity of each of the devices may be changed in a very simple manner, namely, by changing the current flow through the field coil 16 in the device 10 or by providing a permanent magnet 36 of a different strength or magnetic capacity in the case of the device 10A. In addition, it will be noted the the utilization of springs is completely eliminated in the devices of the present invention. Moreover, it will be apparent that these devices are explosion proof since the units are hermetically sealed and the devices can be utilized in an explosive atmosphere.

The embodiment of the invention illustrated and described hereinabove has been selected for the purpose of clearly setting forth the principles involved. It will be apparent however that the present invention is susceptible to being modified in respect to details of construction, combination and arrangement of parts which may be resorted to without departure from the spirit and scope of the invention as claimed.

I claim:

A relay comprising a hollow bobbin closed at both ends thereof, a field coil provided on said bobbin, cooperating leads extending into the hollow interior of said bobbin and defining a gap therebetween, magnetically permeable non-spherical particles provided within said bobbin to bridge said gap in response to the energization of said field coil, and means to positively remove said particles from said gap upon de-energization of said field coil, said leads having only an electric circuit relation with said particles, said particle removing means comprising a single magnetic means provided on said relay and associated with one of said leads, said magnetic means being a single permanent magnet provided within said hollow bobbin interior and providing a magnetic field of lesser intensity than that provided by said field coil, said single magnet straddling said one lead.

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