

July 19, 1960

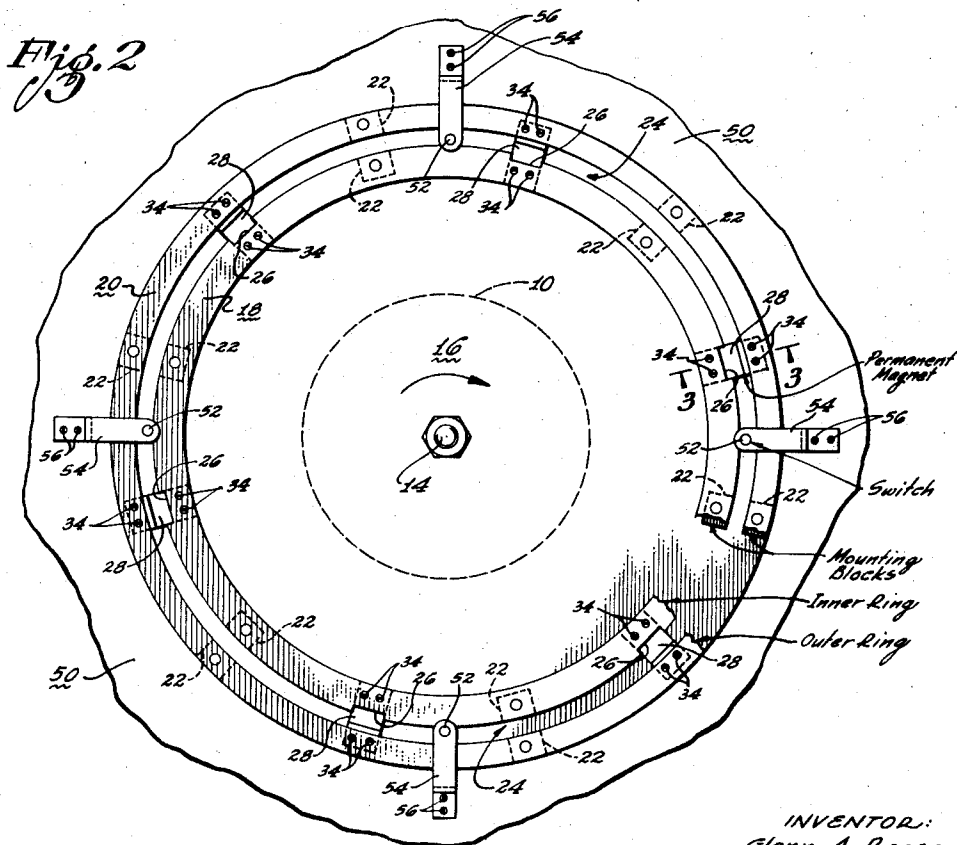
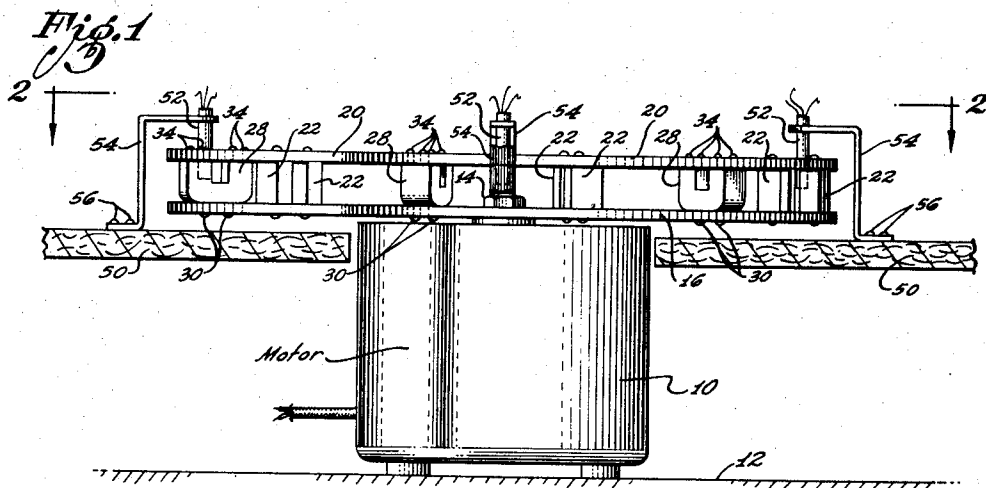
G. A. REESE

2,945,931

SWITCH ASSEMBLY

Filed April 15, 1957

2 Sheets-Sheet 1



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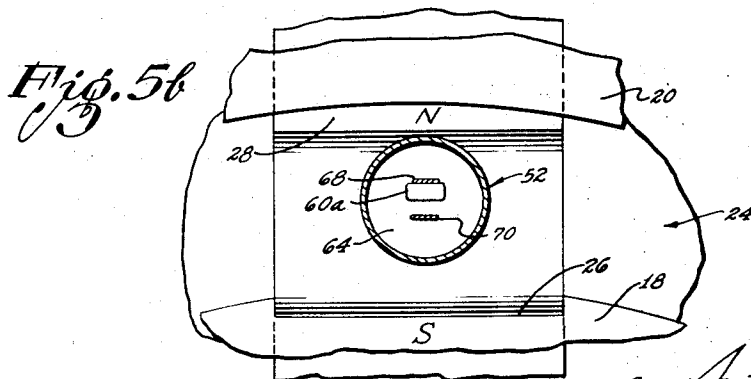
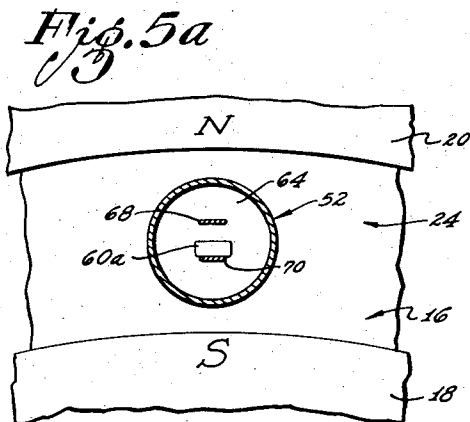
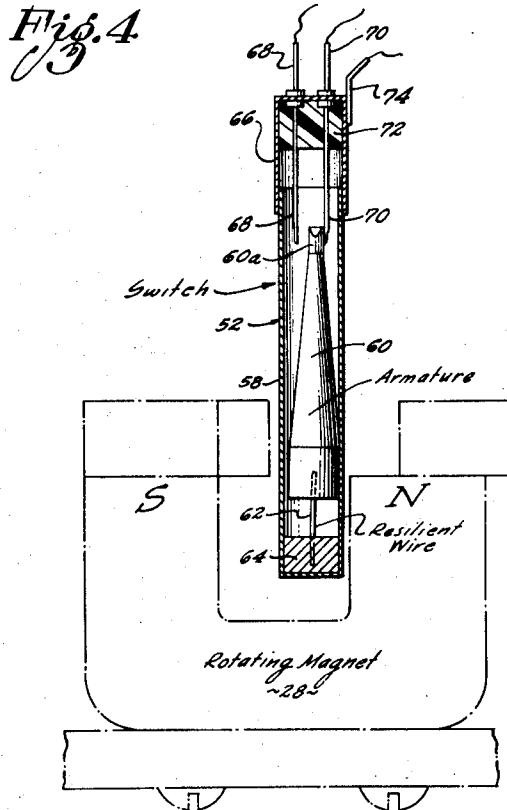
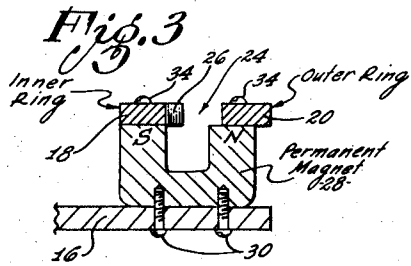
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G. A. REESE
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2 Sheets-Sheet 2



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2,945,931

SWITCH ASSEMBLY

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22 Claims. (Cl. 200—90)

The present invention relates to a switching assembly which is capable of repeatedly performing a plurality of successive switching operations at an extremely high rate of speed and of accomplishing this without the concomitant production of noise or other transient parasitic signals.

The switching assembly of the invention finds general utility in the electrical and electronic arts. In these arts, the requirement for high speed multiple-type switches frequently occurs. For example, high speed multiple switches find general utility as channel selectors in many types of present day digital computers. In fact, the switching assemblies of the type with which the present invention is concerned finds utility in any application where rapid multiple switching or commutator action is required.

The high speed switching assembly to be described in the following specification uses a plurality of individual switching units. The individual units are adapted to be operated from one operational state to another by means of an external magnetic field. Each of the units includes a magnetic armature which is constrained to move from one fixed contact in the particular unit to another for double-throw operations. This movement of the armature is under the control of the external magnetic field, and this movement is effectuated by variations in the field. In like manner, the armature can be made to make or break with a single fixed contact, for single-throw action, in response to variations in the external magnetic field.

The switching assembly to be described includes a magnetic structure which defines an annular air gap. The individual switching units are positioned in this air gap. A magnetic field is produced in the air gap which rotates with respect to the individual switching units, and this field is caused to exhibit radial shifts or variations at different positions around the air gap. As the magnetic field sweeps past the various switching units, these field variations periodically actuate the armatures in the units. In this manner, a succession of switching operations is achieved for each rotational cycle of the magnetic field. The number of these switching operations in each cycle depends, of course, upon the number of individual switching units that are positioned in the air gap. Moreover, these successive switching operations are repeated for each rotational cycle of the magnetic field.

The speed with which the successive switching operations of the assembly may be carried out will be appreciated when it is realized that the magnetic field may be produced by a magnetic structure which may be appropriately coupled to an electric motor for rotation. Therefore, the rotational speed of the magnetic field can be of a relatively high order. Then, by placing a plurality of individual switching units in the annular air gap between these rings, a large number of successive and repeated individual switching operations can be conveniently carried out.

A feature of the invention is the provision of a switching assembly of the type described above which is so con-

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structed that switch-actuating variations in a rotating magnetic field may be precisely located and sharply defined. This permits the assembly to be designed and constructed so as to provide an exact relationship between the instantaneous angular positions of the rotating magnetic field and the corresponding actuation of the switching units. This enables accurate timing of the switch actuations to be realized. Such accurate timing is an essential requirement in most present day uses of multiple cyclic switches.

Another essential requirement that is met by the switching assembly of the present invention is that of high speed switching operation without the accompanying production of undesired noise signals and other extraneous interference. Such unwanted signals are generally due to contact bounce and to unwanted vibrations of the armatures in the individual switching units. The assembly of the present invention operates positively to actuate each individual unit without setting up vibrations in the units so that the generation of such unwanted noise as a by-product of the switching action is avoided. Moreover, the structure and operation of the assembly constituting the invention is such that the individual switching units may be conveniently damped, for example, by a hydraulic fluid, further to preclude any tendency for the switch armatures to vibrate and create the undesired noise signals.

From a mechanical aspect, the switching assembly of the invention has the desirable features of relatively low wear, and this results in extremely long and trouble-free operation. Moreover, the assembly is relatively simple and inexpensive to construct and operate.

In the drawings where are to be considered as merely illustrative of one embodiment of the invention:

Figure 1 is a side view of one constructed embodiment of the switching assembly of the invention on a somewhat reduced scale, and shows apparatus, including a drive motor for producing a desired rotational motion of a magnetic field to successively actuate a plurality of individual switching units which are included in the assembly;

Figure 2 is a top plan view of the switching assembly on the same scale as Figure 1, and showing a pair of annular members which are positioned to form an annular air gap, and this view also shows a plurality of magnets which create a magnetic flux in the air gap controlling the individual switching units which extend into the annular air gap at various positions around the assembly;

Figure 3 is a sectional view substantially on the line 3—3 of Figure 2 to show the mounting of magnets which are used to create the flux in the annular air gap;

Figure 4 is a view, partly in section and partly in phantom and on an enlarged scale with respect to the views of Figures 1 and 2, of one of the individual switching units used in the assembly and its relation to a typical one of the magnets shown in Figure 2; and

Figures 5A and 5B are fragmentary top plan views which schematically illustrate the action of an armature in the individual switching unit shown in Figure 4 as the magnetic flux in the air gap is swept past the armature such that the armature is actuated between first and second fixed contacts in the switching unit.

The switching assembly of the illustrated embodiment of the invention includes an electric motor 10 which is supported on an appropriate supporting surface 12 and which is preferably a synchronous motor. The electric motor includes a drive shaft 14. This drive shaft extends upwardly in a substantially vertical direction, and it is secured to a turntable 16 to impart rotational motion to the turntable. The turntable 16 is disposed in a horizontal plane, and it is composed of a non-magnetic material such as, for example, aluminum. The diameter of the turntable may be of the order of 9 inches.

The turntable 16 supports a pair of annular members

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18 and 20. These annular members are supported in spaced, nested uni-planar and concentric relation, and they are also spaced from the turntable 16. A series of blocks composed, for example, of aluminum and designated as 22 are secured to the turntable and to the respective annular members 18 and 20. These blocks rigidly support the annular members 18 and 20 on the turntable 16, with the annular members lying in a plane above the turntable and parallel to the plane of the turntable.

The annular members 18 and 20 may be composed of a magnetic material such as, for example, cold rolled steel. These members define an annular air gap 24 between the outer peripheral edge of the member 18 and the inner peripheral edge of the member 20. The member 18, for example, may have an inner diameter of 6.3 inches and an outer diameter of 7.5 inches. The annular member 20, on the other hand, may have an inner diameter of 7.75 inches and an outer diameter of 8.7 inches.

It is evident that when the motor 10 is energized, its drive shaft rotates the turntable 16 which, in turn, causes the annular members 18 and 20 to rotate.

The annular member 18 has a series of channels 26 formed as notches in its outer peripheral edge. Each of these channels extends axially along the outer peripheral edge of the annular member 18 and each has a predetermined radial depth. These channels are placed at selected angular positions around the annular member 18.

A plurality of permanent U-shaped magnets, such as the magnet 28 in Figure 3, are secured to the turntable 16 by screws such as the screw 30 in Figure 3. These permanent magnets are positioned to correspond to the angular positions of the channels 26 in the peripheral edge of the annular member 18, and one of the permanent magnets is located at each such channel. Each U-shaped magnet 28 has a pair of spaced parallel legs, and these legs extend upwardly from the turntable 16 into respective engagement with the annular members 18 and 20. One of the legs represents a south pole, and the other leg represents a north pole. These legs may be secured respectively to the annular members 18 and 20 by a pair of screws 34.

The permanent magnets 28 are offset radially with respect to the annular members 18 and 20 so that the leg associated with the annular member 20 is displaced inwardly from that member and projects into the annular air gap 24. Likewise, the leg associated with the annular member 18 engages that member at the base of the corresponding one of the channels 26.

The permanent magnets 28 cooperate with the annular members 18 and 20 to produce a magnetic flux in the annular air gap 24. The lines of the resulting magnetic field extend in a radial direction from the annular member 20 which constitutes the north pole to the annular member 18 which constitutes the south pole.

The fact that the permanent magnets 28 are offset inwardly in the illustrated manner, and the provision of the channels 26 in the outer peripheral edge of the annular member 18, create well-defined and precisely located shifts or variations in the magnetic flux in the air gap 24 at the regions of the individual channels 26. Therefore, as the turntable 16 and the annular members 18 and 20 with their associated magnets 28 are rotated by the motor 10, the resulting flux in the annular air gap 24 also rotates.

As shown in Figure 1, the top of the motor 10 projects through a stationary supporting table 50, and the turntable 16 and annular rings 18 and 20 are supported for rotation on the upper side of the table. The table 50 forms a convenient support for a plurality of stationary individual switching units 52 which extend into the annular air gap 24 of Figure 2. Each of the switching units 52 is supported on an S-shaped bracket 54 which, in turn, is secured to the top of the table 50 by a pair of screws

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56. The units 52 are disposed at selected angular positions about the turntable 16. It will be understood that as many switching units 52 are used as it is desired to have successive switching operations for each cycle of rotation of the turntable 16 and of the annular members 18 and 20.

Details of one of the switching units 52 are shown in Figure 4. The unit may contain a tubular outer casing 58 which is preferably composed of a non-magnetic, electrically conductive material such as brass. The unit is supported so that this housing extends vertically down into the annular air gap 24 of Figure 2. An armature 60 is mounted in the casing 58, and this armature may be composed of a magnetic material such as soft iron. The armature is rigidly supported against axial motion by a resilient wire 62. This wire extends from the base of the armature into a soft iron plug 64 disposed at the bottom of the tubular casing 58 in press-fit with the casing.

As illustrated, the armature 60 is supported by the wire in the casing 58 in such a manner that it may be moved back and forth in a radial direction with respect to the casing. Since the armature is composed of a magnetic material, it is susceptible to extraneous magnetic fields which enter through the non-magnetic casing 58, and such fields cause the armature to move in one direction or another against the resilience of the wire 62. In the illustrated embodiment, the armature tapers upwardly and has a contact portion 60a at its upper extremity. This contact portion is composed, for example, of 24 carat gold.

The tubular casing 58 may have an inner diameter of the order of .067 inch and an outer diameter of the order of .083 inch. The resilient wire 62 may, for example, be a piece of piano wire of .010 inch diameter. The armature 60 may have a diameter of .065 inch at its base, and its contact portion 60a may have a diameter of .025 inch and a length of .050 inch.

The switching unit 52 is supported in the annular air gap 24 by the bracket 54 in such a position that the north pole of each of the U-shaped magnets 28 passes within about .014 inch from the armature as the turntable 16 is rotated. The tubular casing 58 has an upper portion 66 composed, for example, of an electrically conductive non-magnetic material such as brass. A pair of fixed contacts 68 and 70 are supported in mutually insulated relation in a plastic compound 72 in that portion. These contacts extend through the plastic compound and protrude in spaced parallel relation to be disposed on opposite sides of the armature contact portion 60a.

Each of the fixed contacts 68 and 70 may be composed of 24 carat gold, and they may have a diameter of, for example, .032 inch. These contacts may extend about $\frac{3}{32}$ of an inch below the plastic 72, and their contact area may be flattened to have a width of about .045 inch. Suitable electrical connections may be made to each of the fixed contacts 68 and 70 by appropriate external terminals. Connection to the armature 60 is made by way of a terminal 74. The terminal 74 is secured to the casing 66. Its connection with the armature 60 may be traced through the conductive casings 66 and 58 and through the plug 64 and through the wire 62 to the armature 60.

It is evident, that when the armature 60 is moved under the influence of an external magnetic field, it may make contact with one or the other of the fixed contacts 68 or 70. Therefore, a single-pole double-throw switch is provided in which selective connection may be made from the common armature terminal 74 to either of the external terminals of the fixed contacts 68 or 70.

The casing 58 is preferably filled with an hydraulic fluid to prevent undesired vibration of the armature 60 and to provide suitable damping for the unit.

When the switching unit 52 is placed in the annular

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air gap 24 of Figure 2, its armature contact portion 60a assumes the illustrated position in Figure 5A in contact with the fixed contact 70. This is due to the magnetic flux established in the air gap 24. However, each time that one of the magnets 28 passes the switch 52 as the assembly is rotated, the shift or variation in the flux due to the channel 26 and the offset arrangement of the magnet 28 causes the armature control portion 60a to move into engagement with the fixed contact 68 and out of engagement with the fixed contact 70.

Therefore, each time a channel 26 and its associated magnet 28 sweeps by one of the switching units as the assembly is rotated, it actuates that unit from one operating condition to the other. Each one of the plurality of switching units 52 may be operated any desired number of times during each rotation of the turntable 16, as determined by the number of channels 26 and the permanent magnets 28 respectively associated with those channels.

As noted previously, the provision of the channels 26 and of the offset magnets 28 provides precisely located and well-defined shifts or variations in the magnetic flux in the air gap 24 so that the actuation of the switches can be accurately controlled and timed. Moreover, the actuation of the switches is positive and there is no vibration in the switch armatures. This reduces extraneous noise to a minimum and sharply defined switching action is obtained.

The apparatus constituting this invention has certain important advantages in addition to those described previously. One advantage results from the fact that the apparatus can be disposed in any other plane than the horizontal plane. This advantage is obtained because the armature 60 is held against the contacts 68 and 70 by a force in the order of 50 to 100 G's and a gravitational force of 1 G would have little effect on such a holding force.

Another advantage results from the fact that all leakage flux is produced internally in the air gap between the annular members 18 and 20. This results from the closed loops provided for the members 18 and 20. Since relatively little leakage flux can traverse the area outside of the members 18 and 20, electrical leads and even magnetically receptive equipment can be disposed in the immediate vicinity of the apparatus constituting this invention without having any undesirable signals induced in such leads and magnetically receptive equipment.

Although this application has been disclosed and illustrated with reference to particular applications, the principles involved are susceptible of numerous other applications which will be apparent to persons skilled in the art. The invention is, therefore, to be limited only as indicated by the scope of the appended claims.

I claim:

1. A switching assembly including: means including first and second walls spaced to define a continuous air gap between the walls and having contours to define a displacement in said air gap in at least one position along said walls and having properties to produce in said air gap a field exhibiting variations at the position of displacement, means coupled to the first and second walls for producing a magnetic field in the air gap in accordance with the disposition of the air gap at successive positions, switching means disposed in said air gap and responsive to such variations in said field to be actuated from one operating condition to another, and means for producing relative motion between said walls and said switching means to bring said switching means periodically under the influence of the variations in the field.

2. A magnetically controlled switching assembly including: means including first and second walls spaced to define a continuous air gap between the walls and provided with contours in at least one wall to define a displacement in said air gap in the direction between the walls and having properties to produce in said air gap

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magnetic flux at successive positions along said air gap in the direction between the walls and to produce variations in such magnetic flux at the position of displacement and in accordance with such displacement, means coupled magnetically to the first and second walls for producing a magnetic flux in the air gap in accordance with the disposition of the air gap at successive positions, switching means disposed in said air gap and including an armature responsive to such variations in the magnetic flux to control the operating condition of said switching means, and means for producing relative motion between the walls and said switching means to bring said armature periodically under the influence of the variations in the magnetic flux.

3. A magnetically controlled switching assembly including: rotatable means including first and second walls spaced from each other in a direction transverse to the plane of rotation to define an air gap extending in the direction of rotation and provided with contours to define a displacement in the air gap at a particular position and in the transverse direction, means including the first and second walls for producing a magnetic flux across said air gap in accordance with the positioning of the air gap in the transverse direction to obtain variations in the magnetic flux at the position of displacement of the air gap and in accordance with such displacement, at least one stationary switching unit disposed in said annular air gap and including an armature constructed at least in part of magnetic material and responsive to such variations in the magnetic flux to control the operating condition of said switching unit, and means for rotating said rotatable means to produce relative motion between said magnetic flux and said switching unit to bring said armature periodically under the influence of the variations in the magnetic flux.

4. A magnetically controlled switching assembly including: means including first and second walls spaced to define a continuous air gap between the walls and having contours in at least one wall to define a displacement in said air gap in at least one position along said walls and in a direction transverse to the walls and having properties to produce in said air gap magnetic flux extending between the walls to obtain variations in the magnetic flux at the position of displacement and in accordance with such displacement, at least one switching unit disposed in said air gap, said switching unit including a resiliently mounted armature and at least one fixed contact engageable by said armature under the control of such variation in the magnetic flux, and means for producing relative motion between said walls and said switching unit in a direction transverse to the displacement in said air gap to bring said armature periodically under the influence of such variations in said magnetic flux.

5. A magnetically controlled switching assembly including: means including first and second walls spaced to define a continuous air gap between the walls and provided with contours in at least one wall to define a displacement in said air gap in the direction between the walls and having properties to produce in said air gap magnetic flux at successive positions along said air gap in the direction between the walls and to produce variations in such magnetic flux at the position of displacement and in accordance with such displacement, at least one switching unit disposed in said air gap, said switching unit including a housing of non-magnetic material, and said switching unit further including a resiliently mounted armature and at least one fixed contact engageable by said armature under the control of such variations in the magnetic flux, a damping fluid included in said housing to inhibit vibrations of said armature, and means for producing relative motion between said walls and said switching unit in a direction transverse to the displacement in the air gap to bring said

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armature periodically under the influence of said variations in said magnetic flux.

6. A magnetically controlled switching assembly including: means for defining an air gap and including first and second walls spaced to define a continuous air gap between the walls and having contours in at least one wall to define a displacement in said air gap in at least one position along said walls and in a direction transverse to the walls and having properties to produce in said air gap magnetic flux extending between the walls to obtain variations in the magnetic flux at the position of displacement and in accordance with such displacement, at least one switching unit disposed in said air gap, said switching unit including a housing of non-magnetic material and a pair of fixed contacts supported in said housing at mutually spaced positions, said switching unit further including an armature resiliently supported in said housing and having a contact portion extending between said fixed contacts and further having a magnetic portion responsive to said magnetic flux in said air gap to cause said contact portion to engage one of said fixed contacts and responsive to said variations in the magnetic flux to cause said contact portion to engage the other of said fixed contacts, a damping liquid included in said housing to inhibit vibrations of said armature, and means for producing relative motion between said walls and said switching unit in a direction transverse to the displacement in said air gap to bring the magnetic portion of said armature periodically under the influence of said variations in said magnetic flux.

7. A magnetically controlled switching assembly including: a pair of annular members supported in concentric relation to define an annular air gap therebetween and provided with contours to produce a displacement in said air gap in at least one position in a direction perpendicular to said annular direction, means associated with said annular members for producing in said annular air gap a magnetic flux exhibiting variations at the position of displacement in said air gap and in accordance with such displacement, at least one switching unit disposed in said annular air gap and including an armature constructed at least in part of magnetic material and responsive to such variations in the magnetic flux to control the operating condition of said switching unit, and means for producing relative motion between said switching unit and said pair of annular members in the annular direction to bring said armature periodically under the influence of the variations in the magnetic flux.

8. A magnetically controlled switching assembly including: a pair of annular members each composed of magnetic material and the inner diameter of one of said annular members exceeding the outer diameter of the other of said annular members, rotatable means for supporting said annular members in concentric relation to define an annular air gap therebetween, means associated with said annular members for producing in said annular air gap a magnetic flux in a direction substantially perpendicular to the annular direction, means associated with said annular members for producing a displacement in said air gap in at least one position and in a direction substantially perpendicular to said annular direction to obtain flux variations at that position in said air gap in a direction substantially perpendicular to said annular direction and in accordance with the displacement in the air gap, at least one stationary switching unit disposed in said annular air gap and including an armature constructed at least in part of magnetic material and responsive to such variations in the magnetic flux to control the operating condition of said switching unit, and means for rotating said rotatable means to produce relative motion between said switching unit and said pair of annular members to bring said armature periodically under the influence of the variations in the magnetic flux.

9. A magnetically controlled switching assembly in-

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cluding: first and second annular members each composed of magnetic material and the inner diameter of said annular member exceeding the outer diameter of said second annular member, one of said annular members having at least one transverse channel of a selected width and depth formed in a peripheral edge thereof at a selected angular position and extending axially along said peripheral edge, rotatable means for supporting said annular members in concentric relation to define an annular air gap therebetween, means associated with said annular members for producing in said annular air gap a magnetic flux exhibiting diametrical displacements at a position corresponding to the angular position of said channel, at least one stationary switching unit disposed in said annular air gap and including an armature constructed at least in part of magnetic material and responsive to such displacements in the magnetic flux in said air gap to control the operating condition of said switching unit, and means for rotating said rotatable means to produce relative motion between said switching unit and said pair of annular members to bring said armature periodically under the influence of said displacements in said magnetic flux.

10. A magnetically controlled switching assembly including: first and second annular members each composed of magnetic material and the inner diameter of said first annular member exceeding the outer diameter of said second annular member, one of said annular members having a plurality of transverse channels each of a selected width and depth formed in a peripheral edge thereof and at selected angular positions and each such channel extending axially along such peripheral edge, rotatable means for supporting said annular members in mutually fixed concentric relation to define an annular air gap therebetween, means associated with said annular members for producing a magnetic flux in said air gap and including portions extending radially into said air gap at respective angular positions corresponding to said angular positions of said channels and cooperating with said channels to produce diametrical displacements in said magnetic flux, at least one stationary switching unit disposed in said air gap and including an armature constructed at least in part of magnetic material and responsive to such displacements in the magnetic flux to control the operating condition of said switching unit, and means for rotating said rotatable means to produce relative motion between said switching unit and said pair of annular members to bring said armature periodically under the influence of said displacements in said magnetic flux.

11. A magnetically controlled switching assembly including: first and second annular members each composed of magnetic material and the inner diameter of said first annular member exceeding the outer diameter of said second annular member, one of said annular members having a plurality of transverse channels each of a selected width and depth formed in a peripheral edge thereof at selected angular positions and each such channel extending axially along such peripheral edge, a turntable composed of non-magnetic material supporting said annular members in mutually fixed concentric relation to define an annular air gap therebetween, said annular members being so supported in a plane spaced from the plane of said turntable, electric motor means coupled to said turntable for imparting rotational motion to said turntable and to said annular members, means associated with said annular members for producing a magnetic flux in said annular air gap and including portions extending radially into said air gap at respective angular positions corresponding to said angular positions of said channels and cooperating with said channels to produce radial displacements in said magnetic flux, at least one stationary switching unit disposed in said annular air gap and including an armature constructed at least in part of magnetic material and responsive to such displace-

ments in the magnetic flux to control the operating condition of said switching unit, and means for rotating said rotatable means to produce relative motion between said switching unit and said pair of annular members to bring said armature periodically under the influence of said displacements in said magnetic flux.

12. A magnetically controlled switching assembly including: first and second annular members each composed of magnetic material and the inner diameter of said first annular member exceeding the outer diameter of said second annular member, said second annular member having a plurality of transverse channels each of a selected width and depth formed in a peripheral edge thereof at selected angular positions and each such channel extending axially along such peripheral edge, rotatable means positioned under said annular members for supporting said annular members in mutually fixed nested concentric relation to define an annular air gap therebetween, a plurality of U-shaped permanent magnets mounted on said rotatable means at said selected angular positions of said transverse channels, each of said magnets having a pair of spaced poles extending upwardly from said rotatable means into respective engagement with said first and second annular members, and said permanent magnets being offset radially with respect to said annular members so that one of said poles is displaced radially away from said first annular member into said annular air gap and the other of said poles is displaced radially toward said second annular member away from the corresponding one of said channels therein, said permanent magnets producing a magnetic flux in said annular air gap which exhibits radial variations at positions corresponding to the angular positions of said channels, at least one stationary switching unit disposed in said annular air gap and including an armature constructed at least in part of magnetic material and responsive to such variations in the magnetic flux to control the operating condition of said switching unit, and means for rotating said rotatable means to produce relative motion between said switching unit and said pair of annular members so as to bring said armature periodically under the influence of said variations in said magnetic flux.

13. A switching assembly for controlling at least one stationary switching unit, said assembly including: a pair of annular members supported in concentric relation to define an annular air gap therebetween for receiving the switching unit and provided with relative contours to produce an axial displacement in the air gap in at least one position along the air gap, permanent magnet means associated with said annular members for producing in said annular air gap a magnetic flux extending in an axial direction at successive positions along the air gap and exhibiting axial variations in at least the position of axial displacement in said air gap, and means for rotating said annular members and said permanent magnet means to produce relative motion between the magnetic flux in the air gap and the switching unit to bring the switching unit periodically under the influence of the variations in the magnetic flux in said air gap.

14. In a switching unit, a casing made from an electrically conductive material, a plug made from an electrically conductive material and disposed at one end of the casing, a wire disposed in the casing and extending from the plug, an armature made from a soft magnetic material and coupled to the wire for a pivotal movement, a first electrical contact carried by the armature at the opposite end of the armature for a pivotal movement of the contact with the armature, and a second electrical contact supported by the casing but insulated therefrom for engagement with the first electrical contact upon a pivotal movement of the armature, the casing being filled with a hydraulic fluid to provide a damping for the pivotal movements of the armature.

15. In a switching unit, a casing having a first portion made from an electrically conductive material and having a second portion also made from an electrically conductive material, a plug made from electrically conductive material disposed in the casing at one end of the first electrically conductive portion, a wire extending from the plug, an armature coupled to the wire at one end for pivotal movement at the other end and made from a material having magnetizable properties, a first electrical contact carried by the armature at the free end of the armature, an insulating plug disposed in the casing at one end of the second portion of the casing, a second electrical contact extending through the insulating plug and disposed in the casing relative to the first electrical contact to engage the first contact upon a pivotal movement of the armature, the end of said second electrical contact extending through the insulating plug forming a first terminal of the switching unit mounted in electrically conductive contact with the second electrically conductive portion of said casing to form a conductive path through the switching unit when the second contact engages the first contact, the conductive path being from the second terminal through the second portion of the casing, the first portion of the casing, the electrically conductive plug, the wire, the armature, and the engaged contacts to the first terminal.

16. The assembly set forth in claim 3 in which a plurality of additional switching units corresponding to the first switching unit are disposed in the annular air gap for response to the variations in the magnetic flux.

17. The assembly set forth in claim 4 in which the first and second walls are provided with contours to define a plurality of displacements in the air gap and in which a plurality of switching units corresponding to the first switching unit are disposed in the air gap and are provided with resiliently mounted armatures to bring the armatures periodically under the influence of the variations in the magnetic flux resulting from the displacements in the air gap.

18. The assembly set forth in claim 9 in which one of the annular members is provided with a plurality of transverse channels and in which a plurality of stationary switching units are disposed in the air gap and are provided with armatures responsive to the variations in the magnetic flux at the transverse channels.

19. In a switching unit, a casing being made at least in part from an electrically conductive material and forming an envelope for the switching unit, a first output terminal connected to the conductive material of the casing, a movable armature made from a magnetic and conductive material and electrically coupled at one end to the electrically conductive material of said casing, a first electrical contact carried by the armature at the other end of the armature, a stationary second electrical contact supported by said casing but insulated from the conductive material of said casing so as to be engaged by said first electrical contact upon a movement of said armature whereby a conductive path is established through the conductive material of the casing and through said first and said second contacts, and a second output terminal electrically connected to said second contact.

20. In a switching unit, a casing being made at least in part from an electrically conductive material and forming an envelope for the switching unit, a first output terminal connected to the conductive material of the casing, a plug made from an electrically conductive material and disposed in one end of the casing in electrical contact with the conductive material of the casing, a flexible and conductive wire disposed in the casing and extending from the plug, an armature made from a magnetic and conductive material and coupled at one end to the wire for a pivotal movement, a first electrical contact carried by the armature at the other end of the armature, a stationary second electrical contact supported by said casing

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but insulated from the conductive material of said casing and positioned in said casing so as to be engaged by said first electrical contact upon a movement of said armature whereby a conductive path is established through the conductive material of the casing and through said first and said second contacts, a plug made from an insulating material at the other end of the casing for supporting said second contact, and a second output terminal supported by said insulating material plug and electrically connected to said second contact.

21. A switching assembly, including, a plurality of switches arranged in a circle, each of said switches having a movable armature, a circular rotor concentrically positioned in the circle of said plurality of switches and having a peripheral surface spaced from said plurality of switches to form an annular space between said rotor and said plurality of switches, means coupled to said rotor for rotating said rotor, and actuating means supported on said rotor in the annular space formed between the peripheral surface of said rotor and said plurality of switches and spaced from said plurality of switches for successively moving the armatures of said switches one after another without touching them as said rotor rotates said actuating means adjacent thereto.

22. A high speed cyclically operated switching assembly, including, a plurality of switches each including a movable armature having a normal and an operated position, means for supporting said plurality of switches in a circle of predetermined radius, a circular member positioned concentrically in the circle of said plurality of switches having a peripheral surface spaced at a predetermined distance from said plurality of switches to

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form an annular space between the peripheral surface of said member and said plurality of switches, actuating means supported on said circular member in the annular space between the peripheral surface of said member and said plurality of switches for actuating any one of said switches adjacent which it is positioned to move the armature of said actuated switch from its normal to its operated positions, said actuating means being spaced from any one of said plurality of switches adjacent which it is positioned so as not to touch any one of said switches at any relative position between said circular member and said switches, and means for establishing relative motion between said switches and said member to cause said actuating means to cyclically operate said switches.

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