

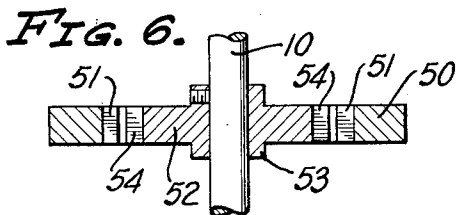
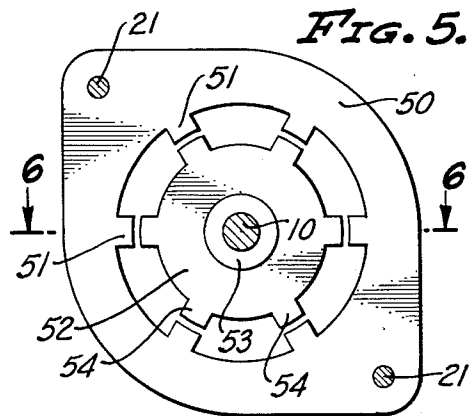
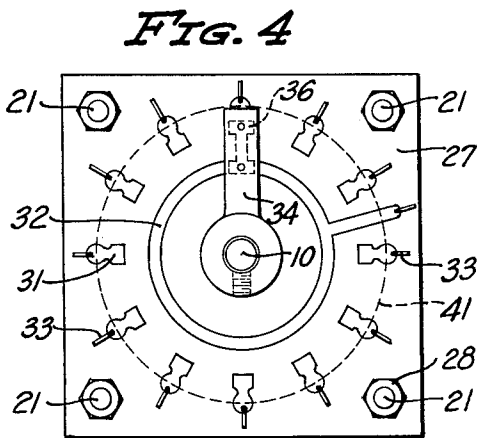
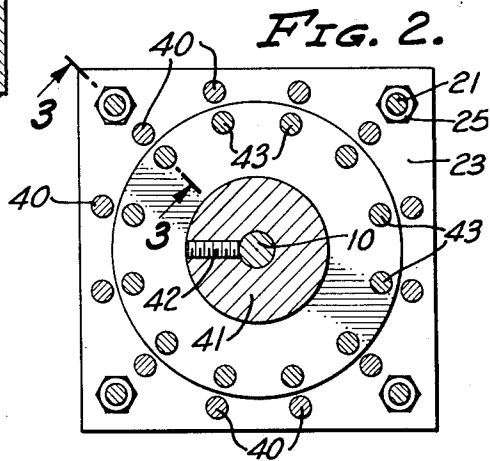
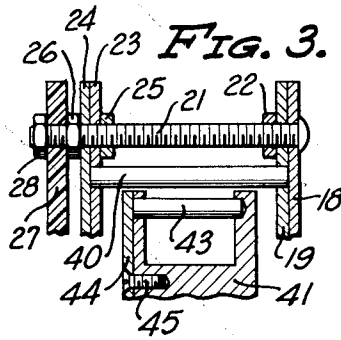
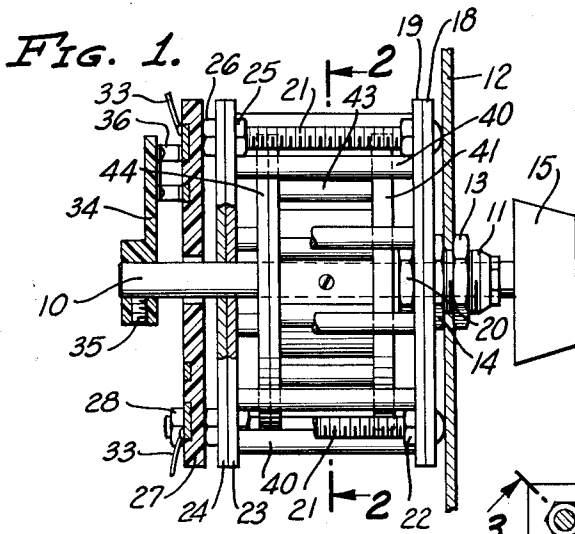
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SILENT SWITCH

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SILENT SWITCH

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2 Claims. (Cl. 200—11)

This invention relates to switches for electrical circuits and, in particular, to electrical switches which are silent in operation.

A conventional multiple circuit switch includes a frame and a rotating shaft for moving one electrical contact into engagement with a selected one of a plurality of additional electrical contacts. In order to positively position the one contact at each of the additional contacts, rather than between contacts or at an edge thereof, a detent mechanism in the form of a spring-loaded member and a receptacle for the member is provided in the switch. The spring-loaded detent produces an audible sound during its operation which is undesirable in many switch applications. Various expedients have been used to reduce this noise, including sound absorption and damping techniques, but these are expensive and not entirely satisfactory.

Accordingly, it is an object of the invention to provide an electrical switch that is silent in operation, thereby eliminating any requirement for sound absorption or damping. A further object is to provide such a switch which may be used in hearing testing equipment without interfering with the test procedure. A further object is to provide such a switch having the desirable snap action and the positive contact positioning characteristics of conventional detent switches while eliminating the noise associated therewith. Another object is to provide such a switch having no mechanically engaged parts in the switch centering mechanism thereby eliminating wear and its associated problems.

It is an object of the invention to provide a silent switch having two magnetic members, one on the rotating shaft and one on the frame, with at least one of the members magnetized to provide an attraction force therebetween. A further object is to provide such a silent switch in which at least one of the magnetic members has a plurality of poles with a spacing corresponding to the spacing of the contacts of the switch so that the magnetic attraction will align the two magnetic members and simultaneously position the electrical contacts in engagement. Another object of the invention is to provide a silent switch wherein one of the magnetic members may be moved axially relative to the other to vary the force required for operation of the switch.

It is an object of the invention to provide a silent switch using a permanently magnetized magnet to provide the switch centering force in a compact and inexpensive package. A further object is to provide such a switch which may utilize electrically energized magnets.

The invention also comprises novel details of construction and novel combinations and arrangements of parts, which will more fully appear in the course of the following description. The drawing merely shows and the description merely describes preferred embodiments of the present invention which are given by way of illustration or example.

In the drawing:

Fig. 1 is a side view of a preferred embodiment of the invention, shown partly in section;

Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is a partial sectional view taken along the line 3—3 of Fig. 2;

Fig. 4 is an end view of the switch of Fig. 1;

Fig. 5 is a view corresponding to that of Fig. 2 of an alternative form of the switch; and

Fig. 6 is a sectional view taken along the line 6—6 of Fig. 5.

The silent switch of the invention includes two switch members which are rotatable relative to each other and two magnetic members which are rotatable relative to each other. One switch member and one magnetic member are carried on a shaft which rotates in a frame on which the other switch member and other magnetic member are supported. One of the switch members carries a plurality of circumferentially disposed switch contacts. The magnetic members are provided with means defining magnetic poles to generate a corresponding plurality of shaft-restraining positions by attraction between the two magnetic members.

In the switch of Figs. 1—4, a shaft 10 is mounted in a bushing 11 which in turn is clamped to a panel 12 by nuts 13, 14. A knob 15 is fixed to the shaft for manual rotation thereof.

Plates 18, 19 are mounted on the bushing 11 by a nut 20. The plates are clamped together at the corners thereof by screws 21 and nuts 22. Plates 23, 24 are mounted on the screws 21 spaced from the plates 18, 19 by nuts 25, 26. A switch contact deck 27 is also mounted on the screws 21 by nuts 28. The shaft 10 passes through aligned openings in the plates 23, 24 and the deck 27, with the plates preferably serving as a support bearing for the shaft.

Various types of electrical contact arrangements can be used with the silent switch of the invention. In the embodiment illustrated, twelve contacts 31 are molded in place in the deck 27. A contact ring 32 is also molded in place in the deck and a lead 33 is connected to each contact and to the ring. An arm 34 is mounted on the shaft 10 by a set screw 35 and carries a contact wiper 36 with resilient fingers for engaging the contacts 31 and the contact ring 32 to provide a connection therebetween.

Twelve rods 40 are positioned in aligned openings in the plates 19, 23 and are held in place by the plates 18, 24 (Fig. 3). The rods are circumferentially positioned about the shaft with the same angular spacing as the contacts 31. A hub 41 having a peripheral U-shaped groove is mounted on the shaft 10 by a set screw 42. Twelve rods 43 are positioned in aligned openings in the arms of the U-shaped groove and are held in place by a plate 44 fixed to the hub by screws 45 (Fig. 3). The rods 43 are circumferentially positioned about the shaft with the same angular spacing as the rods 40.

In the particular embodiment illustrated herein, the plates 18, 19, 23, 24, and the hub 41 and plate 44 are made of a nonmagnetic material such as aluminum. The rods 40 are made of a magnetic material such as soft iron, and the rods 43 are permanent bar magnets. The attraction force between the magnets 43 and the rods 40 causes the shaft to rotate to a position as shown in Fig. 2 with the magnets at their closest position to the rods 40. The switch members and the magnetic members are positioned in the frame and on the shaft so that when the magnetic members are in the position of Fig. 2, the switch members are in the position of Fig. 4; i.e., with the magnetic members in the normal rotation-restraining position, the contact wiper will be

exactly centered on a contact. A manual torque may be applied to the knob 15 to rotate the shaft more than one-half the angular distance between contacts. Then the magnetic attraction will cause the shaft to continue rotating in the same direction until the components are again aligned as shown in Figs. 2 and 4 with the contact wiper at the next fixed contact. This construction produces a torque which always moves the wiper to a position in exact engagement with a fixed contact and tends to maintain the wiper in this position. Thus it is seen that the silent switch not only provides a detent action for exactly positioning the wiper, but it also prevents the switch being left in a position between two contacts. Furthermore, this action is achieved without generating any audible noise and without any mechanical engagement to produce wear. The silent switch does not have to be installed in any sound-absorbing or protective housing and is not susceptible to jamming or malfunctions due to foreign particles or adverse environments. The force required to operate the switch is a function of the magnetic characteristics of the components and their physical location and can be selected to provide any desired value.

Various modifications of the structure shown herein can be used while achieving the desired silent operation. For example, the rods 40 could be made permanent magnets while the rods 43 were made of soft iron. Alternatively, permanent magnets could be used for both the rods 40 and the rods 43. Electrically energized magnets could be used if desired, although such a structure ordinarily would be more cumbersome.

Some of the magnets 43 could be omitted from the hub 41. In fact, the silent switch would operate with only a single magnet 43, but the restraining force would be considerably reduced unless a much larger magnet was utilized. Similarly, the number of poles or rods 40 in the plates could be reduced, even down to one, with the corresponding reduction in magnetic attraction force.

Another alternative structure is shown in Figs. 5 and 6. A magnetic member 50 having ears for mounting on the screws 21 is provided with six circumferentially disposed poles 51. Another magnetic member 52 having a hub 53 for mounting on the shaft 10 is also provided with six circumferentially disposed poles 54. The shaft-mounted member 52 may be a sintered permanent magnet with alternate north and south poles while the frame-mounted member 50 may be stamped from soft iron sheet. This form of construction provides a very inexpensive silent switch suitable for mass production techniques. The particular switch shown in Figs. 5 and 6 is for a six-position switch but, of course, any number of positions and poles may be provided.

The variations discussed in connection with the embodiment of Figs. 1-4 are applicable to this embodiment also. For example, the member 50 could be the magnetized member, either permanently or electrically, and the member 52 could be merely of a magnetic material such as soft iron. Also, the number of poles on one or the other of the members or both can be reduced without affecting the total number of positions available.

While the force required to operate the silent switch is determined by the characteristics of the material and the layout of the components, the force required to operate a particular switch can be adjusted after the switch is assembled. Referring to Fig. 6, the member

52 can be moved axially along the shaft 10 relative to the member 50 and thereby vary the air gap between the poles of the two members. This structure provides a simple and easy method of exactly setting the torque requirements of a particular switch.

Although exemplary embodiments of the invention have been disclosed and discussed, it will be understood that other applications of the invention are possible and that the embodiments disclosed may be subjected to variation changes, modifications and substitutions without necessarily departing from the spirit of the invention.

I claim as my invention:

1. In a silent switch, the combination of: a first switch member having a plurality of circumferentially disposed first switch contacts; a second switch member having a second switch contact; a frame; a rotating shaft mounted in said frame; means for mounting one of said switch members on said frame and the other on said shaft so that rotation of said shaft causes said second switch contact to engage said first switch contacts in succession; a first magnetic member having a plurality of inwardly projecting poles with the angular spacing between poles corresponding to that of said first switch contacts and multiples thereof; a second magnetic member having a plurality of outwardly projecting poles with the angular spacing between poles corresponding to that of said first switch contacts and multiples thereof, at least one of said magnetic members being permanently magnetized; means for mounting one of said magnetic members on said frame and the other on said shaft for rotation relative to each other with said second magnetic member within said first magnetic member and with said poles in a plane perpendicular to the axis of rotation of said shaft; and means for moving one of said magnetic members relative to the other along said axis of rotation for varying the magnetic tension between said members.

2. In a silent switch, the combination of: a first switch member having a plurality of circumferentially disposed first switch contacts; a second switch member having a second switch contact; a frame; a rotating shaft mounted in said frame; means for mounting one of said switch members on said frame and the other on said shaft so that rotation of said shaft causes said second switch contact to engage said first switch contacts in succession; a first magnetic member; a second magnetic member, at least one of said magnetic members being magnetized, at least one of said magnetic members having a plurality of circumferentially disposed poles with the angular spacing between poles corresponding to that of said first switch contacts and multiples thereof; means for mounting one of said magnetic members on said frame and the other on said shaft for rotation relative to each other with a pole of one magnetic member attracting a pole of the other to restrain rotation of said shaft at each angular position where said second switch contact is engaging one of said first switch contacts; and means for moving one of said magnetic members relative to the other along the axis of rotation of said shaft for varying the magnetic tension between said members.

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