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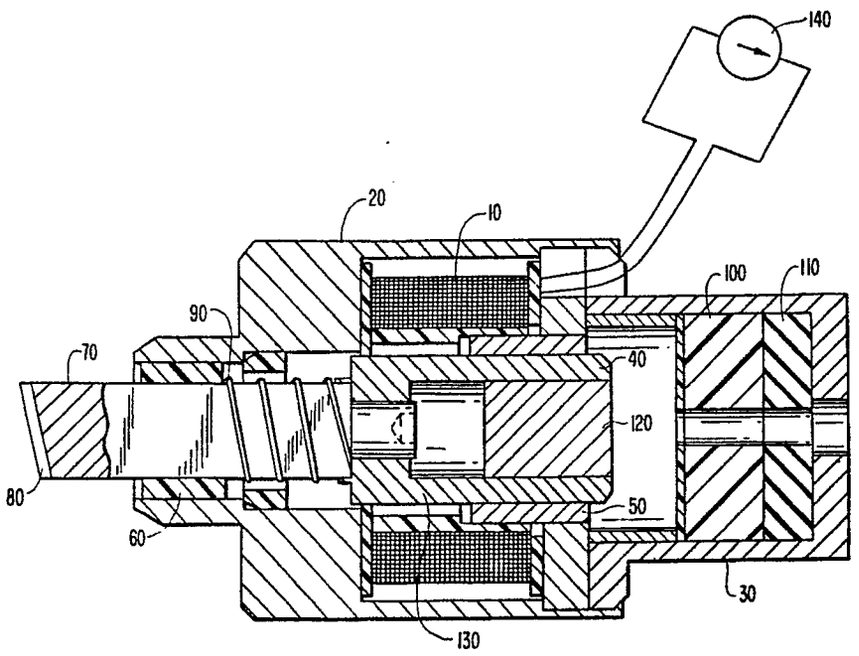
(54) Hammer solenoid.

(57) A hammer solenoid for impact printers includes a hollow ferromagnetic plunger. A ferromagnetic flux booster is attached to the rear end of the plunger to enhance the characteristics of the solenoid by shifting the magnetic center of the plunger while, at the same time, providing a dead structure which minimizes vibration and bounce. In an alternate embodiment, the plunger walls may include a permanent magnet which is polarized to be attracted by the solenoid coil.



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HAMMER SOLENOID.

The invention relates to electromagnetic actuators. More specifically, the invention relates to a solenoid actuator which is particularly suited for hammering type bars in an impact printer.

BACKGROUND OF THE INVENTION

Electromagnetic solenoids are used in many impact printers to drive type bars and printing pins. Ideally, a printer solenoid actuator should exert relatively high mechanical force to produce clear print impressions and should have low inertia to enable high printing rates. Furthermore, the actuator mechanism should be mechanically damped to avoid bounce and vibration which can distort printed characters and produce multiple images.

Japanese Patent 61 194802 to Shindengen apparently describes a hammer solenoid which is specially adapted to reduce impact bounce and vibration. The solenoid plunger comprises a hollow cylinder with a truncated recess at its rear end. A steel ball floats in the recess, between the rear end of the plunger and the back of the solenoid housing, and functions to dampen vibration and rebound when a hammer of the plunger strikes the anvil of a type bar. The steel ball is, however, relatively insignificant in terms of the magnetic mass of the plunger and does not significantly affect its magnet properties.

SUMMARY OF THE INVENTION

In accordance with the invention, the plunger of a printer hammer solenoid is constructed as a hollow ferromagnetic cylinder. A slug of ferromagnetic material attached to the rear end of the plunger as a flux booster significantly shifts the magnetic center mass of the plunger to enhance the force supplied by a solenoid coil. The hollow plunger structure is relatively "dead" to reduce hammer bounce and vibration. In a preferred embodiment of the plunger, the walls of the hollow cylinder are sufficiently thinned so that they magnetically saturate when the coil is actuated. This further shifts the magnetic mass of the plunger to the rear and enhances the impact force.

In another embodiment of the invention, the ferromagnetic slug comprises a permanent magnet which is attracted by the field of the solenoid coil.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention can be understood with reference to the attached drawing which is a sectional view of a printer hammer solenoid with the hammer extended through one halt ot its total travel.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The Figure illustrates a hammer solenoid of the invention. A hollow coil 10 is contained within a cylindrical ferromagnetic housing which includes a front housing half 20 and rear housing half 30. A hollow, cylindrical ferromagnetic plunger 40 is contained within coil 10 and flux return ring 50. A hammer actuator 70 is attached to the front end of the plunger 40 and slidably supported by bushing 60. The front end of the hammer actuator 70 is provided with a surface 80 which is adapted to impact an anvil of a type bar, for example on a printer daisy wheel. A spring 90, disposed between the front end of the plunger 40 and the housing 20, rearwardly urges the plunger so that its magnetic center of mass is remote from the center of the coil 10 when the coil is in an unactuated state. Plastic and rubber damping members 100, 110 are disposed in the rear end of the housing 30 to cushion the impact of the plunger when it returns to its rest condition. In accordance with the invention, a slug of ferromagnetic material 120 is disposed within the rear end of the hollow plunger 40. The slug 120, which may be press fit or adhesively bonded to the plunger, acts as a flux booster to rearwardly shift the magnetic center of the plunger which increases the force and travel of the plunger when the coil is actuated.

In a preferred embodiment of the invention, the side walls 130 are sufficiently thinned so that they magnetically saturate when the coil is energized at its desired working current, for example, by current source 140. The magnetic center of the plunger is thus further shifted to the rear to enhance the operating force and travel.

In an alternate embodiment of the invention, the side walls are permanently magnetized and are polarized so that the permanent magnetic field attracts the magnetic field of the energized coil, thus further enhancing the force and travel of the plunger. In an alternate embodiment the flux produced in the plunger walls 130 by the permanent magnet is sufficient to magnetically saturate the walls.

The solenoid of the invention provides a relatively vibration and bounce free printing hammer which has high impact force and travel and is well suited for use in printing applications.

Claims

1. A solenoid comprising:
a coil;
a hollow, cylindrical, ferromagnetic plunger slidably disposed within the coil, the plunger having a first end and a second end;
an actuator attached to the first end of the plunger and extending axially from the coil;
a ferromagnetic flux booster attached to the second end of the plunger; and
spring means which exert an axial force on the plunger and slide the flux booster away from the magnetic center of the coil when the coil is deenergized.

2. The solenoid of claim 1 wherein the actuator includes a printing hammer.

3. The solenoid of claim 1 wherein the flux booster is a solid slug of magnetically soft material.

4. The solenoid of claim 3 further including means which energize the coil.

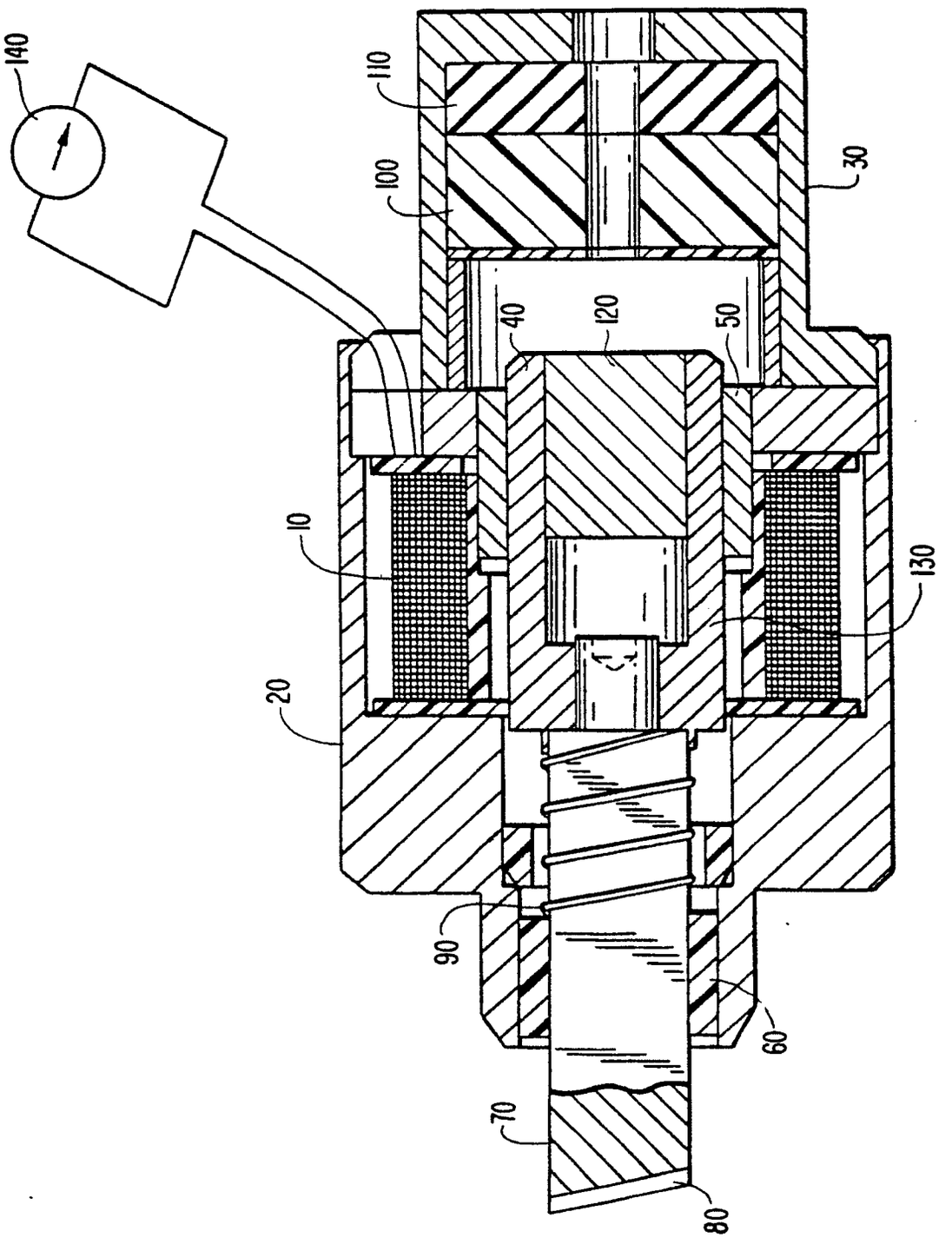
5. The solenoid of claim 4 wherein the means which energize the coil cause the coil to generate a magnetic flux which saturates the walls of the hollow plunger.

6. The solenoid of claim 1 wherein the plunger has walls which include a permanent magnet.

7. The solenoid of claim 6 wherein the permanent magnet generates a magnetic flux which saturates the walls of the hollow plunger.

8. The solenoid of claim 7 further comprising means which energize the coil to produce a magnetic field and wherein the polarity of the permanent magnet is attractive to the magnetic field produced by the coil.

9. The solenoid of claim 6 further comprising means which energize the coil to produce a magnetic field and wherein the polarity of the permanent magnet is attractive to the magnetic field produced by the coil.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