

Nov. 28, 1950

G. W. CARPENTER
ROTARY SOLENOID

2,531,905

Filed Aug. 4, 1947

2 Sheets-Sheet 1

Fig. 1

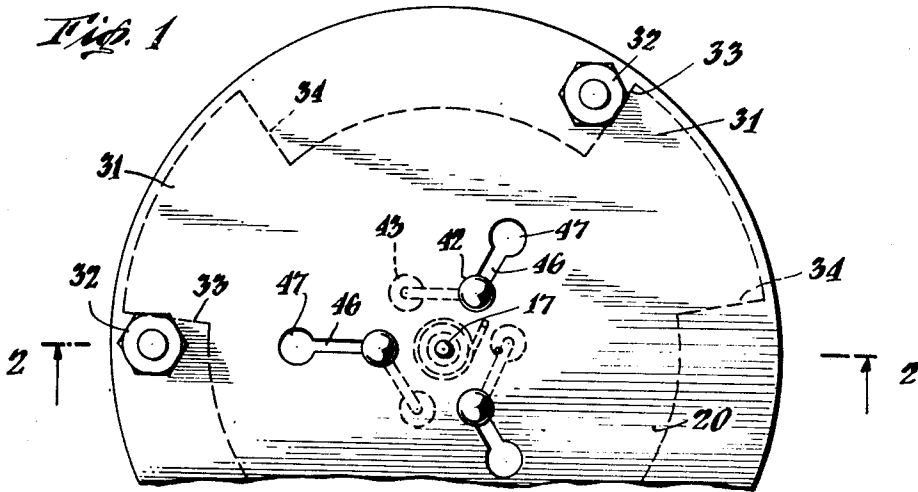


Fig. 2

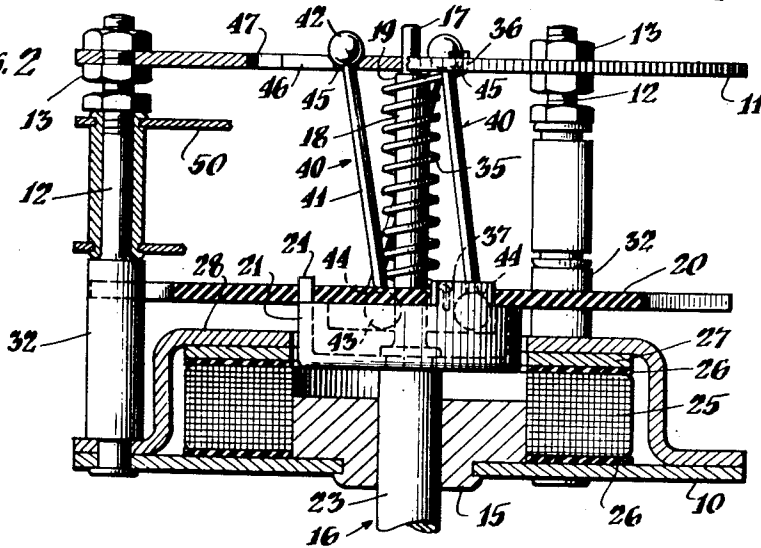
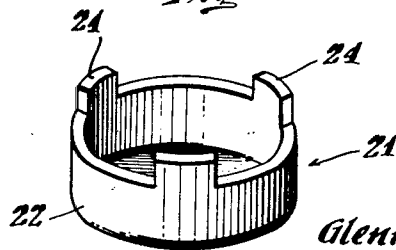


Fig. 3



INVENTOR.
Glenn W. Carpenter

BY *Nicholas Laugel*
ATTORNEY

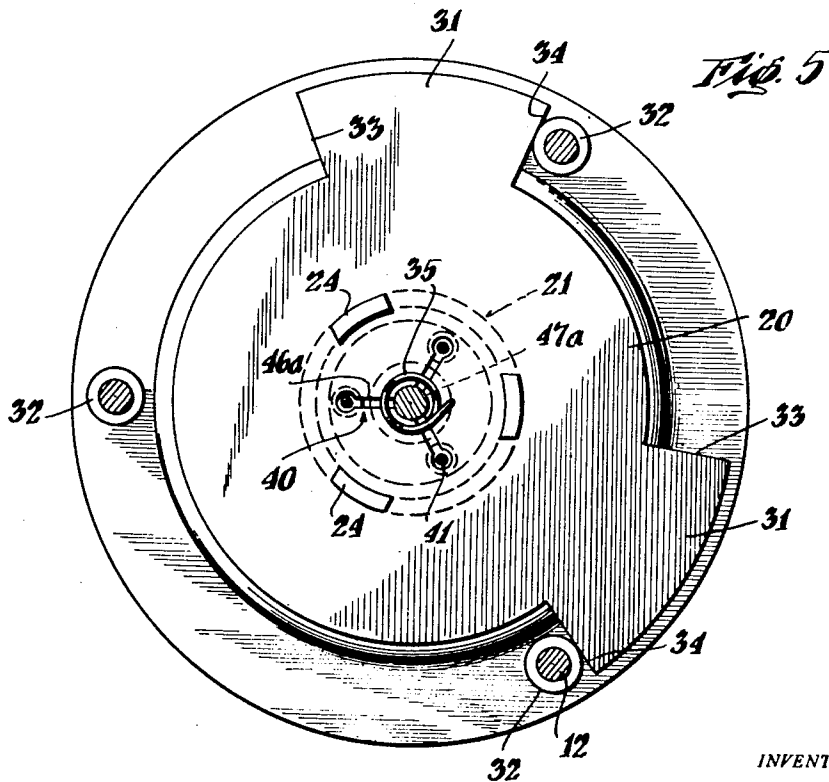
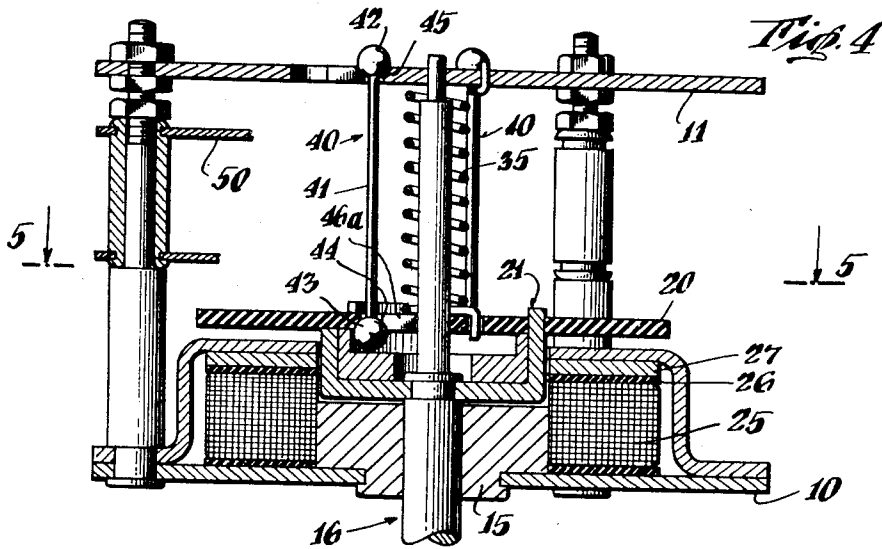
Nov. 28, 1950

G. W. CARPENTER
ROTARY SOLENOID

2,531,905

Filed Aug. 4, 1947

2 Sheets-Sheet 2



INVENTOR.

Glenn W. Carpenter

BY *Nicholas Lange.*

ATTORNEY

UNITED STATES PATENT OFFICE

2,531,905

ROTARY SOLENOID

Glenn W. Carpenter, Indianapolis, Ind., assignor
to P. R. Mallory & Co., Inc., Indianapolis, Ind.,
a corporation of Delaware

Application August 4, 1947, Serial No. 765,907

9 Claims. (Cl. 74—1)

1

This invention relates to a rotary solenoid and, more particularly, to a solenoid wherein axial movement resulting from attraction of an armature by a solenoid coil is transformed into rotary movement.

Solenoids heretofore utilized have ordinarily comprised a coil, and an armature which is axially displaced when the coil is energized, this axial movement being utilized for various purposes, such as to close one or more sets of contacts. In accordance with the present invention, the axial movement of the armature is transformed into intermittent angular or rotary movement which may be utilized, for example, to actuate a timer mechanism by means of a suitable pawl and ratchet arrangement.

It is an object of the invention to improve the construction and operation of rotary solenoids.

It is a further object of the invention to provide a novel mechanical linkage for transforming the axial movement of the solenoid armature to intermittent rotary movement.

It is a still further object of the invention to provide a rotary solenoid in which the space occupied is reduced to a minimum and which may advantageously be used with an associated timing apparatus.

It is a still further object of the invention to provide a rotary solenoid which is simple in construction, reliable in operation, and which may be manufactured at low cost.

Other objects of the invention will be apparent from the following description and accompanying drawings taken in connection with the appended claims.

The invention accordingly comprises the features of construction, combination of elements, arrangement of parts, and method of manufacture referred to above or which will be brought out and exemplified in the disclosure hereinafter set forth, including the illustrations in the drawings, the scope of the invention being indicated in the appended claims.

For a fuller understanding of the nature and objects of the invention as well as for specific fulfillment thereof, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

Figure 1 is a top view, partially broken away, of the novel rotary solenoid with the parts in one angular position;

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

2

Figure 3 is a perspective view of the paramagnetic armature member;

Figure 4 is a sectional view of the rotary solenoid with the parts in a second angular position; and

Figure 5 is a sectional view taken along the line 5—5 of Figure 4.

Referring now to the drawings in detail, and particularly to Figures 1 and 2, the rotary solenoid may comprise a base 10 and an adjustable support, such as a plate 11, spaced therefrom and parallel thereto. The base and support may be interconnected by a plurality of screws 12 having nuts 13 threaded thereon for holding the support 11 in the described parallel spaced position with respect to the base 10. A core piece 15 is mounted in a central aperture of the base 10 and a shaft 16 is journaled in the core 15 and support 11. The shaft 16 is adapted for rotation in its bearings and also for limited axial movement. To this end, the upper part of the shaft has a reduced end portion 17 which extends through a suitable opening in the support 11 while an enlarged central portion 18 of the shaft forms a shoulder 19 for limiting the upward movement of the shaft.

A generally circular plate 20 of non-magnetic material and a paramagnetic armature member 21 are fixed to the shaft and rotatable therewith. As best shown in Figure 3, the armature may comprise a cup-shaped body portion 22 which is seated upon an enlarged butt portion 23 of the shaft. A plurality of lugs 24 are formed on the body portion 22 and these lugs are fitted forcibly into suitable openings in the plate 20 to provide a rigid assembly comprising the shaft, plate 20 and armature 21. A solenoid coil 25 is disposed circumferentially of the core 15 and maintained in its proper position by structure which may include insulating spacers 26, a metal plate 27, and a dished retaining member 28 which is secured to the base 10 by the screws 12. When the coil 25 is energized, the paramagnetic armature member 21 is attracted and the shaft moves axially from the position shown in Figure 2 to the position shown in Figure 4.

As stated, the plate 20 is rotatable with the shaft 16. However, the rotation of the shaft and plate is limited by stop means which confine the rotation of the shaft and plate between a first angular position shown in Figure 1 and a second angular position shown in Figure 5. To this end, the plate 20 has a plurality of projections 31 formed thereon which protrude from the circumference of the plate and are adapted to engage

sleeves or spacers 32, Figure 5, on the screws 12. Thus, when the plate 20 is in its first angular position, Figure 1, the surfaces 33 of the projections engage the respective spacers 32 and, when the plate is in its second angular position, Figure 5, the surfaces 34 of the projections engage the respective spacers 32 thereby limiting the angular movement or displacement of the plate and shaft between such angular positions. The shaft and plate 20 are urged toward the first angular position shown in Figure 1 by a helical spring 35, one end of which is secured at 36 in the support 11 and the other end of which is fastened at 37 in the rotatable plate 20.

In accordance with the invention, axial movement of the shaft 16 resulting from energization of the coil 25 is transformed into rotary movement by a plurality of link members 40 which interconnect the stationary support 11 and rotatable plate 20. In the example shown, three links are utilized, each of which comprises a central rod-like portion 41 with ball-shaped portions 42, 43 at the respective ends thereof. The plate 20 adjacent each ball 43 is cut away to form a socket 44, Figure 4, and a similar socket 45 is provided in the support 11 for receiving the ball 42. To facilitate the insertion and removal of the links, a channel 46 is formed in plate 11 which extends radially outward from each socket 45, this channel being of sufficient width to accommodate the rod portion 41 but not the ball 42. A circular opening 47 is provided at the outer end of each channel 46 which is of sufficient size to permit the ball 42 to pass therethrough. Accordingly, when assembling the solenoid, the ball 42 is passed upwardly, Figure 2, through the opening 47 after which the rod portion 41 is forced inwardly through the channel 46 until the ball 42 seats in socket 45. A similar structure including a channel 46a, Figure 5, communicating with the central shaft opening 47a in plate 20, may be provided in connection with each of the sockets 44 to insure that the link structure may be readily assembled and disassembled. When the links are assembled, it will be apparent that one end of each link is effectively pivoted in the stationary support 11 while the other end thereof is pivoted in the rotatable plate 20.

The sockets or pivot points 45 in the support 11 are all spaced a uniform distance from the axis of the shaft 16 and, likewise, the sockets or pivot points 44 in plate 20 are spaced a uniform distance from the axis of the shaft. The arrangement of the sockets is such that, when the shaft is in its first angular position, Figures 1 and 2, the links are uniformly tilted with respect to the axis of the shaft. It will be recalled that the parts are urged toward this position by the spring 35 and that, in this position, the surfaces 33 of the stops 31 are in engagement with the spacers 32. When the coil 25 is energized, the armature member 21 is attracted with the result that the shaft and plate 20 move downwardly to the respective positions shown in Figure 4. This downward movement causes the distance between the pivot points 44, 45 to increase with the result that the links tend to straighten out and become parallel to the axis of the shaft. This applies a torque to the plate 20 causing it to move in a clockwise direction against the force exerted by spring 35 from the first angular position shown in Figure 1 to the second angular position shown in Figure 5. When the coil 25 is deenergized, the spring 35 urges the plate 20 in a counterclockwise direction from the second angular position shown

by Figure 5 to the first angular position illustrated in Figure 1 and the links return to their original tilted positions. Accordingly, each energization of the solenoid causes an angular movement of the plate 20 and the shaft 16 which is rotatable therewith, the plate and shaft returning to their original positions upon deenergization of the coil. This angular movement of the shaft may be utilized to actuate a timer, such as the device indicated diagrammatically at 50, Figure 2. Alternatively, the intermittent rotary movement may be utilized to drive any other suitable mechanical device or to effect operation of contacts.

It will be apparent that the scope of this invention should not be restricted to the specific embodiment shown. Thus, assuming the respective ends of each link to be fixed in the pivots 44, 45 and that such links are tilted as in Figure 2, movement of plate 20 toward support 11 would further tilt the links and tend to move the plate 20 in a counterclockwise direction, Figure 1, while, conversely, movement of the plate 20 away from support 11 would straighten out the links, that is, the links would tend to become parallel with the axis of the shaft 16, thereby moving the plate 20 in a clockwise direction, Figure 1. In the example shown, the plate 20 is moved away from support 11 by energization of the solenoid and toward support 11 by action of the spring 35. However, from the preceding description, it will be apparent that the plate 20 could as well be moved toward the support by solenoid action and away from the support by spring action, provided each link were permanently fixed in its pivots 44 and 45. Alternatively, if considerable amounts of power were required in both directions of angular movement, solenoid action could be utilized to move the plate 20 in both directions, that is, both toward and away from the support 11.

It is to be further understood that the number of links utilized is not critical but that a greater or less number may be used as desired. In addition, the term "link" in the appended claims is to be broadly construed to include equivalent mechanical means for interconnecting the plate 20 and support 11 to cause rotation of the shaft and plate in response to axial movement thereof.

While a preferred embodiment of the invention is described herein, it is contemplated that considerable variation may be made in the method of procedure and the construction of parts without departing from the spirit of the invention. In the following description and in the claims, parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a rotary solenoid, a stationary support, a shaft journaled in said support and adapted for axial movement with respect thereto, means rotatable with said shaft including a paramagnetic armature member and a plate, stop means for establishing first and second limiting positions for the angular movement of said shaft, a link interconnecting said support and said plate, said link being radially offset from said shaft, and a coil for attracting said armature member to effect axial movement of said shaft thereby to move said link and cause rotation of said plate between said first angular position and said second angular position.

2. In a rotary solenoid, a stationary support, a shaft journaled in said support and adapted for longitudinal movement, stop means for establishing first and second angular positions limiting the rotation of said shaft, means rotatable with said shaft including a plate and a paramagnetic armature member, a plurality of links interconnecting said support and said plate, said links being spaced a uniform distance from the axis of said shaft, and a solenoid coil for attracting said armature member to effect longitudinal movement of said shaft thereby to move said links and cause rotation of said shaft between said first angular position and said second angular position.

3. In a rotary solenoid, a stationary support, a shaft journaled in said support and adapted for axial movement, means including a plate and a paramagnetic armature member rotatable with said shaft, a plurality of stops for limiting said rotation between a first angular position and a second angular position, means for biasing said shaft toward said first angular position, a plurality of links interconnecting said support and said plate, said links being spaced a uniform distance from the axis of said shaft and being tilted with respect to said axis when the shaft is in said first angular position, and a solenoid coil for attracting said armature member to effect axial movement of said shaft, said axial movement increasing the distance between said plate and said support thereby straightening said links and causing the shaft to move to said second angular position.

4. In a rotary solenoid, a stationary support, a shaft mounted for axial and rotary movement with respect to said support, a rotatable member fixed to said shaft, stop means establishing first and second limiting positions for the angular movement of said shaft, means for biasing said shaft toward said first angular position, a link pivoted at one end thereof on said stationary support and at the other end thereof upon said rotatable member, said link being tilted with respect to the shaft axis when the shaft is in said first angular position, and means for moving said shaft axially in such direction as to increase the distance between said pivot points thereby displacing the shaft to said second angular position.

5. In a rotary solenoid, a stationary support, a shaft mounted for axial and rotary movement with respect to said support, means rotatable with said shaft including a plate and armature member, stop means establishing first and second limiting positions for the angular movement of said shaft, means for biasing said shaft towards said first angular position, a plurality of links radially offset from said shaft and tilted with respect to the axis of said shaft, each link interconnecting said plate and said stationary support, and a solenoid coil for attracting said armature member to cause axial movement of said shaft, said axial movement forcing the links toward a parallel position with respect to the shaft axis thereby moving said plate member to said second angular position.

6. In a rotary solenoid, a stationary support, a shaft mounted for axial and rotary movement with respect to said support, means rotatable with said shaft including a plate and a paramagnetic member, stop means establishing first and second

limiting positions for the angular movement of said shaft, means for biasing said shaft towards said first angular position, a plurality of links interconnecting said stationary support and said plate, said links being uniformly tilted with respect to the shaft axis when the shaft is in said first angular position, and a solenoid coil for moving said shaft axially in such direction as to increase the distance between said plate and said support, said axial movement straightening out said links to displace the shaft to said second angular position.

7. In a rotary solenoid, a stationary support, a shaft mounted for axial and rotary movement with respect to said support, means rotatable with said shaft including a plate and a paramagnetic member, stop means establishing first and second limiting positions for the angular movement of said shaft, means for biasing said shaft towards said first angular position, a plurality of links spaced a uniform distance from the shaft and uniformly tilted with respect thereto, each link being pivoted at one end thereof on said support and at the other end thereof upon said plate, and magnetic means for attracting said paramagnetic member to effect axial movement of said shaft and increase the distance between said pivot points thereby displacing the shaft to said second angular position.

8. A rotary solenoid comprising, in combination, a support, a shaft mounted for axial and rotary movement with respect to said support, means rotatable with said shaft including a plate and a paramagnetic member, magnetic means for attracting said member to cause axial displacement of said shaft, and a link spaced from said shaft and interconnecting said support and said plate to effect rotary movement of said shaft in response to said axial displacement.

9. A rotary solenoid comprising, in combination, a support, a shaft mounted for axial and rotary movement with respect to said support, means rotatable with said shaft including a plate and a paramagnetic member, stop means for establishing first and second limiting position for the rotary movement of said shaft, a plurality of links spaced a uniform distance from said shaft and tilted with respect thereto when the shaft is in said first angular position, each link being pivoted at one end thereof on said support and at the other end thereof on said plate, a solenoid coil for attracting said member to effect axial displacement of said shaft and increase the distance between said pivot points, said axial movement straightening the links to cause rotation of said shaft to its second angular position.

GLENN W. CARPENTER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
31,522	Andress	Feb. 26, 1861
1,226,697	Rinsche	May 22, 1917
2,027,386	Krummer	Jan. 14, 1936

FOREIGN PATENTS

Number	Country	Date
107,622	Great Britain	July 3, 1917