Jan. 21, 1947. W. A. CHAMBERS 2,414,688

MAGNETIC DEVICE

Filed July 22, 1943 5 Sheets-Sheet 1

FIG. 1.

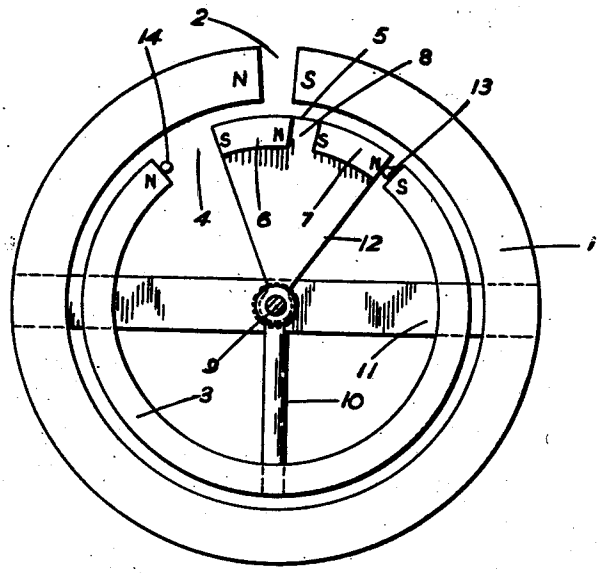
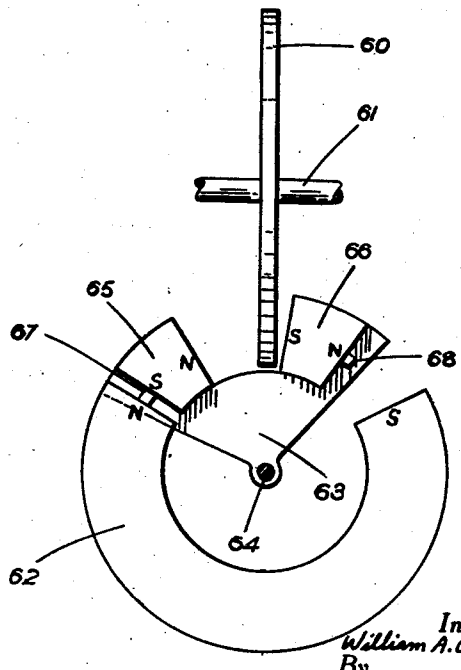


FIG. 5



Inventor
William A. Chambers
By Ralph B. Stewart
Attorney

Jan. 21, 1947. W. A. CHAMBERS 2,414,688

MAGNETIC DEVICE

Filed July 22, 1943 5 Sheets-Sheet 2

FIG. 2.

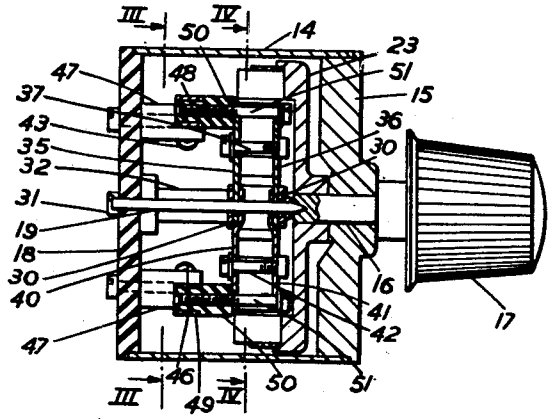


FIG. 3.

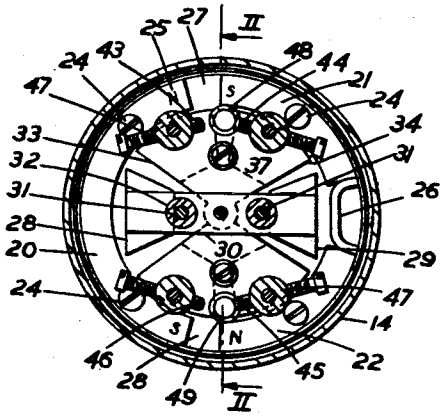
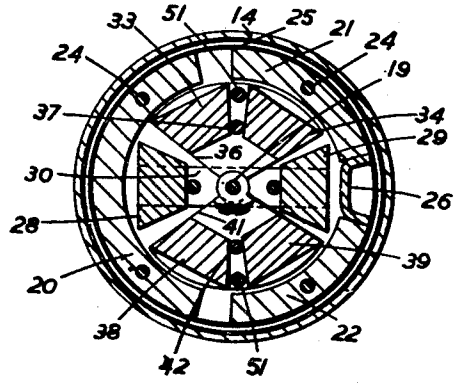


FIG. 4.



Inventor
William A. Chambers
By
Ralph B. Stewart
Attorney

Jan. 21, 1947. W. A. CHAMBERS 2,414,688

MAGNETIC DEVICE

Filed July 22, 1943 5 Sheets-Sheet 3

FIG. 6.

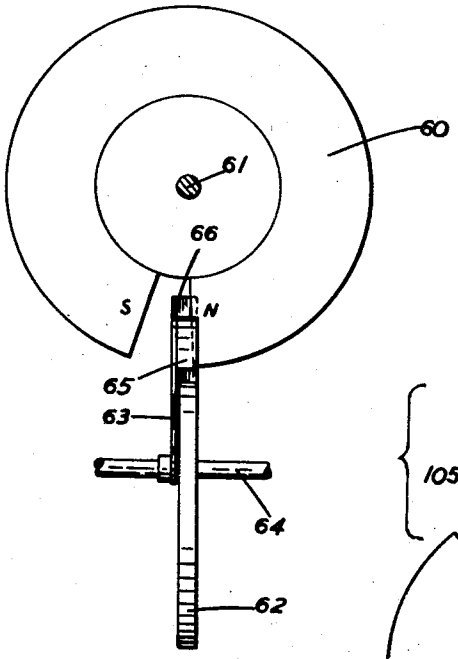


FIG. 13.

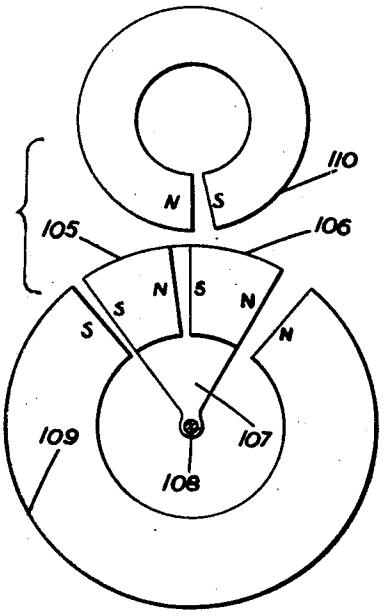
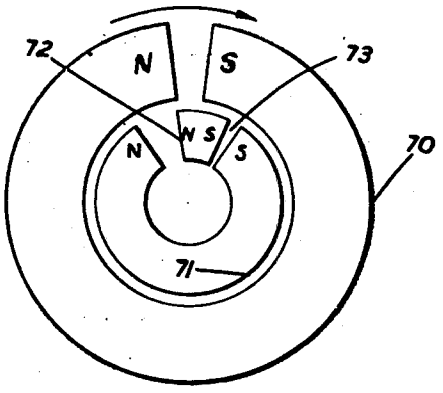


FIG. 7.



Inventor
William A. Chambers
By
Ralph B. Stewart
Attorney

Jan. 21, 1947. W. A. CHAMBERS 2,414,688

MAGNETIC DEVICE

Filed July 22, 1943 5 Sheets-Sheet 4

FIG. 8.

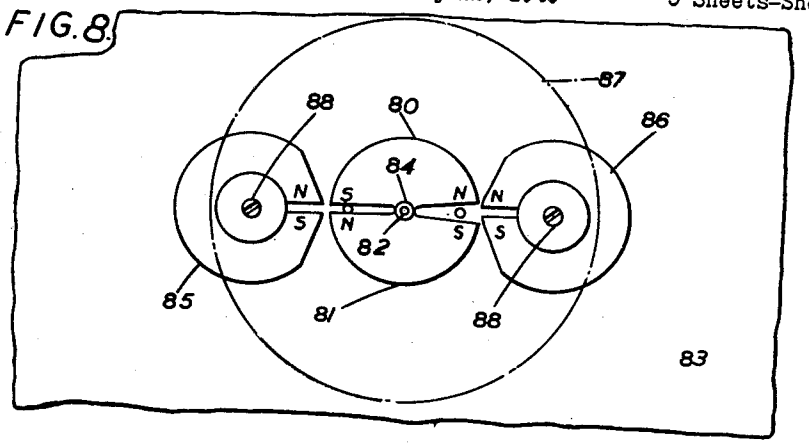
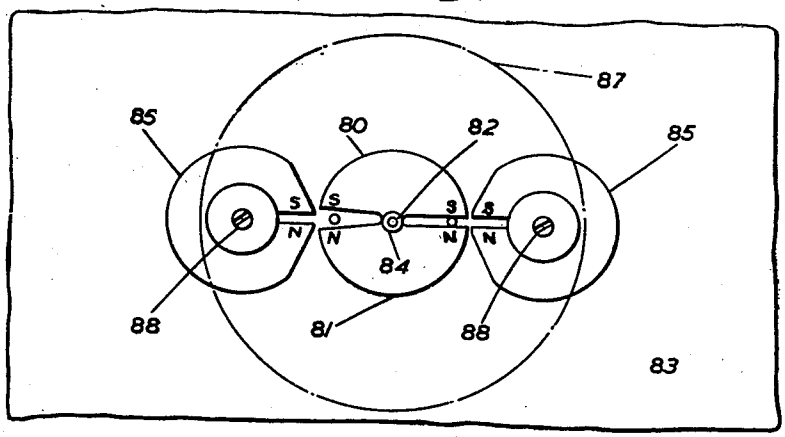


FIG. 9.



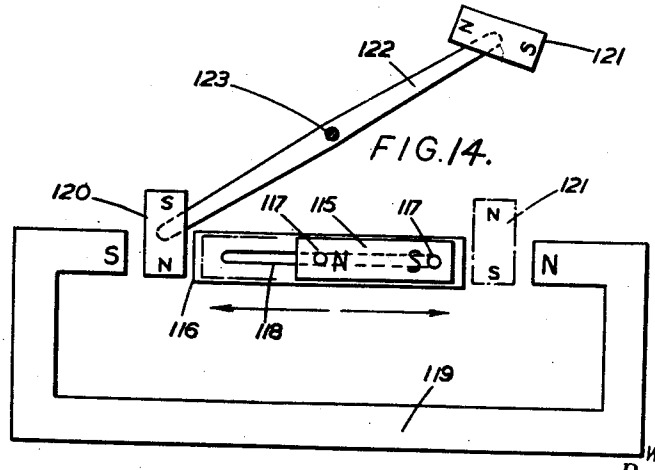


FIG. 14.

Inventor
William A. Chambers
By Ralph B. Stewart
Attorney

Jan. 21, 1947. W. A. CHAMBERS 2,414,688

MAGNETIC DEVICE

Filed July 22, 1943 5 Sheets-Sheet 5

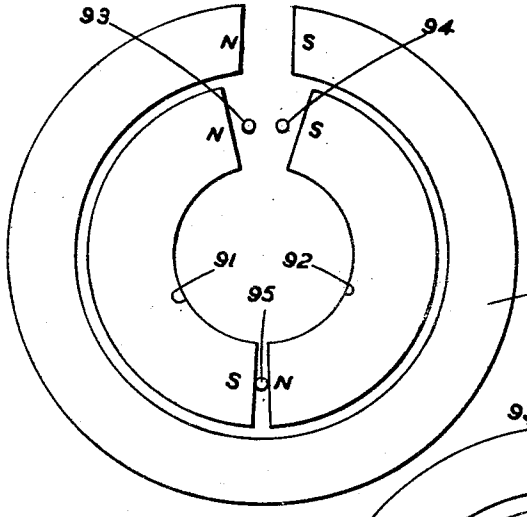


FIG. 10.

FIG. 11.

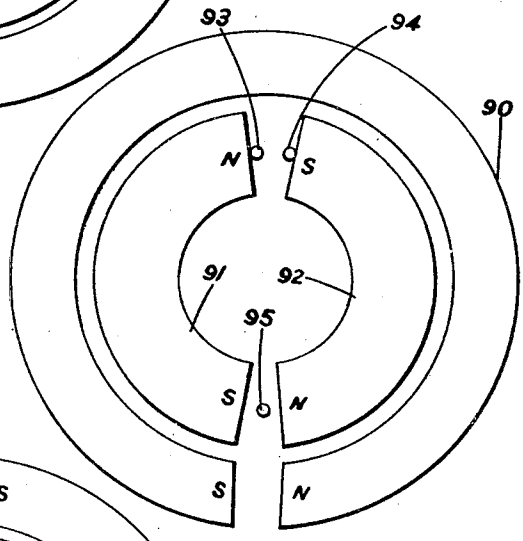
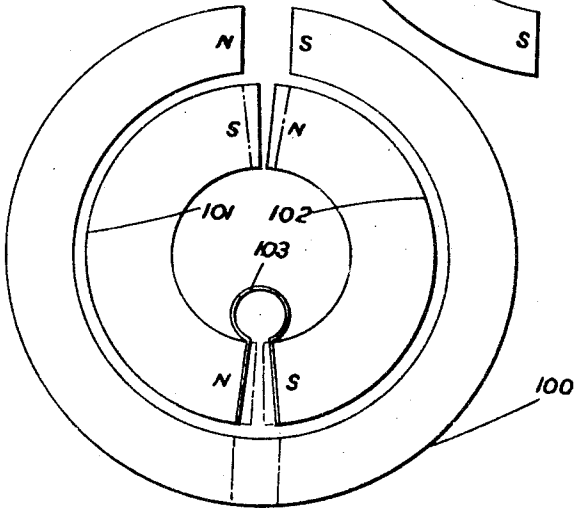


FIG. 12.



Inventor
William A. Chambers
By Ralph B. Stewart
Attorney

Patented Jan. 21, 1947

2,414,688

UNITED STATES PATENT OFFICE

2,414,688

MAGNETIC DEVICE

William Arnold Chambers, Ewell, England, assignor to Ronald Trist & Co. Limited, Slough, England, a British company

Application July 22, 1943, Serial No. 495,755
In Great Britain August 22, 1942

18 Claims. (Cl. 172—284)

1

This invention relates to magnetic devices for transmitting energy, and is particularly applicable, although not limited, to devices forming parts of switches.

The basic conception underlying the invention is to make use of the possibilities afforded by the high magnetic properties of modern magnetic alloys to maintain a member in a position of rest magnetically and when desired to move it positively (generally with snap action), also by means of magnetic forces. According to this invention a field set up by an actuated permanent magnet (which may have one or more pairs of poles) or an actuated magnetic structure, that is to say, a single member including two or more permanent magnets, interacts with a field set up by a second permanent magnet or magnetic structure to retain the first magnet or magnetic structure in a position of rest until it is moved as a result of the relative movement of an actuating magnetic field set up by a third permanent magnet or magnetic structure. Preferably the actuated magnet or structure is mounted to move freely in one plane and is retained in a rest position by the resultant force in that plane of the first and second magnetic fields until it is moved by the action of the actuating field. To move the actuated member, the actuating field or fields may interact with either or both of the other two fields to change the direction of the resultant magnetic force, which is then the resultant of at least three fields acting on the actuated member.

The retaining magnetic forces do not depend upon the actuating field for their act of retention. Although they are preferably produced by the interaction of two magnetic fields (neither being the actuating field) they may be the forces of attraction between a magnet and a piece of soft iron or other magnetic material.

The actuating field may be set up by a magnet or a magnetic structure, and there may be more than one actuating field so that the magnetic forces on the actuated member may be successively disturbed by different fields. In general the actuating field is positively moved relatively to the actuated member, but it is within the invention to maintain the actuating field stationary, and to move a complete assembly that includes the actuated member.

The invention may be embodied in many different forms of construction by means of which different actions may be performed or different effects produced.

Thus, for switch actuation or other purposes, the actuated member may be mounted to move

2

between two rest positions in each of which it is held magnetically, and be caused to move between these two positions with arcuate or linear motion. This general arrangement is particularly suitable for use with a primary actuating member which rocks or reciprocates and by which the actuating field is moved. As the actuated member is to move between two rest positions (in order, for example, to make electrical contacts in each) it may conveniently move in the space between two unlike magnetic poles, and preferably it is shaped and arranged so that in moving towards either pole it presents to it a pole of opposite polarity. Thus if it is a bar magnet moving in a gap between two poles it presents a south pole to the north pole at the one end of the gap and a north pole to the south pole at the other end of the gap. Being free to move relatively to the poles it will always tend to move to and rest in an end position, i. e. (in the case given as an example) closer to one end of the gap than the other or even in contact with one or other bounding wall of the gap, since the neutral position in which the two attractive forces are equal is one of unstable equilibrium. It will, however, be caused to move between its rest positions by the actuating magnetic field when this exerts a force strong enough to overcome the resultant force exerted by the two poles at either end, that is to say, the force that is for the time being retaining the actuated member in one or other rest position. When this happens, the actuated member will move with snap action into the other rest position, and in so doing it may change over switch contacts or bring about any other desired movement. It will be appreciated that with this arrangement movement of one part is caused to bring about snap movement of another part wholly by magnetic action and without any direct mechanical connection, and the part that is moved (i. e. the actuated member) is retained firmly in position by magnetic means until it is so moved.

Various forms of the invention are illustrated in the accompanying drawings in which

Figure 1 shows an arrangement in which the actuating and actuated assemblies are formed of two concentric annular assemblies mounted in the same plane;

Figures 2 to 4 illustrate the preferred embodiment of the invention involving concentric annular assemblies similar to Figure 1 but having a greater number of gaps and poles, Figures 3 and 4 being sectional views of Figure 2 taken along the lines III—III and IV—IV;

Figures 5 and 6 are side and end elevational

views of another form of the invention in which the actuating magnet is mounted on an axis at right angles to the axis of the actuated magnet, and the actuating magnet enters a gap in the actuated assembly;

Figure 7 illustrates a variation of Figure 1;

Figures 8 and 9 illustrate another modification in which the actuating assembly is formed of two magnets mounted on opposite sides of a pair of segmental magnets constituting the actuated assembly;

Figures 10 and 11 illustrate another construction involving concentric assemblies in which the actuated assembly is formed of two segmental magnets;

Figure 12 illustrates a variation of the arrangement of Figures 10 and 11;

Figure 13 shows a variation of Figure 1 in which the actuating magnet is mounted on an axis outside of the actuated assembly; and

Figure 14 illustrates an arrangement in which the actuated magnet is mounted for reciprocation along a straight line and the actuating magnets are mounted on a rocking rod.

A feature of the invention consists in bringing about the actual movement by the interaction of magnetic fields by means of the invention described and claimed in my pending application Serial No. 450,773, dated July 13, 1942, now Patent No. 2,378,129, issued July 12, 1945. That invention involves the use of an actuating magnet arranged to move an actuated magnet reversibly and with snap action between two mechanically limited positions as a result of the passage of the magnets through a position of unstable equilibrium in which the forces resulting from the reaction of the poles of the two magnets do not tend to bring about any relative movement. This previous invention may be incorporated in a device according to the present invention in various ways. In principle, the actuated member is retained in each of the two mechanically limited positions by magnetic forces until they are overcome by the forces resulting from the interaction of the field of the actuating magnet (or magnetic structure) and the actuated magnet (or structure). Conveniently the actuated member may be a magnetic structure including a gap at which there is a field with poles which interact with those of the actuating field in the manner described in my pending application No. 450,773. This may perhaps be most easily understood by means of an example.

This example is shown in Figure 1 of the accompanying drawings. There is an annular magnet 1 with a single short gap 2 in which the south pole leads the north pole in the clockwise direction of rotation and an inner assembly concentric with the magnet 1. This inner assembly consists of an annular segmental magnet 3 having a longer gap 4 and an actuated member 5 in the form of a magnetic structure mounted to rock in this gap about the common axis. The member 5 consists of two bar magnets 6 and 7 (arcuate as shown or straight) rigidly connected together and separated by a short gap 8. The magnet 3 is fixed and the other parts are movable. For the purposes of illustration, the magnet 3 is shown as fixed to a stationary shaft 9 by a radial bar 10; the outer magnet 1 is shown as carried by a bar 11 which is positively rocked on the shaft 9, e. g. by a float that rises and falls with the level of a liquid in a container; and the actuated member is shown as including

a segmental element 12 mounted to rock freely about the shaft 9 and rigidly carrying the magnets 6 and 7. The bars 10 and 11 and the element 12 are all made of non-magnetic material. It is preferred to prevent the actual magnetic parts from coming into contact with one another at either end of the travel of the actuated member 5, that is to say, in the two rest positions, so non-magnetic spacers 13 and 14 may be provided in the inner assembly, e. g. on the fixed magnet 3. In the complete inner assembly north and south poles alternate around the circle, that is to say, at each gap (whether fixed or variable in length) the south pole leads the north pole in the clockwise direction, the arrangement of the poles thus being the same as in Figure 18 of my pending application No. 450,773. The difference is that the main force holding the actuated member 5 against the stop is not the force (or can be entirely independent of the force) produced by the field of the actuating magnet; this main force is the resultant force exerted by the actuated and fixed magnets. Thus as the magnet 1 rocks clockwise as seen in Figure 1 the interaction of the poles at the gaps 2 and 8 produces an anticlockwise torque on the actuated member 5 which causes that member to move through the gap 4 until the magnet 6 strikes the spacer 14.

It will be seen that in this construction the field of a positively driven primary magnet 1 (which may, of course, be a magnetic structure) interacts with that of a second magnet (or magnetic structure) to displace the latter through a limited space within the field of a relatively fixed third magnet 3 (or magnetic structure). This displacement of the secondary or actuated member 5 is so regulated that the primary torque is adequate to release it from either of the alternative attracted positions in which it is normally held by the third magnet 3. In its travel it receives an additional acceleration from the third magnet 3.

A particularly effective construction is produced when two concentric annular assemblies such as those just described are used but the number of gaps and poles is increased, i. e. the outer or driving assembly consists of two or more relatively fixed segmental magnets, one of which may conveniently subtend at the centre an angle greater than that subtended by the other, and the inner assembly consists of the same number of actuated members and the same number of fixed magnets or magnetic structures. Such an arrangement can be formed into an extremely compact and effective switch, one example of which is shown in Figures 2, 3 and 4, Figure 2 being an axial section taken on the line II—II in Figure 3, and Figures 3 and 4 being cross-sections on the lines III—III and IV—IV of Figure 2 respectively.

This switch comprises a cylindrical brass casing 14 closed at one end by a plate 15 which forms a bearing for a spindle 16 carrying an operating knob 17. At the other end the casing is closed by an insulating plate 18 which carries a pin 19 constituting a footstep bearing for the spindle 16. The outer assembly consists of three magnets 20, 21 and 22, all fixed to a brass carrier disc 23 which is made rigid with the spindle 16. These magnets are secured by set screws 24, so that they can be adjusted circumferentially (and thus the relative lengths of the gaps between them can be varied) and a copper ring 25 is provided to facilitate their accurate loca-

tion. The magnets 21 and 22 are magnetically united by a soft-iron bridge 26, which can be changed for another of different length if it should be desired to alter the total length of the gaps, and they thus form one magnetic structure. Thus the outer assembly includes two gaps 27 and 28 which remain constant in length and relative position once the switch has been adjusted and which are not diametrically opposite one another in the switch shown.

The inner assembly structure consists of six segmental magnets, each subtending an angle of 50° at the centre. Two of these, 28 and 29, are fixed, being secured between cross-bars 30 by brass screws 31 which pass through tubular brass distance pieces 32 placed between one bar 30 and the end plate 18. The other four segmental magnets are arranged in pairs to form two actuated members, one pair 33 and 34 being held fixed between brass segments 35 and 36 by a bolt 37, and the other pair, 38 and 39, being similarly held between segments 40 and 41 by a bolt 42, and the gap between the two magnets of each pair being 15°. The two actuated members thus formed are both free to rock about the pin 19. The total width of the two gaps that lie one on each side of each actuated member is 15°, and each actuated member may travel through 10°, i. e. from a position in which the gap between it and a fixed segment is 2½° to a position in which it is 12½°. This limitation on the movement of the actuated members is imposed by contacts in the form of screws 43, 44, 45 and 46 which are carried by terminals 47 secured to the end plate 18, these contacts forming abutments for other contacts 48 and 49 mounted on insulating bushes 50, which in turn are carried by bolts 51 that pass through the actuated members. It will readily be seen that electric leads (not shown) can be taken from the terminals 47 and from the contacts 48 and 49 through the end plate 18.

As the knob 17 is turned the outer assembly moves round the inner assembly and the actuated members are caused to rock so that the contact 48 is brought alternately into contact with the contacts 43 and 44, and the contact 49 is brought alternately into contact with the contacts 45 and 46. If the knob is continuously rotated in one direction the actuated members will be reciprocated; in other words, continuous rotary motion is converted into reciprocating motion by the interaction of the magnetic fields alone.

Although the arrangements illustrated in Figures 1 to 4 incorporate the principle of the invention of my pending application No. 450,773, it should be understood that in the present invention snap movement of the actuated member can be brought about otherwise; in particular, in the arrangements illustrated in principle by Figures 1 to 4 the relationship of the north and south poles in one assembly may be reversed.

As another example, an actuating magnet (or structure) may be mounted to rock through a gap in an annular magnetic assembly, in accordance with the principle illustrated by Figures 18 and 19 of my pending application No. 450,773, and the magnetic assembly may comprise one fixed magnet and one movable structure, the latter including the gap through which the actuating magnet or structure rocks. This is illustrated by Figures 5 and 6, which are two views taken at right angles to one another. The actuating magnet, which is annular, is shown at 60 and is carried by a shaft 61. The co-operating magnetic assembly comprises a fixed segmental magnet 62

and an actuated member consisting of a brass stamping 63 which is free to rock around a rod 64 which is co-axial with the magnet 62. The stamping 63 carries two magnets 65 and 66 and between these is cut away to leave a gap into which the circumferential part of the magnet 60 projects. The stamping 63 is mounted to clear the magnet 62, that is to say, its free ends can pass beneath the magnet, and it carries two non-magnetic spacers 67 and 68 which, as the whole actuated member rocks, come into contact alternately with the magnet 62. In the position shown in the drawings the north pole of the magnet 60 has attracted the south pole of the magnet 66 and the spacer 67 is in contact with the north pole of the magnet 62. The actuated member is maintained in this position by the magnetic attraction between the south pole of the magnet 65 and the north pole of the magnet 62. When the magnet 60 is rocked so that its south pole comes closer than its north pole to the south pole of the magnet 66 the whole driven member rocks clockwise until the spacer 68 abuts against the south pole of the magnet 62. In the course of this movement the attraction between the north pole of the magnet 65 and the south pole of the magnet 60 plays a considerable part in ensuring snap action. In the rest positions the whole actuated member is firmly retained by the attraction of the north or south pole of the magnet 62 as the case may be.

One construction in which rotary motion continuous in direction is converted into reciprocating motion by the interaction of the magnetic fields alone has been described, being shown in Figures 2 to 4. It will be appreciated that this construction works on the principle that the actuated member in moving from one rest or limiting position to another shortens one magnetic gap and lengthens another. The rotary actuating field is applied to each gap in turn during the course of the rotation and is operative to overcome the existing magnetic forces to move the actuated member to alter the length of the gap. This principle may be embodied in other constructions. Indeed if the outer magnet 1 shown in Figure 1 is continuously rotated the actuated member will be reciprocated. In another simple construction there may be an annular actuating magnet with a single gap at which the actuating field is produced, and an inner assembly consisting of a fixed segmental magnet and a movable segmental actuated member mounted to rock in the space between the ends of the fixed magnet about the common axis. In the inner assembly north and south poles alternate around the circle. In the actuating magnet the relationship of the poles to the gap is the opposite of that in the inner assembly, that is to say, assuming that the south pole leads the north pole, as the actuating magnet rotates it passes the south pole of the fixed magnet before it arrives at the movable magnet. This is illustrated in Figure 7, which is purely diagrammatic and in which the outer actuating magnet is shown at 70, the fixed inner segmental magnet at 71 and the movable inner segmental magnet at 72. As any gap is approached, it will be at a minimum, and the resultant of the fields at the two ends of the magnet 72 will hold it in this position. In Figure 7 the gap 73 is at a minimum and is just being approached by the actuating field, assuming that the magnet 70 is rotating in a clockwise direction. Depending on the relative lengths of the gaps and strengths of the poles a position will ultimately

be reached in which the torque produced by the actuating field overcomes that exerted by the retaining force. Of course, the movable magnet **72** will not turn through an indefinite angle when this occurs, but it is easy to choose the dimensions so that the movable magnet will turn through a large enough angle for the resultant of the forces exerted by the fixed magnet **71** on the movable magnet **72** to reverse in direction, with the result that the movable magnet **72** snaps into its other end position. As the actuating magnet continues to rotate it reaches a position in which the resultant torque serves to lengthen the next gap in the same way, i. e. causes the movable segment to move back again.

In the construction just described the arrangement of the poles of the actuating magnet, and thus the action of the actuating field, may be reversed, that is to say, the field may cause each gap it reaches to tend to close.

In a somewhat similar construction, both the parts of the inner assembly may be movable around the common axis, and as each gap is approached or reached they will move in opposite directions of rotation, although not necessarily simultaneously. It will, of course, be understood that each movable magnet or actuated member will be moved once in one direction and back again in each revolution of the actuating magnet. The factors that determine whether the actuated members will move simultaneously or at different positions of the outer assembly are the relative widths of the gaps and the distribution of the intensity of each field. It may be convenient in some cases to ensure that both members move together and in others to ensure that one member moves at one position of the actuating field and the other member at another position. In any case the construction may be convenient in enabling one set of contacts to be actuated by one member and another set by the other member.

If there are two actuating fields moving at 180° apart from one another around two segmental magnets of the kind just described and one tends to open each gap and the other to close each gap, the actuating torque will be increased so that the movement of the magnets is much more positive. Figures 8 and 9 illustrate this principle. In the device shown two driven segmental magnets **80** and **81** are mounted to rock about a spindle **82** carried by a support **83**, the magnets being actually secured to brass stampings having lugs **84** that surround the spindle **82**. There are two actuating magnets **85** and **86** carried by a disc **87** fixed to the spindle **82** and actually fitting rightly around circular non-magnetic bosses which are secured to the disc by screws **88**. With the arrangement of the poles shown in the figures, the magnet **85** tends to close each gap and the magnet **86** tends to open each gap, so that when the disc **87** turns through 180° from the position shown in Figure 8 to that shown in Figure 9 the magnets **80** and **81** rock in opposite directions.

There may, if desired, be more than two magnets in the inner assembly and each may be a movable magnet or actuated member.

In other constructions, the arrangement may be such that the actuated member, after moving from a rest position, tends upon any further relative movement of the actuating field to revert to the rest position. This may be useful, for instance, if the actuated member is to make an electric circuit and immediately to break it or vice versa. One construction resembles that in Figures 8 and 9 and is diagrammatically illustrated by Figures 10 and 11. There is a single actuating magnet **90** and two movable inner segmental magnets **91** and **82**. Three non-magnetic stops **93**, **94** and **95** are provided. The polar arrangement is such that the actuating field tends to open the gaps between the magnets **91** and **92** and the normal position is shown in Figure 10. The stop **95** holds the magnets 5° apart from one another and the wider gap then subtends an angle of 30° at the centre. It can be closed to 20° by the movement of each magnet through 5°, but the stops **93** and **94** prevent it from being reduced to less than this. It will be seen that the one gap has a minimum length greater than the maximum length of the other, and this is all that is necessary to ensure immediate return of the magnets after they have been moved by the action of the actuating field. When the magnet **90** moves from the position shown in Figure 10 to that shown in Figure 11 it will open the gap around the spacer **95**, but as soon as the actuating field moves further the attractive force between the two magnets at that gap will overcome that at the other or longer gap and the movable magnets will snap back again. When the actuating field arrives at the longer gap it will find it already at the maximum and no movement of the movable magnets will occur. The effect is thus the same as if the actuating field, every time it passed one gap, opened it against a spring which restored the parts to their original position when the actuating field moved onwards.

The same effect can, in fact, be produced with segmental magnets arranged to open and close to equal angular limits if a spring is placed in one gap. For instance the actuating field may tend to open the gaps in the inner assembly and it will therefore close one against the spring in opening the other. Alternatively, it may tend to close the gaps, as shown in Figure 12. Here, an actuating magnet **100** surrounds two magnets **101** and **102**, arranged so that the gaps between them can close to 5° and open to 15°, and having a non-magnetic spring **103** in the gap which the actuating field closes as it travels. When the actuating field reaches the other gap it will find that gap closed by the action of the spring in opening the other to the maximum.

In yet further constructions, the rest position may be one of equilibrium in which the resultant force is zero and from which the actuated member is moved by the actuating field and to which it returns when the actuating field ceases to exert sufficient force to maintain the resultant actuating force which has moved the actuated member. Such a construction is illustrated by Figure 13, in which the actuated member is a magnetic structure consisting of two magnets **105** and **106** carried by a segment **107** which is free to rock about a vertical shaft **108**. This actuated member rocks in the gap between the poles of an annular magnet **109** and presents like poles to the poles of the magnet **109**, so that it always tends to lie in the middle of the gap. A magnet **110** produces a moving actuating field which serves to displace the actuated member to one or other pole of the fixed magnet **109**. In the position shown in Figure 13 the actuated member is being displaced towards the south pole of the magnet **109**. The force producing this displacement decreases as the actuating field moves on, that is to say, in general the movement is not of a snap nature.

In yet another form of construction, the mov-

able member may be a magnet mounted to reciprocate with straight-line movement between two magnetic poles and means may be provided for moving one or more fields to cause the resultant force to change in direction. A construction illustrating this principle is shown in Figure 14 and includes a magnet 115 which is mounted to slide along a rectangular guide 116, being furnished with two pins 117 which enter a slot 118 in the guide. The magnet 115 lies and slides in the gap between the ends of a fixed rectangular magnet 119. Two bar magnets 120 and 121 are fixed to a rod 122 that is mounted to rock about an axis 123. As the rod 122 rocks the ends of the magnets which it carries enter first one gap and then the other, and in each case displace the magnet 115. Thus in the position shown in full lines the south pole of the magnet 115 is closer to the north pole than to the south pole of the fixed magnet 119. The rod 122 is then rocked so that the magnet 120 moves away from the magnet 115 and the south pole of the magnet 121 enters the gap to lie close to the north pole of the fixed magnet 119 as shown in dotted lines, with the result that the direction of the resultant force on the magnet 115 is changed; the magnet 115 thereupon moves to the left into the position shown in dotted lines. In the reverse movement of the rod 122, the resultant force is changed again and the magnet 115 moves back again.

It will be understood that it is not necessary for all the movements of the structures to take place in the same plane. For example the actuating field may move in one plane and the driven member in another. Moreover, any structure or part may move in more than one plane.

In the appended claims the term "primary magnetic field" is to be interpreted as a magnetic field established by a permanent magnet or by an electromagnet as distinguished from an induced magnetic field.

I claim:

1. A magnetic device for transmitting energy comprising, in combination, an actuated member having a primary magnetic field, a second member having a primary magnetic field which interacts with the field of said actuated member to retain the actuated member in a position of rest, and a movable actuating member having a primary magnetic field interacting with the field of said actuated member for moving the same from said position of rest.

2. A device according to claim 1 in which the actuated member is mounted to move freely in one plane and is retained in a rest position by the resultant force in the plane of the first and second magnetic fields until it is moved by the action of the actuating field.

3. A magnetic device for transmitting energy comprising in combination, an actuated member having a primary magnetic field and mounted to move between two positions of rest, a stationary member having a magnetic field acting on said actuated member to retain the same in either position of rest, and a movable actuating member having a primary magnetic field interacting with the field of said actuated member for moving the same between said positions of rest.

4. A device according to claim 3 in which the actuated member moves in the space between two unlike magnetic poles of said stationary member.

5. A device according to claim 3 in which the actuated member moves between two spaced magnetic poles of unlike polarity produced by the field of said stationary member, and said actuated member embodies means for presenting magnetic poles of opposite polarity to said spaced poles.

6. A magnetic device for transmitting energy comprising, in combination, an actuated member having a primary magnetic field and mounted for reversible movement between two mechanical stops, a movable actuating member having a primary magnetic field which interacts with the magnetic field of said actuated member to move the actuated member between said two stops with snap action by repulsion between said two primary fields, and magnetic means embodying magnetic fields for holding said actuated member into engagement with either of said stops by an attractive force which is overcome by the interaction of the fields of said actuated and actuating members.

7. A magnetic device for transmitting energy comprising, in combination, an actuated element having a pair of spaced magnetic poles for establishing a primary magnetic field, an actuating member having a primary magnetic field for interacting with the field of said actuated member to reversibly move the actuated member with snap action between two limiting positions by repulsion between said primary magnetic fields, and means including a pair of magnetic poles positioned on opposite sides of the two limiting positions of said actuated member and serving to retain the actuated member in its end positions until it is positively moved by the forces resulting from the interaction of said primary fields.

8. A magnetic device for transmitting energy comprising, in combination, a magnetic structure for establishing a magnetic field within a limited space, an actuated member having primary field producing magnetic poles mounted for movement within said magnetic field, a movable actuating member having a primary magnetic field which interacts with the field of the actuated member to move the actuated member within said space, said first magnetic field serving to hold said actuated member in a position of rest except when it is being moved by said actuating field.

9. A device according to claim 8 wherein said movable actuating member is formed as an annular structure, and the other two magnetic structures are embodied in an annular assembly positioned within said actuating member.

10. A magnetic device for transmitting energy comprising, in combination, an annular magnetic assembly comprising a fixed permanent magnet having a gap therein, a movable permanent magnet structure positioned within said gap and including a smaller gap formed therein, and a movable actuating magnet mounted to move into said smaller gap.

11. A device according to claim 10 in which said actuating magnet comprises an annular magnet mounted to rotate about an axis at right angles to the axis of said magnetic assembly.

12. A device for translating continuous rotary motion in one direction into reciprocating motion by the interaction of magnetic fields alone, comprising a magnetic structure having a magnetic gap formed therein, an actuated member mounted for reciprocating motion between the poles of said gap whereby the gap on one side of said actuated member increases while the gap on the other side thereof decreases, a rotary member mounted for continuous rotation in one direction and embodying means for establishing

a magnetic actuating field which interacts successively with the fields in said two gaps during the rotation of said rotary member, whereby first one gap and then the other is caused to increase, or vice versa.

13. A device for translating continuous rotary motion into reciprocating motion by the interaction of magnetic fields alone, comprising a pair of segmental magnets arranged in an annular assembly and having gaps formed between the poles thereof at diametrically opposed points, each of said segmental magnets being mounted for oscillation so that as one gap is increased the other gap is decreased, and an annular magnet surrounding said annular assembly and mounted for continuous rotation about the axis of said assembly whereby the field in the gap of said annular magnet interacts successively with the fields in the diametrically opposite gaps in said annular assembly.

14. A device for translating rotary motion into reciprocating motion by the interaction of magnetic fields alone, comprising an annular actuating assembly composed of at least one rotary magnet, and a second assembly concentric with the first assembly and including at least one

fixed segmental magnet and at least one movable segmental magnet mounted to rock about the common axis of said annular assemblies.

15. A device according to claim 14 in which said two assemblies are formed so that north and south poles therein alternate in opposite directions around said assemblies.

16. A device according to claim 1 and including means tending to return said actuated member to its position of rest upon further relative movement of the actuating field with respect to the actuated member.

17. A device according to claim 13 wherein one gap formed between said segmental magnets has a minimum length greater than the maximum length of the other gap formed between said magnets.

18. A device according to claim 1 in which the actuated member tends to remain in a rest position of equilibrium in which there is no resultant force tending to move it and from which it is moved by the actuating field and to which it returns when further relative movement of the actuating field takes place.

WILLIAM ARNOLD CHAMBERS.