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SOLENOID PLUNGER STOP

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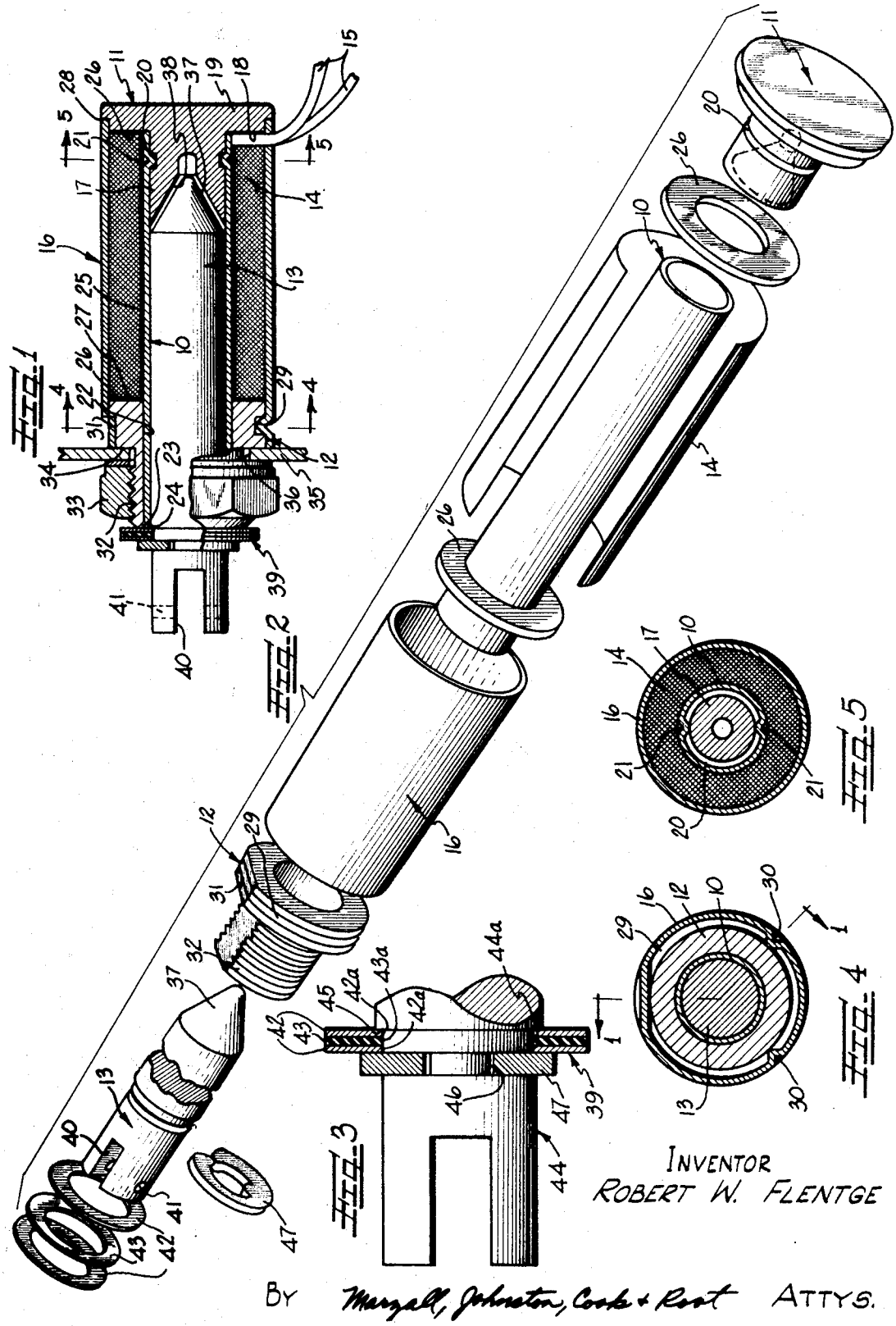


FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

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SOLENOID PLUNGER STOP

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ABSTRACT OF THE DISCLOSURE

Solenoid having a plunger and plug and a plunger stop for cushioning the plunger during seating and for providing a positive predetermined air gap between the plunger and plug in seated position.

This invention relates in general to a solenoid, and more particularly to a improved solenoid plunger stop that greatly increases the life of a solenoid by cushioning the plunger when it moves from protracted to seated position. Further, where the solenoid is provided with a plug, the improved plunger stop provides the necessary assurance of a given air gap to minimize residual build-up between the plunger and plug when the plunger is in seated position.

Solenoids having solenoid plunger stops have been well known, and heretofore many solenoids have been designed with devices to cushion the plunger during movement from protracted to seated position. But all such devices have required complex mounting arrangements and have ben expensive and even impractical for certain solenoids.

The present invention relates to an improved solenoid plunger stop that is especially useful for solenoids of the pull-type disclosed in my copending application Ser. No. 440,826, filed Mar. 18, 1965, now Patent No. 3,303,445.

The solenoid plunger stop of the present invention includes a pair of rigid outer annular members usually called washers having a resilient intermediate annular member sandwiched therebetween and all of which are received and locked into place on the outer free end of the solenoid plunger and which coact with a part of the solenoid to cushioningly stop the plunger when it moves with considerable force to seated position following energization of the coil. The washers are mounted on the plunger by slightly diametrically reducing the size of the plunger at the outer end to define a shoulder against which one of the outer washers may abut, and for convenience locking the washers in place against the shoulder through a C-type retaining clip engaging in a groove formed in the plunger and engaging against the other of the outer washers. The outer washers are of rigid material such as metal, but may be of magnetic or non-magnetic metal, while the intermediate washer is of a resilient material such as rubber or the like.

Accordingly, it is an object of the present invention to provide a solenoid of the pull-type having a plunger stop cushioning against the closing forces, wherein the plunger stop may be inexpensively manufactured and assembled on the plunger, and will greatly increase the life of the solenoid.

Another object of the present invention is in the provision of a plunger stop for a solenoid plunger that includes a resilient washed sandwiched between a pair of rigid washers and fixed in position along a plunger to coact with a part of the solenoid mounting and cushion against closing forces when the plunger moves from protracted to seated position.

Still another object of the present invention is to provide a plunger stop for the solenoid plunger of a solenoid where the plunger mates with a plug when the plunger

is in seated position, and where the plunger stop cushions the solenoid against the closing forces of the plunger and assures a given air gap between the plunger and plug to minimize residual build-up and to also preclude bottoming of the plunger on the plug.

Other objects, features and advantages of the invention will be apparent from the following detailed disclosure, taken in conjunction with the accompanying sheet of drawing, wherein like reference numerals refer to like parts, in which:

FIG. 1 is an axial sectional view taken through a solenoid having the solenoid plunger stop according to the present invention and showing some parts broken away for purposes of clarity;

FIG. 2 is an exploded view of the solenoid of FIG. 1;

FIG. 3 is an enlarged fragmentary view of a part of the plunger and showing the plunger stop construction in section according to the present invention;

FIG. 4 is a transverse sectional view taken substantially along line 4—4 of FIG. 1; and

FIG. 5 is a transverse sectional view taken substantially along line 5—5 of FIG. 1.

Referring now to the drawings, the solenoid illustrated is of a pull-type that is employed to be mounted in fixed position so that the plunger can apply a pulling force to a member to be actuated. It should be further appreciated that the present invention may be employed on other types of solenoids where it is desired to cushion the plunger against closing forces, and that the solenoid illustrated is merely a type that can effectively employ the plunger stop of the present invention to enhance its life.

The solenoid generally includes a coil tube **10** of non-magnetic material, a plug **11** of magnetic material, a face plate **12** of magnetic material, a plunger **13** of magnetic material, a coil **14** having electrical leads **15**, and a cover or casing member **16**. While the plunger stop of the present invention is shown as used on a tubular solenoid, it should be appreciated that it could well be used on other types of solenoids.

The coil tube **10** is in the form of a cylindrical sleeve which is at one end telescopically received over a cylindrical portion **17** of the plug **11**. The tube is abutted against a shoulder **18** formed by a radial flange **19** at the outer end of the plug, and an annular groove **20** is formed in the cylindrical portion **17** so that staking **21** fixes the coil tube **10** onto the plug **11**.

The other end of the coil tube is telescopically received within a bore **22** formed in the face plate **12**. An annular relieved portion or beveled portion **23** is formed at the outer end of the face plate **12** and directly along the outer end of the bore **22** so that the outer end of the coil tube **10** may be flared at **24** to prevent movement of the face plate **12** off the end of the coil tube.

Insulating tape **25** is wound over the coil tube **10** and coacts with insulating washers **26**, **26** arranged against the shoulder **18** of the plug **11** and the radial end face **27** of the face plate **12** to define an insulative surface against which the coil turns of the coil **14** may be wound. It should also be appreciated that the coil tube, plug and end face thereby define a bobbin for the coil **14**.

The plug flange **19** is annularly notched at one end to define a shoulder **28** against which the cover member **16** abuts when arranged in position over the coil **14**. An annular groove **29** is formed in the face plate **12** so that staking **30** may be performed on the casing **16** to secure the casing in position. A flattened portion **31** is also provided on the face plate **12** so that the end of the cover member **16** may be deformed to preclude possible rotation of the casing relative to the face plate.

The outer end of the face plate **12** is diametrically reduced and threaded at **32** to receive a nut **33** thereon that

coacts with a shoulder **34** to sandwich therebetween a fixed panel or bracket **35** which is apertured at **36** to receive the reduced portion of the face plate. Thus, the solenoid is mounted to a panel or bracket **35** by the face plate **12**.

The inner end of the plunger **13** is conically formed at **37** to enter into a conical recess **38** formed in the adjacent end of the plug **11**. A plunger stop **39**, which comprises the present invention, is mounted on the outer free end of the plunger **13** and coacts with the face plate **12** to hold the conically-shaped end **37** of the plunger **13** in slightly spaced relation from the plug recess **38** when the plunger is completely closed and in seated position. While not shown, it shouuld be appreciated that the mating ends of the plunger and plug may be otherwise shaped than shown. For example, the ends may be flat where the end faces would be in radial planes, or they may be angular or inclined in a different fashion than that shown. Moreover, the plunger stop **39** cushions the plunger against the closing forces and transmits the closing only to the face plate **12**, all of which greatly increase the life of the solenoid. The outer end of the plunger **13** is bifurcated at **40** and provided with a transverse hole **41** to facilitate connection of the plunger to a member to be actuated. While the plunger is cylindrical and formed with bifurcated and conical ends, it should be appreciated that it could take other shapes and still utilize the plunger stop of the present invention.

The plunger stop **39** includes a pair of annular members or washers **42**, **42** of rigid material having arranged therebetween an annular member or washer **43** of resilient material. The washers **42** are preferably of metal, but may be of magnetic or non-magnetic material, while the washer **43** is preferably of rubber, plastic or the like. The washers **42** and **43** are substantially identical in size, and are provided with bores **42***a* and **43***a* therethrough of equal size whereby the washers are snugly received on a diametrically reduced portion **44** formed on the outer end of the plunger. The inner washer **42** abuts against a shoulder **45** formed by the reduced portion **44**. An annular groove **46** is formed in the diametrically reduced portion **44** to receive a C-shaped retaining ring or clip **47** that holds the washers **42** and **43** on a portion **44***a* of the reduced portion **44**. The portion **44***a* has an axial length substantially equal to the combined axial width of the washers **42** and **43**. Thus, the retaining ring **47** fixes the washers **42** and **43** on the plunger and against axial movement therealong except on the portion **44***a*, and against radial movement.

In the operation, when the solenoid plunger **13** is drawn from protracted to closed and seated position, the plunger stop **39** serves to stop the plunger from allowing the inner conical end **37** to seat against the conical recess **38** of the plug thereby maintaining a given gap between the plunger and plug to minimize residual build-up. Further, during the closing of the plunger, the inner ring or washer **42** engages against the outer end of the face plate **12** and transmits a force against the resilient washer **43** which because of its fixed position absorbs the force to effectively cushion the plunger during the seating thereof. A slight movement of the innermost washer **42** will take place during closing of the plunger, and this movement is in the direction of the outermost or backup washer **42** and the retaining ring **47**, whereby the innermost or protective washer **42** will move axially along the diametrical portion **44***a* of the plunger. Cushioning of the plunger greatly increases the life of the solenoid by a substantial amount. That the intermediate resilient washer is sandwiched substantially between the outer rigid

washers serves to protect and prolong its life. Further, the washers **42** and **43** are of substantially uniform thickness. And since the washers **42** are sized substantially identical to the resilient washer **43** and are substantially radially positioned on the plunger, the retaining ring **47** is substantially radially positioned on the plunger and the washer **42** adjacent the face plate **12** seats against the end of the face plate which is also subsatntially radially arranged, forces transmitted to the resilient washer are substantially uniform over the entire dimension thereof.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present inventino, but it is understood that this application is to be limited only by the scope of the appended claims.

The invention is hereby claimed as follows:

1. A solenoid comprising a coil tube having a coil thereover, a plug secured at one end of said coil tube, a face plate for mounting of said solenoid secured at the other end of said coil tube, a plunger slidably received in said tube and movable toward said plug upon energization of said coil, and means on said plunger cushioning said plunger against said face plate during energization of said coil and keeping said plunger in slightly spaced relation from said plug when in seated position, said means being fixed against movement along the plunger and including a pair of annular members of rigid material and an annular member of resilient material therebetween.

2. A solenoid as defined in claim **1**, wherein said rigid annular members are of magnetic material.

3. A solenoid as defined in claim **2**, wherein said rigid annular members are of non-magnetic material.

4. A solenoid as defined in claim **1**, wherein said rigid annular members are of metal and said resilient annular member is of rubber.

5. A solenoid as defined in claim **1**, wherein said plunger includes a stepped portion defining a shoulder at the outer free end and an annular groove adjacent thereto, and wherein said cushioning means includes a resilient washer arranged between a pair of rigid washers all arranged against said shoulder, and a retaining clip is mounted in said groove to hold the washers in fixed relation along the plunger.

6. A solenoid as defined in claim **1**, and means on the face plate for mounting said solenoid on an apertured panel.

7. A solenoid as defined in claim **1**, wherein said annular members extend substantially radially of said plunger.

8. A plunger stop for a pull-type solenoid having a plunger, said plunger stop comprising a resilient washer sandwiched between a pair of rigid washers all fixed on said plunger and mounted on the plunger so that the rigid washer striking the solenoid in seated position is movable along the plunger against said resilient washer.

9. A plunger stop as defined in claim **8**, wherein the rigid and resilient washers are of substantially the same radial dimensions.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,400,351 September 3, 1968

Robert W. Flentge

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 20, after "closing" insert -- forces --; line 42, after "C-shape" insert -- spring --. Column 4, line 13, "inventino" should read -- invention --.

Signed and sealed this 17th day of February 1970.

(SEAL)
Attest:

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