

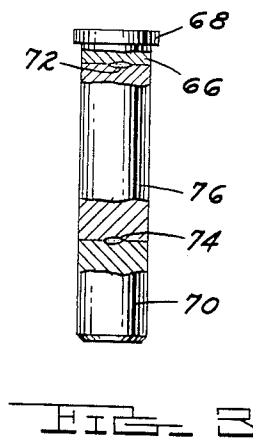
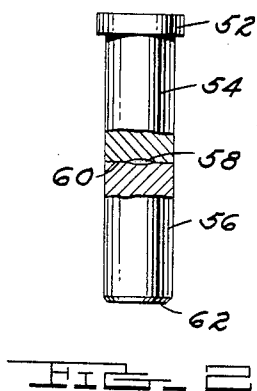
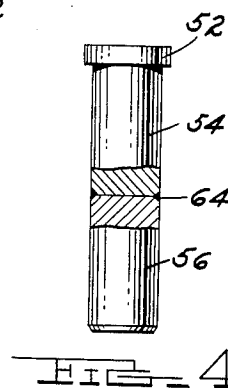
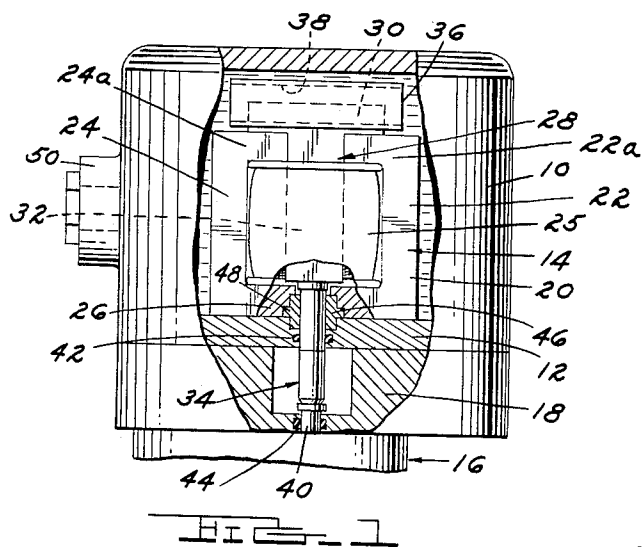
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SOLENOID PUSH PIN

Filed June 10, 1957



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SOLENOID PUSH PIN

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This invention relates to solenoids and particularly to a push pin for push type solenoids.

Push type solenoids, as distinguished from pull type solenoids, transmit their force to the device to be actuated by pushing rather than by pulling upon energization of the solenoid coil. In order to transmit the force from the solenoid plunger or armature to the device to be actuated, it has been the practice to provide a push pin between the plunger and the part to be shifted such that upon movement of the plunger upon energization of the coil, the plunger pushes against the push pin which, in turn, pushes against the part to be shifted.

In many of the push type solenoids commercially available today, the solenoid includes a U-shaped frame which extends around the outside of the coil with the bight portion of the frame extending across an end of the coil. With the plunger in the coil, the magnetic lines of flux created upon energization of the coil travel around the outside of the coil through the frame, and down through the coil by way of the plunger. The air gap between the end of the plunger and the bight portion of the frame, across which the lines of flux tend to jump, is responsible for the sucking action of the magnetic flux tending to pull the plunger toward the bight portion of the frame. A push pin or actuating rod, reciprocable through the bight portion of the frame, is pushed as the plunger is sucked into the coil toward the bight portion. If the pin is not a magnetic insulator it will permit a magnetic short circuit between the bight of the frame and the plunger, materially reducing the pushing power of the solenoid. Because presently known non-magnetic materials are relatively soft, a serious problem arises in overcoming the propensity of the push pin to pean-over at the end struck by the plunger, and the opposite end which strikes the part to be actuated by the solenoid.

It is an object of the invention to provide a push pin composed of readily available material and which is a magnetic insulator and nevertheless has a long and useful life.

Another object of the invention is the provision of a push pin comprising a plurality of pieces at least one of which is of a non-magnetic material.

Still another object of the invention is the provision of a push pin comprising three pieces of material with the pieces disposed in coaxial alignment and secured together at their meeting ends with the end pieces being of a hardened material such as tool steel, and the intermediate piece being of non-magnetic material such as stainless steel, beryllium copper, brass, or the like. This pin has particular utility in a solenoid operated in air.

A still further object of the invention is the provision of a two-piece push pin, one piece being of non-magnetic material and the other piece of hardened steel. This pin has particular utility in oil-immersed solenoids, such as disclosed in our copending application, Serial No. 583,323, filed May 7, 1956.

Other objects, advantages, and meritorious features will more fully appear from the following description, claims, and accompanying drawings, wherein:

FIG. 1 is a fragmentary cross sectional view through a push type oil-immersed solenoid showing our improved push pin in operative position therein;

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FIG. 2 is a fragmentary cross sectional view through one form of our improved push pin;

FIG. 3 is a fragmentary view through another form of our improved push pin; and

FIG. 4 is a fragmentary cross sectional view through still another form of our improved push pin.

A push type solenoid generally representative of a number of such solenoids available commercially today is shown in FIG. 1. It includes a housing 10, a base 12, and a solenoid 14 within the housing and seated upon the base. The base may be supported on the device 16 to be actuated, such as a valve or the like, by an adapter plate 18. The solenoid includes a coil having a hollow center portion within which is received a reciprocable plunger. Means are provided for conducting the lines of flux around the outside of the coil. In the drawings such means comprises a generally U-shaped frame 20 between the arms 22 and 24 of which is disposed the solenoid coil 25. The frame includes a bight portion 26 extending between the arms and across the lower end of the coil. The upper ends of the arms have inward extensions 22a and 24a which lightly abut the sides of the plunger 28 received in the open central portion of coil 25. The plunger has a head portion 30 and a shank portion 32, the lower end of which is spaced slightly from the bight 26 when the plunger is fully drawn into the coil. The lower end of the plunger abuts the push pin 34.

A back stop 36 having a plunger striking surface 38 is secured to the frame 20 in any convenient fashion, not shown, and serves to limit upward travel of the plunger upon de-energization of the solenoid coil. The part 40 to be actuated, such as a valve stem or spindle in the device 16, may be provided with return means, not shown, urging it upwardly, and such return means serves to raise a plunger against the back stop. If the solenoid is to be operated in oil, such as is shown in our above-mentioned copending application, the housing 10 may be filled with oil with an O-ring gasket 42 preventing escape of oil around the push pin. Another O-ring 44 in the adapter plate prevents leakage of fluid upwardly around the part 40 out of the device to be actuated.

The U-shaped solenoid frame is secured to the base 12 in any convenient fashion. Disposed within a counter-bore in the base is a bushing 46 adapted to support the push pin for reciprocation. The bushing extends into the bight portion 26 of the U-shaped solenoid frame. The bushing is held in place by a shoulder 48 against which the frame bears. The lower end of the push pin is adapted to abut the part 40 to be actuated. Electric leads, not shown, may be extended outwardly of the housing 10 through the boss 50 to carry current to the solenoid coil.

As is well known in the solenoid art, the lines of flux developed upon energization of the solenoid coil travel axially through the central opening in the coil and around the outside of the coil. By providing a magnetic conductor around the outside of the coil, such as the U-shaped frame 20, the lines of flux have a magnetic path of low resistance to follow. Because the extensions 22a and 24a of the frame lightly abut the plunger, the lines of flux pass through the central opening in the coil by way of the plunger. However, because the lower end of the plunger is spaced from the bight portion 26 of the frame, the lines of flux must jump the gap, and this gap therefore creates a space into which the magnetic flux 10 tends to pull the plunger. If this air space is bridged by a magnetic conductor, the sucking power of the solenoid will be materially reduced. Therefore, if the push pin 34 is formed of a magnetically conductive material which will permit the lines of flux to readily pass between

the bight of the U-shaped frame and the lower end of the plunger, the pushing force of the plunger is materially reduced. Therefore it is imperative that the push pin be of such character as to prevent shorting of the magnetic lines between the bight of the U-shaped frame and the lower end of the plunger.

Heretofore, in order to form a push pin of non-magnetic characteristics, the push pin has been formed of brass, beryllium copper, plastic materials, or any other non-magnetic material which has some degree of hardness. However, when formed of such materials, the push pin would tend topeen at one or both ends under repeated blows by the plunger thereagainst as the coil was successively energized. In time the peening was sufficient to shorten the length of the pin such that the part 40 to be actuated was not shifted the proper amount, and frequently the mushrooming ends or end of the push pin would interfere with its proper operation.

We have discovered that a push pin having a non-magnetic characteristic and which will prevent shorting of the lines of flux between the bight of the U-shaped frame and the lower end of the plunger may be provided while still retaining a high degree of resistance to peening or mushrooming of the ends. We have discovered that in an oil-immersed solenoid where the end of the push pin abutting the plunger is immersed in oil, such end may be formed of a non-magnetic material such as beryllium copper or stainless steel, and the other end, which is not immersed in oil and which abuts the part to be actuated, may be formed of a hardened steel such as tool steel. Under these circumstances, a pin of this construction while retaining the necessary magnetic insulating property, will resist to a marked degree any tendency to mushroom or peen over. In FIGS. 1, 2, and 4, we have shown such a pin while in FIG. 3 we have shown a three-piece pin.

The push pin shown in FIGS. 1, 2, and 4, includes an upper portion having a head 52 which abuts the lower end of the plunger 28 of the solenoid. Extending downwardly from the head is a shank portion 54 which is butt-welded in the FIG. 2 modification to a coaxially extending portion 56. The butt-weld is indicated at 53. It will be understood that in the butt-welding the material of the two portions fuses at the interface 60 and in such manner the interface is bonded together across the entire area. The lower end of the portion 56 may be chamfered as at 62. The upper portion which abuts the lower end of the plunger may be formed of any suitable non-magnetic material such as brass, beryllium copper, stainless steel, or the like. The lower end of the pin may be formed of a hardened steel such as tool steel.

In the modification shown in FIG. 4, the materials of which portions 54 and 56 are made may be the same as that of FIG. 2, but the portions are secured together by first chamfering their meeting ends and then filling the chamfer with weld as at 64.

The pins shown in FIGS. 2 and 4 are particularly well suited for use in an oil bath or oil-immersed solenoid where the relatively softer end 54 of the push pin is immersed in oil so that an oil film exists between the head 52 and the lower end of the plunger. Such oil film will cushion the shock of the plunger striking the pin and prevent peening thereof even though the material is relatively soft as compared to the lower end of the pin. The lower end of the pin operates in air where it abuts the part 40 to be actuated and the tool

steel prevents such end of the pin from peening. Even though the push pin may be extended upwardly through the bushing 48 so that the tool steel portion of the pin is disposed in the lines of magnetic flux circulating around the coil, the non-magnetic portion of the pin which is in abutment with the plunger prevents shorting of the magnetic lines between the bight of the frame and the plunger.

The modification of the pin shown in FIG. 3 has particular utility in solenoids operated in air and would be used in the FIG. 1 construction in place of the push pin therein shown if the oil in the housing 10 were drained away. In the FIG. 3 construction, the upper end 66 and the head 68 are formed of hardened steel such as tool steel, as is the lower end 70. These opposite end portions are butt-welded as at 72 and 74 to opposite ends of intermediate portion 76. Intermediate portion 76 may be formed of the same material used in forming the end portions 54 of the FIGS. 2 and 4 constructions. It will be noted that even though a magnetically conductive material is used in portion 66 and head 68, which abuts the plunger, so long as portion 76 is disposed between portion 66 and the bight of the U-shaped frame, portion 76 will act as an insulator.

What we claim is:

1. A push type solenoid comprising, in combination: a coil, means for conducting lines of magnetic flux around the coil including a portion extending across one end of the coil, a plunger reciprocable in the coil toward and away from said portion, said lines of magnetic flux urging the plunger toward said portion upon energization of the coil, a push pin extending through said portion and guided thereby for reciprocation therein and floatingly connected to the plunger to be abutted by and pushed by said plunger as the same moves toward said portion, said pin including a plurality of metal pin-like elements secured together in rigid end abutting coaxial alignment with one of said elements being of a non-magnetic metal and disposed in the magnetic flux path between the plunger and said portion of the flux conducting means to prevent magnetic short circuiting of the magnetic path between said portion and the plunger, another of said elements extending outwardly beyond said portion on the opposite side from the plunger and being of a harder metal than the non-magnetic element of the pin and adapted to actuate the device to be operated by the solenoid, and said harder metal element having a length at least as great as its diameter.

2. The invention as defined in claim numbered 1 characterized in that said pin includes three pinlike elements with those elements of the pin at opposite ends being formed of a hardened steel and with that element intermediate the end elements being of a non-magnetic metal.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,991,399

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Hollis W. Jencks et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 36, for "tween the plunger and said portion" read -- pin lying in the path of the lines of magnetic flux between the plunger and said portion --.

Signed and sealed this 21st day of November 1961.

(SEAL)

Attest:

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Commissioner of Patents

USCOMM-DC

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