Jan. 8, 1963 L. P. LAZZARINI 3,072,830

ROTARY SOLENOID

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FIG_1

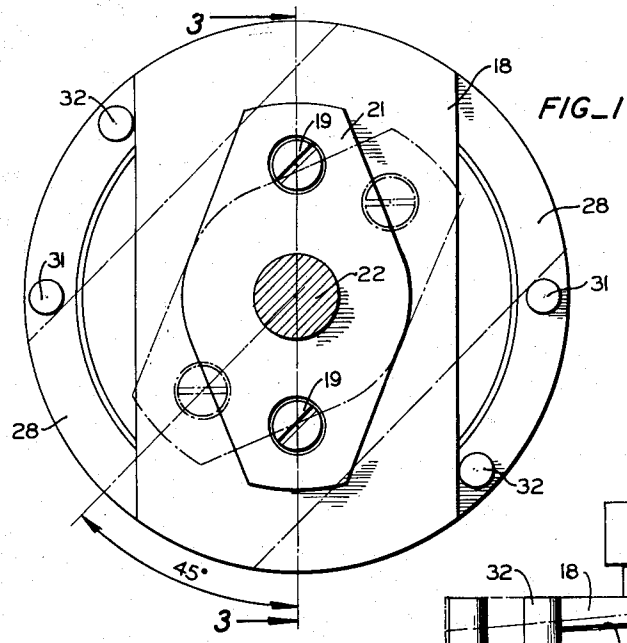


FIG_2

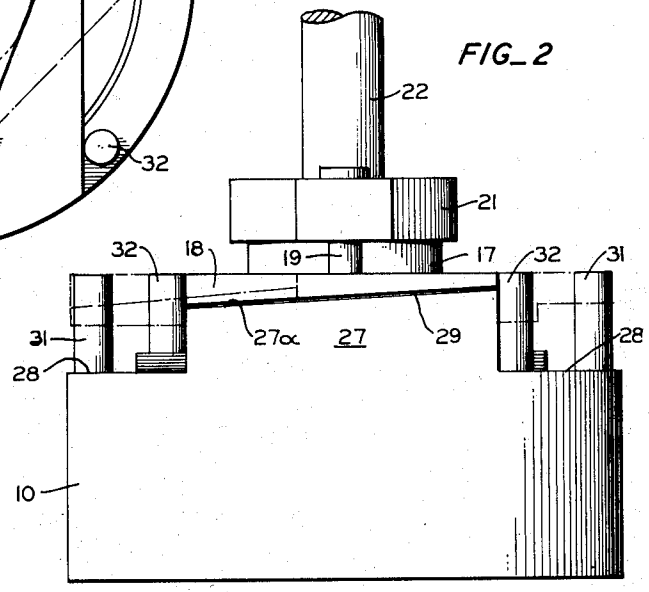
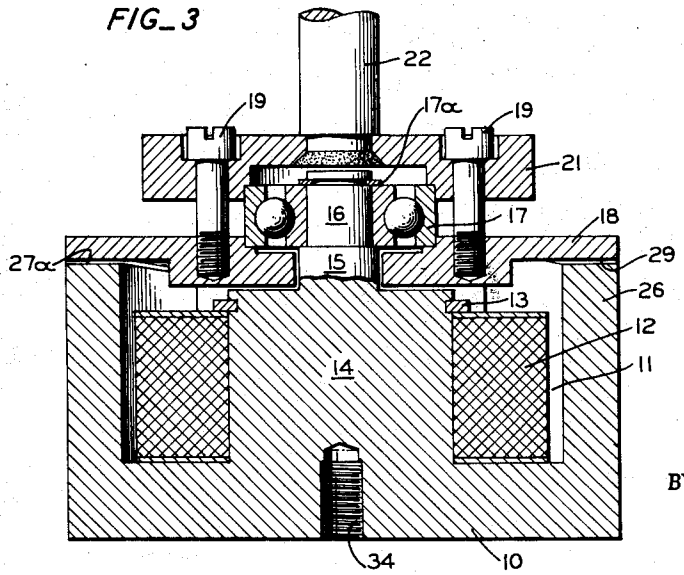


FIG_3



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FIG_4

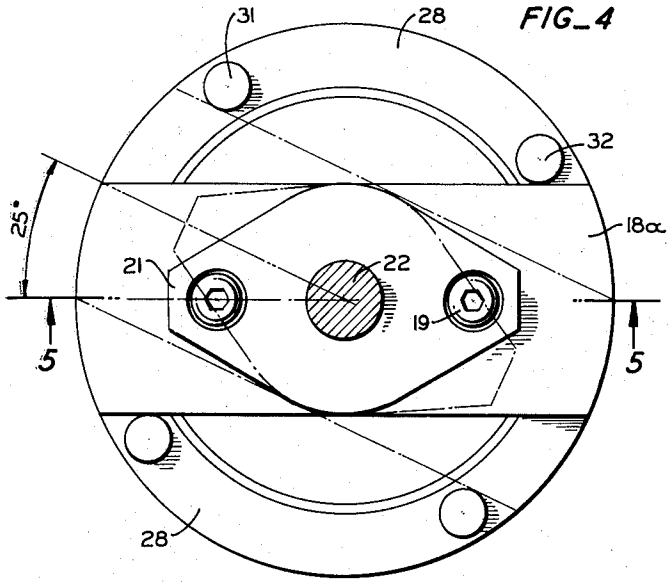
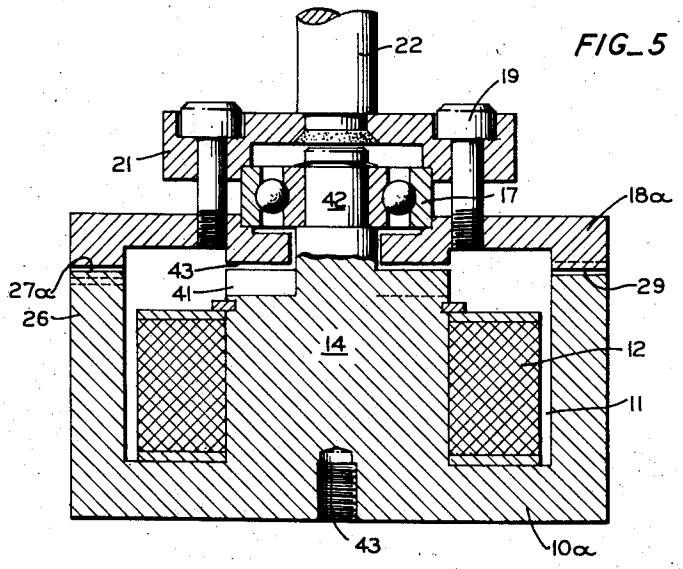


FIG_5



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ROTARY SOLENOID

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5 Claims. (Cl. 317—197)

A present invention that relates to rotary solenoids, and more particularly to one which operates by means of the mutual attraction of the armature and a pole through a closing air gap to produce rotary movement of the armature without axial movement thereof.

It is a general object of the invention to provide an improved closing-air-gap type of rotary solenoid.

Another general object of the invention is to provide a rotary solenoid of the closing-air-gap type in which the surfaces defining the gap are helical or inclined surfaces formed at the end of a cylinder disposed parallel to the axis of the solenoid, and in which the motion produced in closing the air gap is wholly rotary.

A further object of the invention is to provide a solenoid of the above character in which a plurality of helical or inclined surfaces are provided, with closing air gaps between a wide pole member face and a wide armature face so that an enhanced torque results in the solenoid.

Other objects and advantages of the invention will be apparent from the following description of a certain preferred embodiment thereof, as illustrated in the accompanying drawings, in which:

FIGURE 1 is a plan view partially in section of a rotary solenoid embodying the invention;

FIGURE 2 is a side elevational view;

FIGURE 3 is a transverse section taken in a plane indicated by the line 3—3 in FIGURE 1;

FIGURE 4 is a plan view of a modified form of the invention;

FIGURE 5 is a section taken as indicated by the line 5—5 in FIGURE 4.

Referring to FIGURES 1–3 there is shown a frame or pole member **10** having an annular recess **11** in which a suitable electromagnetic coil **12** is secured by means of a retaining ring **13**. The central pole or core member **14** of the magnet has a central extension **15** in the form of a shaft portion provided with a reduced portion **16** upon which the inner race of a ball bearing **17** is seated and held by a retainer ring **17***a*. The outer race of the ball bearing **17** is seated at one side in an armature plate **18** which is secured by a pair of screws **19** to a retainer plate **21** seated on the other side of the outer race and having an output shaft **22** welded therein coaxially with the bearing **17**. It is seen therefore that the mounting means for the armature provides for rotary movement thereof while preventing axial movement. As seen the outer annular pole or core member **26** is provided with a pair of relatively wide pole faces **27** separated by cut-away portions **28**, to concentrate the magnetic flux through the active pole face or pole face portions **27**. An upper segmental annular area of pole face **27***a* is formed inclined or in helical fashion with respect to the correspondingly shaped bottom surface **29** of the associated end of the armature **18**. The angle of the helix to a plane perpendicular to its axis is preferably small to provide for a relatively small air gap at its widest point. Preferably, the face **27***a* and the face **29** are disposed substantially parallel so that as the armature **18** moves from its dotted line position as shown in FIGURE 1, to its full line position, the gap between the faces **27***a* and **29** closes to about .002", thereby producing torque in the armature due to the reduction of path of travel in the magnetic flux between the armature and the pole faces, the torque increasing as the air gap closes. The limit of travel of the armature is determined by respective sets of pins **31** and **32** (FIGURES 1–3) which are of non-magnetic material, and are seated in and extend upwardly from the cut-away portions **28** of the pole member. The amount of travel as designed in the solenoid shown herein is approximately 45°. Suitable means may be provided in connection with the armature to return it to its initial position, as for example, a spring attached to the armature retainer plate **21** or secured in some manner to the output shaft **22** in the mechanism being operated.

For purposes of mounting this solenoid, the pole member may be provided with a threaded recess **34**.

Referring to FIGURES 4 and 5, there is shown a rotary solenoid which is similar in construction to the solenoid described in connection with FIGURES 1–3, except for the additional structure described hereafter.

The center pole member **14** is also provided with a pair of inclined or helical faces **41** adjacent the shaft extension **42** thereof upon which the bearing **17** is supported and these pole faces **41** are associated with corresponding helical or inclined faces **43** of the armature **18***a* so that the torque produced by the pole faces **43** and **41** is cumulative in effect with respect to the outer sets of pole faces **29** and **27***a*. The armature **18***a* as shown has movement through 25°.

The operation of the rotary solenoids as shown in both forms is similar. The armature of the rotary solenoid is normally positioned so that the air gap between the armature and the associated pole surfaces is at its widest. Upon energization of the coil of the solenoid by an electrical pulse or current, the magnetic flux set up produces torque tending to close the air gap so that the armature rotates rapidly without axial movement to the position where the air gap is smallest.

While I have shown and described certain preferred embodiments of the invention, it will be apparent that the invention is capable of variation and modification from the form shown so that the scope thereof should be limited only by the scope of the claims appended hereto.

I claim:

1. In a rotary solenoid of the closing-air-gap type, a pole piece having a central pole member and an outer pole member connected to each other, each having an end surface, a magnet winding disposed in the space between said pole members, an armature, means for mounting said armature about an axis on said solenoid for rotative movement with respect to said pole piece, said armature having an axially facing surface in close parallel relation with an end surface of the inner pole member and an outer surface in close parallel relation with an end surface of said outer pole member, said respective surfaces of the inner pole member and the outer pole member and said armature surfaces being similarly inclined to produce a change in axial spacing therebetween upon rotative movement of said armature to provide said closing-air-gap operation.

2. In a rotary solenoid of the closing-air-gap type, a core comprising a pole piece having a central pole member and an outer pole member connected to each other, each pole member having a plurality of spaced end surfaces, a magnet winding disposed in the space between said pole members, an armature, means outside of the direct magnetic field set up in said core for mounting said armature for rotative movement with respect to said pole piece and including a plurality of axially directed surfaces respectively in close parallel relation with said end surfaces of said pole members, said respective related

surfaces being inclined to produce a change in axial spacing therebetween upon rotative movement of said armature.

3. In a rotary solenoid of the closing-air-gap type, the combination of a pole piece of magnetic material having a central pole member and an annular wall, and an annular coil disposed around said central pole member substantially concentrically with said annular wall, said annular wall having a pair of substantially diametrically opposed magnetic pole surfaces which together extend over approximately half of the circumference of said annular wall, said coil when electrically energized providing one magnetic pole on said pole member and a pair of like magnetic poles of opposite polarity on said diametrically opposed pole surfaces, an armature of magnetic material, means for mounting said armature on said solenoid for rotative movement about an axis and for preventing axial movement thereof, each of the ends of said armature having a surface in spaced operative annular wall, said annular wall being cut away between said pole surfaces so as to substantially confine the magnetic flux to the ends of said armature and to said pole surfaces, said armature end surfaces and said pair of magnetic pole surfaces each having opposed substantially parallel inclined faces which in one relative rotative position of said armature and said pole piece overlap each other by approximately one-half of their respective areas with a maximum air gap therebetween, and in another relatively rotative position the effective areas of said substantially parallel inclined faces substantially overlap with a minimum air gap therebetween, and stop means for limiting rotation of said armature.

4. In a rotary solenoid of the closing-air-gap type the combination of a magnetic core comprising a central pole member and an annular wall having projections on substantially diametrically opposite sides thereof forming like magnetic poles and also having the portions of said annular wall between said projections cut away so that the magnetic flux in said core is substantially confined to said projections and to said central pole member, an electromagnet coil disposed concentrically around said pole member to magnetize said pole member and said

projections so that said pole member forms one pole of a magnet and said projections form a pair of like poles of opposite polarity, an elongated armature, means outside of the direct magnetic field set up in said core for mounting said armature so that the ends of said armature are movable with respect to said projections, said armature end portions and said projections having opposed parallel faces which in one relative position of said armature and said projections provide one spacing between said faces and in another position provide another spacing therebetween.

5. In a rotary solenoid of the closing-air-gap type the combination of a magnetic member having a substantially centrally disposed pole, an annular coil disposed around said pole, said magnetic member having a pair of outer substantially diametrically disposed pole faces which assume like magnetic polarity opposed to that of said centrally disposed pole when said coil is electrically energized, an elongated armature of magnetic material, means for rotatably mounting said armature on said centrally disposed pole outside of the direct magnetic field set up in said core, said armature having a width substantially equal to the length of each of said outer pole faces, said armature also having a length such that it substantially overlaps said outer pole faces when it is rotated to its minimum air gap position in which the air gaps between the ends of said armature and the opposed ones of said outer pole faces are substantially closed, the end portions of said armature extending over substantially less than half of said outer pole faces when the air gaps between the ends of said armature and said outer pole members are maximum.

References Cited in the file of this patent

UNITED STATES PATENTS

2,289,227	Walker	July 7, 1942
2,539,090	Leland	Jan. 23, 1951
2,934,680	Buchtenkirch	Apr. 26, 1960

FOREIGN PATENTS

778,371	Great Britain	July 3, 1957