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3,013,137

MAGNETIC SWITCH

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2 Sheets-Sheet 1

Fig. 2.

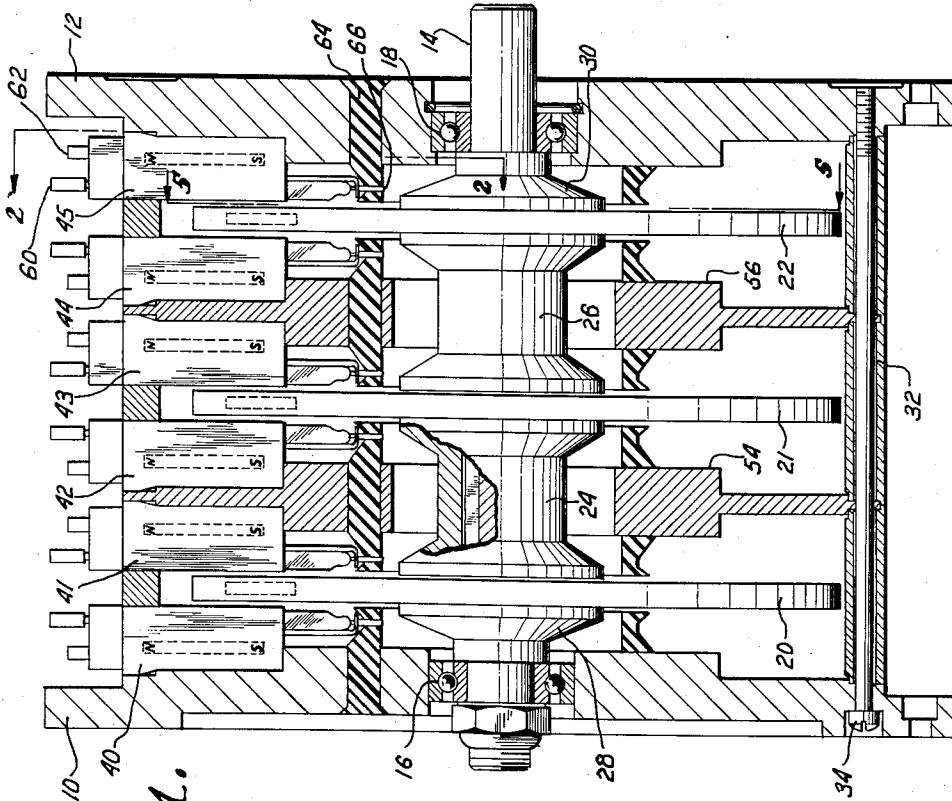
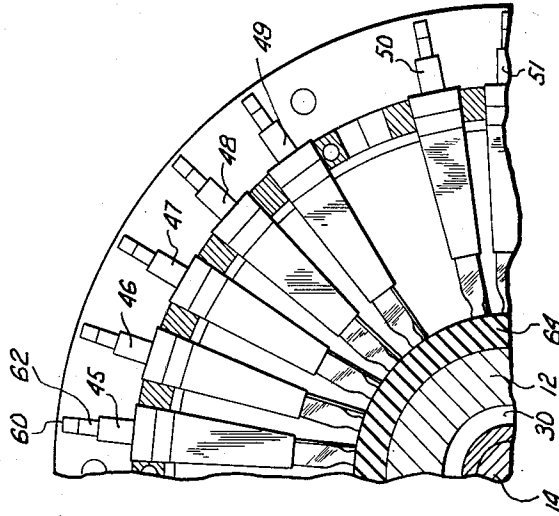


Fig. 1.

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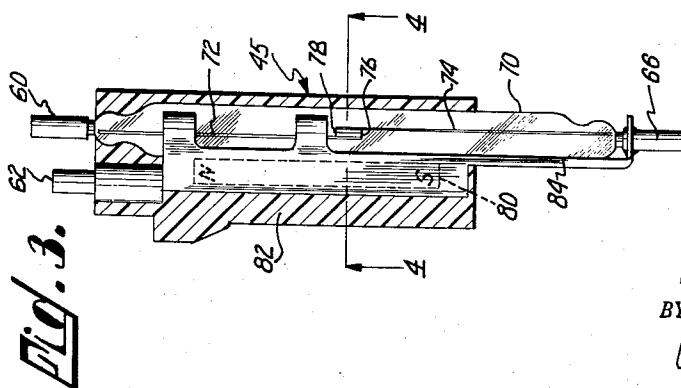
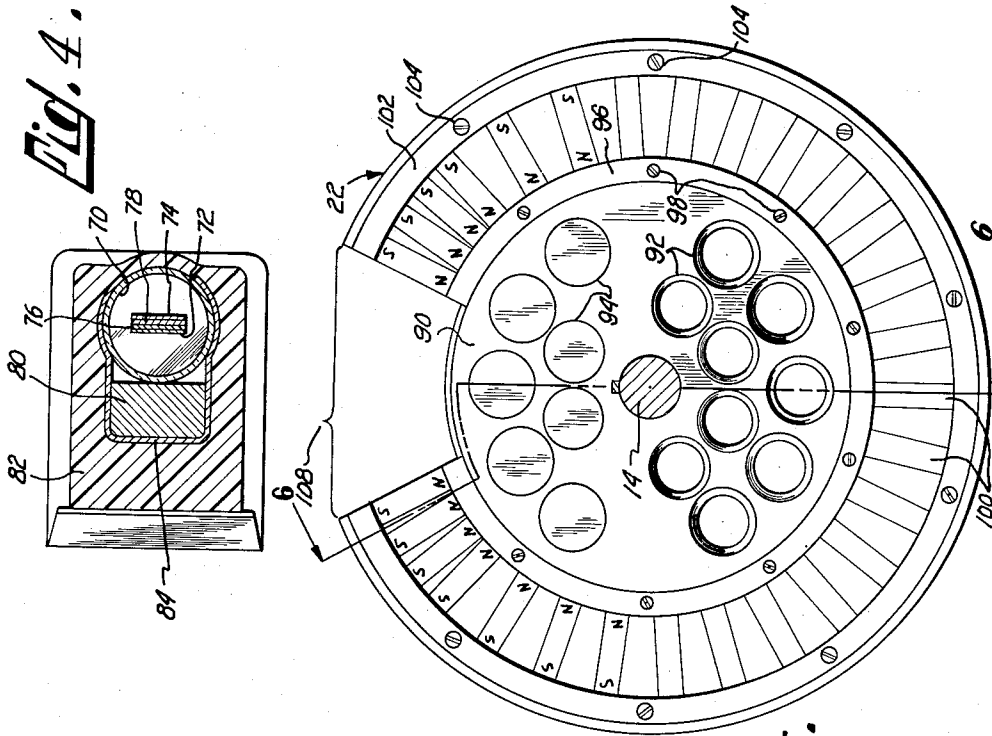
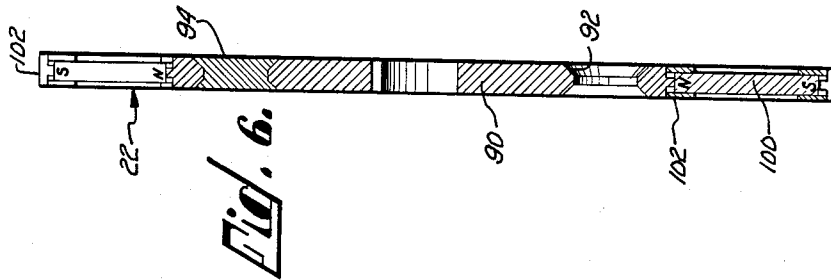
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MAGNETIC SWITCH

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4 Claims. (Cl. 200—87)

This invention relates to mechanical switches and more particularly to such switches which may be mechanically controlled.

In the field of switch devices it is desirable to obtain a switch which can be opened and closed at a high rate, yet with a minimum of contact noise so that low level signals on the order of several microamps can be switched. Where a large number of electrical devices are to be interrogated at high speeds, it is customary in many instances to employ a commutating switch of the type having a plurality of stationary contacts and a moving arm. The various devices interrogated have an output signal connected to the various stationary contacts of the commutating switch. The movable arm is rotated and engages the stationary contacts, thereby interrogating the various devices once each revolution. The wiping action of the moving contact as it crosses the stationary contacts presents several disadvantages, among which are substantially large electrical noise signals from the wiping action and a relatively short useful life from the frictional engagement of the wiping contact with the stationary contacts. As a consequence electrical output signals having an amplitude lower than that of the electrical contact noise cannot be detected. Because of the frictional wear and tear of the stationary and wiping contacts, the useful life of such a commutating switch is limited, and the necessity for periodic repair or replacement renders such a switching device expensive to use as well as often unreliable after only a few hours of use.

In order to overcome the foregoing disadvantages a switch is provided according to the present invention which is magnetically operated and controlled, and a plurality of them may be employed as a commutating switch which has no wiping contacts. High speed sampling of low level signals is permissible, and such switch arrangement is simple and easy to manufacture. Furthermore, it has a long useful life, is relatively small and is inexpensive to manufacture and maintain.

According to a preferred embodiment of this invention, any leaf-type switch may be employed provided the leaves are magnetizable. Numerous magnetic relays commercially available may be suitable. An individual magnet, such as a bar magnet, is disposed adjacent to a leaf-type spring. The switch is preferably of the type which has an inherent bias force, normally holding the leaves open in the absence of a magnetic field. The strength of the bar magnet and its position relative to the leaf-type switch is such as to magnetize the leaves and close them against the inherent spring bias. A plurality of such switch assemblies are arranged in a pattern, a circular pattern being preferred. With a circular pattern of such switches a circular member such as a disk may be employed. The disk member is balanced to minimize mechanical vibrations and includes an inner pole piece disposed toward the hub of the disk and an outer pole piece disposed about the periphery of the disk. A plurality of magnets, such as bar magnets, are positioned between the two pole pieces with the north pole of each magnet associated with one pole piece and the south pole of each magnet associated with the other pole piece. The magnets on the disk are positioned to lie in the vicinity of the magnets associated with the individual switch assemblies.

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In operation the magnet associated with the individual switch assemblies supplies a magnetic field to the leaf members of the switch which magnetizes and closes them against the inherent spring bias. The magnetic fields from the magnets in the disk are disposed in the vicinity of the leaf members and are poled to counteract the magnetic fields of the magnets in the individual switch assemblies. Actually the two magnetic fields aid each other, but divert magnetic lines of flux away from the leaf members. The effect then is to create a resultant magnetic field in the leaf members which is insufficient to hold the leaf members closed against the inherent spring forces, and accordingly the leaf members are separated by the inherent spring force. One portion of the disk is cut out. This cut-out portion has no magnetic field and individual switch assemblies associated therewith are subjected only to the magnetic field of the magnet in the individual switch assembly. Accordingly, the individual switch assemblies associated with the cut-out portion of the disk are closed while the remaining switches associated with the disk are opened. The disk is rotated, and the individual switches are sequentially closed for a short period and then opened as the cut-out portion of the disk passes thereabout. A plurality of switch assemblies may be provided on each side of the disk, and a plurality of disks and associated switch assemblies may be provided in a compact arrangement.

Whenever moving magnets are employed in or near closed electrical circuits, the problem of induced signals arises, and in order to secure accurate measurements of electrical signals from switch devices under interrogation, it is necessary to eliminate the effects of the induced signals. The problem associated with induced signals is overcome in the present invention by making the cut-out portion of the disk sufficiently large, compatible with the speed at which the disk is driven, so that the individual switches closed by the stationary magnets associated with each switch assembly can close the switch arms and remain free of any moving magnetic field sufficiently long to interrogate electrical devices associated therewith. The cut-out portion of the disk represents a field-free region, and in order to permit any transients which might be present to die out before an interrogation is made, the size of the cut-out portion may be increased as needed. Thus any transients which might be present are permitted to dissipate before minute electrical signals from associated devices are sampled, and shortly thereafter the switch may be opened. The time during which such a field-free region is present at a given switch is determined by the size of the cut-out portion and the speed of the movable disk. Such factors as pole strength, size of the cut-out portion and speed of the disk may be varied to provide a given time period during which no signals are induced in each of the closed switches and the associated electrical circuits. It is during this period that the electrical devices under interrogation are sampled and an accurate measurement made of their electrical output signals, substantially free and clear of any induced signal from the magnets in the moving disk which serve to open and close the various circuits in a given order. Accurate electrical measurements can be made with a commutating device of this type operated at high speed.

These and other features of this invention may be more fully appreciated when considered in the light of the following specification and drawings in which:

FIG. 1 illustrates in cross section a commutating-type switch which employs no wiping contacts;

FIG. 2 is a cross-sectional view taken on the line 2—2 in FIG. 1 and illustrates a plurality of individual switch assemblies;

FIG. 3 illustrates in greater detail, partly in cross section, an individual switch assembly;

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FIG. 4 is a cross-sectional view taken on the line 4—4 of FIG. 3;

FIG. 5 is a view taken along the line 5—5 in FIG. 1, illustrating in greater detail the disk assemblies in FIG. 1;

FIG. 6 is a cross-sectional view taken along the line 6—6 in FIG. 5.

Referring first to FIG. 1, a switch assembly according to the present invention is illustrated in cross section. It includes end plates 10 and 12 disposed on opposite ends of a shaft 14. The shaft 14 is mounted in bearings 16 and 18 within respective end plates 10 and 12. Three rotatable disks 20, 21 and 22 are spaced along the shaft 14 by a pair of inner spacers 24, 26 and a pair of outer spacers 28 and 30. A plurality of spacers such as indicated at 32 are employed to properly position the outer periphery of the end plates 10 and 12, and a screw 34 is employed to pull the end plates together against the spacer 32. A plurality of switch assemblies 40 through 45 are disposed in a stationary position. As illustrated in FIG. 2, the switch assemblies extend around the periphery of the disks 20 through 22. The switch assemblies 45 through 51 of FIG. 2 are disposed on the right side of the disk 22 in FIG. 1. A similar arrangement of switches not shown in FIG. 2 are disposed on the left side of the disk 22, but these latter switches include the switch 44 seen in FIG. 2. The end plates 10 and 12 are each employed to support a bank of switches. Inner switch support assemblies 54 and 56 are used to support additional banks of switches on each side thereof. Each switch includes a pair of terminals such as terminals 60 and 62 of the switch 45. Each switch is secured to a circular insulation member within the switch assembly. The switch 45 for instance is friction fitted to an aperture in a circular insulation member 64 by a suitably shaped end portion 66.

Referring next to FIGS. 3 and 4, the details of the switch 45 in FIG. 1 are illustrated, the remaining switches being identical in construction. The switch 45 includes a glass envelope 70 within which a pair of switch arms 72 and 74 are disposed. Switch contacts 76 and 78 are located on respective flexible arms 72 and 74. These flexible arms are mechanically biased to a normally open position. The mechanical bias in the switch arms 72 and 74 is an inherent spring force which tends to part these switch arms, but separate springs may be used to urge the arms apart if such is desired. A magnet 80 supplies a magnetic field to the flexible arms 72 and 74 which normally holds them in the closed position against the spring bias. The glass envelope 70 and the magnet 80 are disposed in a suitable insulation material 82, and a metallic member 84 connects the terminal 62 to the metallic end 66 and the flexible arm 74.

Referring next to FIGS. 5 and 6, the details of the disk 22 are illustrated, the remaining disks 20 and 21 being of identical construction. A hub 90 has a plurality of holes therein such as indicated at 92. These holes may be filled with a material such as lead in order to balance the disk assembly 22 and minimize mechanical vibrations. Holes 94 are indicated with a filler material positioned therein. A circular member 96 is attached to the hub 90 as by screws 98 and forms an inner pole piece. A plurality of magnets 100 are distributed about the periphery of the disk 22 in recesses formed therein. A circular member 102 is connected as by screws 104 to the periphery of the disk 22 and serves as an outer pole piece. A region 108 of the disk 22 is removed as illustrated in FIG. 5. The magnets 100 magnetize the inner pole piece 96 with one magnetic polarity and the outer pole piece 102 with the opposite magnetic polarity. As indicated, the pole pieces 96 and 102 are magnetized with a north and south polarity respectively. The magnets 100 are uniformly distributed about the disk 22 except in the vicinity of the cut-out portion 108. Near this portion the magnets are placed closer together

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to provide a stronger magnetic field which gives a fast snap action in opening and closing the switch arms.

In operation the disk 22 in FIG. 1 is rotated by driving the shaft 14 with suitable driving means not shown. As the disk 22 rotates past the switches 45 through 51 of FIG. 2, the magnetic fields of the magnets 100 combine with the magnetic fields of the magnets positioned within these individual switch assemblies and divert or cancel the magnetic field through the switch arms. For example the magnetic field of the magnets 100 reacts with the magnetic field of the magnet 80 in FIG. 3 and reduces the magnetic field in the switch arms 72 and 74 such that the magnetic attraction established in the switch arms is less than the opening effect of the inherent spring bias. The magnets 100 may be placed about the same distance radially from the center of the switch assembly as the magnet 80. It was found, however, that a faster snap action is obtained in the switch arms if the magnets are displaced slightly from one another in the radial direction. In either case these switch arms consequently separate because of their inherent spring bias previously mentioned. In essence the two magnetic fields are poled unlike, and they starve or divert magnetic lines of flux from the switch blades disposed intermediate the two fields. As the cut-out portion 108 of the disk in FIG. 5 passes over the switches 45 through 51, the magnetic field from the magnets within the individual switches, such as 80 in FIG. 3, is unopposed and closes the switch or switches within the region 108. In other words, the individual switch assemblies associated with the disk 22 in FIG. 1 are opened by the opposing effect of the magnets 100 except for those switches which are within the region of the cut-out portion 108. The switches within this region are closed because the individual magnet within each switch assembly is unopposed and closes the flexible arms against their inherent spring bias. It is seen, therefore, that as the disk 22 in FIG. 1 rotates, the individual switches disposed on either side are sequentially closed for a relatively short period, determined by the length of the gap 108, and then opened for a relatively long period.

Thus a novel switch device is provided which is very reliable in operation, simple and easy to manufacture. The switch is well adapted for use as a commutating switch device. Since wiping contacts are eliminated, its useful life is extended and operating costs are reduced. It is to be understood that various modifications and numerous other arrangements are readily suggested to one skilled in the art.

What is claimed is:

1. A switching device including first means for providing a stationary magnetic field, a pair of magnetizable switch arms spring biased to normally occupy an open position, said switch arms being positioned within the magnetic field of said first means, the magnetic field of said first means serving to close the switch arms against the spring bias, a second means for providing a magnetic field to said switch arms which opposes the magnetic field of said first means whereby the net magnetic field applied to said pair of magnetizable switch arms is insufficient to magnetize the switch arms and cause them to close by a magnetic attraction against the spring bias, whereby the switch arms are separated by the force of the spring bias, and third means for periodically moving said second means to and from the vicinity of said first means whereby the switch arms are periodically closed and opened.

2. A commutator switch device including a plurality of magnetic switches each having a pair of switch arms mechanically biased to one of two positions, means to apply a first magnetic field to said switches sufficient in intensity to magnetize the switch arms and close them against the mechanical bias, said first magnetic field being fixed in position, means to apply a second magnetic field periodically to each of the magnetic switches, the means

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for applying a second magnetic field including a disk member having an inner pole piece and an outer pole piece disposed on said disk, a plurality of magnets disposed on the disk between said pole pieces for magnetizing the pole pieces with opposite polarities, said disk having a cut-out portion with the magnetic field in the cut-out portion being substantially zero, and means to rotate the magnetic disk adjacent to the plurality of magnetic switches, whereby all magnetic switches in the vicinity of the cut-out portion of the disk are closed by the fixed magnetic field and the remaining magnetic switches associated with said disk receive a net magnetic field from the rotating disk and the fixed magnetic field which is insufficient to close the switch arms of such switches against their mechanical bias whereby they are opened.

3. The apparatus of claim 2 wherein the magnets are spaced uniformly around the disk except near the cut-out portion where the magnets are disposed closer together to give a stronger magnetic field which in turn provides a fast snap action in opening and closing the switch arms.

4. A magnetic switch assembly including a plurality of switches each having a pair of magnetizable arms mechanically biased to the open position, means for applying a fixed magnetic field to said switches having sufficient intensity to magnetize the switch arms and close them against the mechanical bias, a magnetized disk having a cut-out portion, said magnetized disk being dis-

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posed adjacent said magnetic switches, and means to rotate said magnetized disk, the magnetic switches associated with the cut-out portion of said disk being operated to the closed position by said fixed magnetic field, the magnetic switches associated with the remaining portion of said disk receiving a magnetic field which combines with the fixed magnetic field to provide a net magnetic field in the magnetizable arms insufficient to hold them closed against the mechanical bias, whereby as the cut-out portion of said magnetized disk approaches each magnetic switch the switch is closed and remains closed until the cut-out portion of the magnetized disk recedes therefrom.

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