Nov. 26, 1946. A. N. DE WILDE 2,411,778

GUN FIRING SOLENOID

Filed Sept. 22, 1942

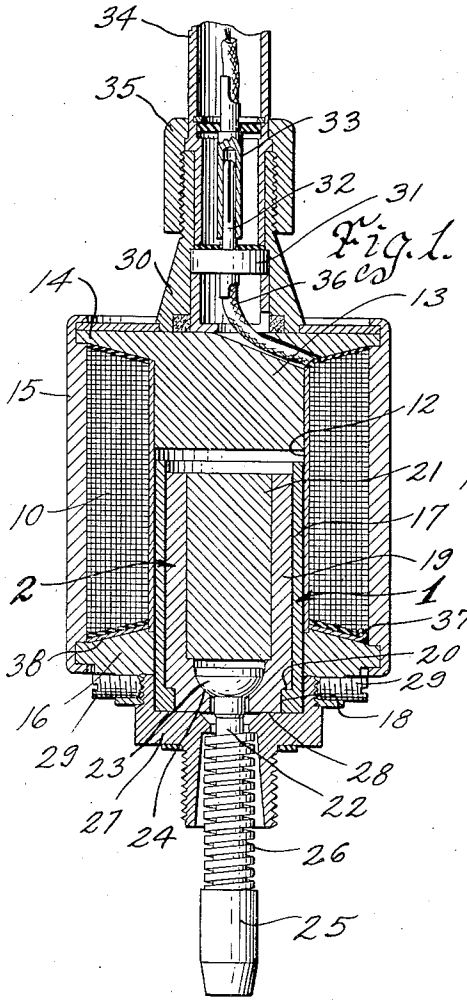


Fig. 1.

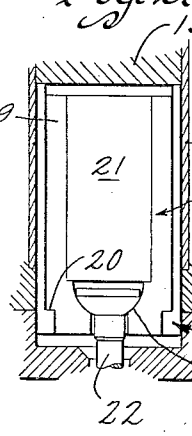


Fig. 2.

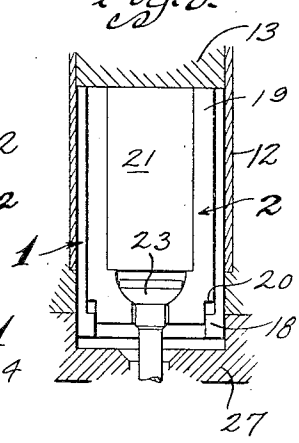


Fig. 3.

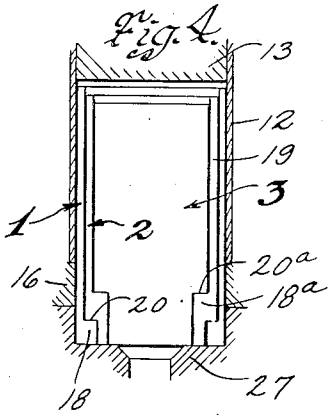


Fig. 4.

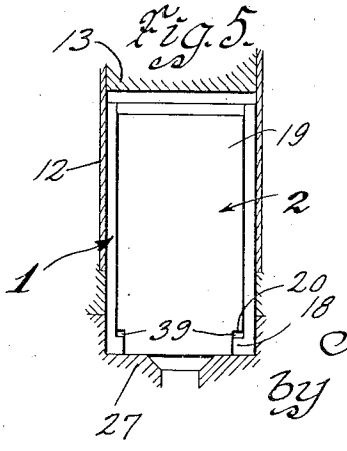


Fig. 5.

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GUN FIRING SOLENOID

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Application September 22, 1942, Serial No. 459,335

1 Claim. (Cl. 175—341)

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My invention relates to a solenoid and plunger structure particularly adapted for use in connection with gun firing equipment.

The object of the invention is to provide a low-cost, compact solenoid having high efficiency from the standpoint of pulling power in proportion to the energizing current.

More specifically, an object of my invention is to provide a novel plural part plunger construction which reduces the effective air gap in such manner as to permit greater pull per unit of current consumption.

Another object is to provide a plunger structure formed of a plurality of plunger parts having different air gap relationship to a core in the solenoid coil, the gaps being successively closed during the operation of the solenoid plunger and the closing of one effecting the narrowing of the next one to thereby, in effect, increase the magnetic pull exerted on the final plunger part which carries the actuating element whereby the solenoid performs its function of pulling a release pin for gun firing equipment or the like.

With these and other objects in view, my invention consists in the construction, arrangement and combination of the various parts of my device whereby the objects contemplated are attained, as hereinafter more fully set forth, pointed out in my claim and illustrated in the accompanying drawing, wherein:

Figure 1 is a sectional view through a gun firing solenoid embodying my invention, the parts being in the position assumed when the solenoid coil is deenergized;

Figures 2 and 3 are semi-diagrammatic figures of my gun firing solenoid showing successive steps in the movement of the plunger resulting from energization of the solenoid coil;

Figure 4 is a semi-diagrammatic view of a modification wherein the plunger is made in three parts instead of two; and

Figure 5 is another modification wherein space is provided at a certain point in the construction shown in Figure 1 for the purpose of permitting slight movement of one plunger part before the next one is picked up to thereby strike it an impact blow.

On the accompanying drawing I have used the reference numeral 10 to indicate a solenoid coil. The coil 10 is wound around a guide tube 12 and has a core 13 projecting into one end thereof. The core 13 is made of magnetic material and is flanged out at its upper end, as indicated at 14, to contact a magnetic casing 15. A lower end plate 16 is provided which is also of magnetic material whereby the parts 13, 14, 15 and 16 form a closed magnetic circuit with the exception of the space in the guide tube 12 below the core 13.

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A plunger is slidable in the guide tube 12 and consists of two parts numbered, in general, 1 and 2. The part 1 consists of a sleeve portion 17 and an inturned flange 18, while the part 2 comprises a sleeve portion 19 having a shoulder at 20 and a plug 21 pressed into the bore of the sleeve 19. An actuating element, in the form of a stem 22, is connected with the plunger 1—2 by means of a head 23 of the stem confined between a seat 24 and the lower end of the plug 21. The lower end of the stem 22 has a latch pin 25 thereon, or other device, to coact with the gun firing mechanism. A spring 26 is interposed between the latch pin 25 and a plug 27, screwed into the head 16, for the purpose of normally keeping the plunger 1—2 in lowered position with the lower ends of the sleeves 1 and 2 stopped against an inner face 28 of the plug 27. The plug 27 is retained in position by a pair of set screws 29.

The gun firing mechanism controlled by my solenoid does not form any part of the present invention but may comprise a gun firing shaft reciprocated by the engine of an aeroplane so as to fire guns pointing through the propeller of the plane, at the proper time, to avoid striking the propeller blades with the bullets from the gun. In gun firing mechanism of this character the gun is stopped by a latch pin thrust into the reciprocating gun firing shaft, and the latch pin 25 serves this purpose, the plug 27 being threaded on its lower end to screw into a casing for the reciprocating shaft. Accordingly, when the latch pin 25 is withdrawn from the gun firing shaft it is reciprocated for firing the gun, the firing being thus accomplished whenever the solenoid coil 10 is energized.

My solenoid structure further includes a fitting 30 at the upper end, in which a base member 31 is mounted and provided with a plug 32. The plug 32 is adapted to be received in a jack 33 carried by a conduit 34 and mounted in position by a union nut 35. A wire 36 extends from the plug 32 to one end of the coil 10, and the other end thereof is grounded at 37 to an end plate 38. The end plate 38 rests against the coil head 16.

Practical operation

It will be noted that the upper end of the plunger part 1 has smaller air gap relation to the lower end of the core 13 than does the upper end of the plunger part 2. Accordingly, when the coil 10 is energized its predominating attraction

will be across this narrow air gap, thereby pulling strongly on the core part 1 and lifting it to the position shown in Figure 2 where its air gap is closed. At the same time, the plunger part 1 lifts the actuating stem 22 and reduces the air gap between the plunger part 2 and the lower end of the core 13. This reduced air gap provides stronger attraction for the plunger part 2 than when its air gap was as great as in Figure 1. There is thus provided a substantial increase in attracting power of the core 13 for the plunger part 2. If it were not for the narrow air gap between 1 and 13 the construction would be conventional, that is, we would have a wide air gap between a one-piece plunger and the core. The magnetic attracting power is increased in such proportion that reducing the air gap to half results in an increase of attracting power to four times. Accordingly, by having part of the plunger presenting a narrow air gap, a greater attracting power is provided for this portion, and when it effects a reduction of the air gap for the other portion, then we have a greater attracting power for said other portion. Therefore, to secure the same distance of travel, a two-part plunger is more efficient than the conventional one-part plunger.

The novel features of my plunger construction can be carried out further by providing three or more parts for the plunger. For instance, in Figure 4 I show three parts designated 1, 2 and 3. The part 1 has an air gap only one-third of the air gap for the part 3, and the part 2 has an air gap only two-thirds of the air gap for the part 3. Therefore, a three-part plunger has even greater efficiency from the standpoint of current consumption with respect to degree and distance of pull than a two-part plunger, and the plural part idea can be carried to any desired extent, limited by mechanical or cost complications resulting from increasing the number of parts of the plunger.

In Figure 5 I show another modification wherein the parts 1 and 2 are substantially similar to

those shown in Figure 1, with the exception of an initial space 39 between the inturned flange 18 and the shoulder 20. A plunger of this type does not provide quite as long a travel for the actuating stem 32 if the same air gaps are retained, or if the same travel is retained the air gaps must be slightly larger. It does have the advantage, however, of the part 1 moving a slight distance before picking up the part 2 and thereby delivering an impact blow to the part 2, effective to increase the starting force for the movement of the part 2 and its actuating stem.

Some changes may be made in the construction and arrangement of the parts of my device without departing from the real spirit and purpose of my invention, and it is my intention to cover by my claim any modified forms of structure or use of mechanical equivalents which may be reasonably included within its scope without sacrificing any of the advantages thereof.

I claim as my invention:

A solenoid structure comprising a guide tube, a core in one end thereof, a solenoid coil surrounding said guide tube, a magnetic casing extending from said core across one end of the coil, around the outside of the coil and across the other end of the coil to said guide tube, a plunger slidable in said guide tube, said plunger comprising a pair of portions, both of which extend through said guide tube from adjacent said core and through the portion of said magnetic casing extending across said second end of said coil, said pair of portions each having an abutment, said abutments being spaced from each other when the solenoid coil is unenergized and engaging each other when the solenoid coil is energized, means for limiting the outward movement of one of said plunger portions so that it is slightly spaced from said core, means to limit the other of said plunger portions so that it is spaced slightly farther from said core than said first portion, and an actuator connected with said second portion.

ALBERT N. DE WILDE.