July 28, 1964 J. P. BAIER ETAL 3,142,790

HERMETICALLY SEALED SOLENOID ASSEMBLY

Filed July 5, 1962 2 Sheets-Sheet 1

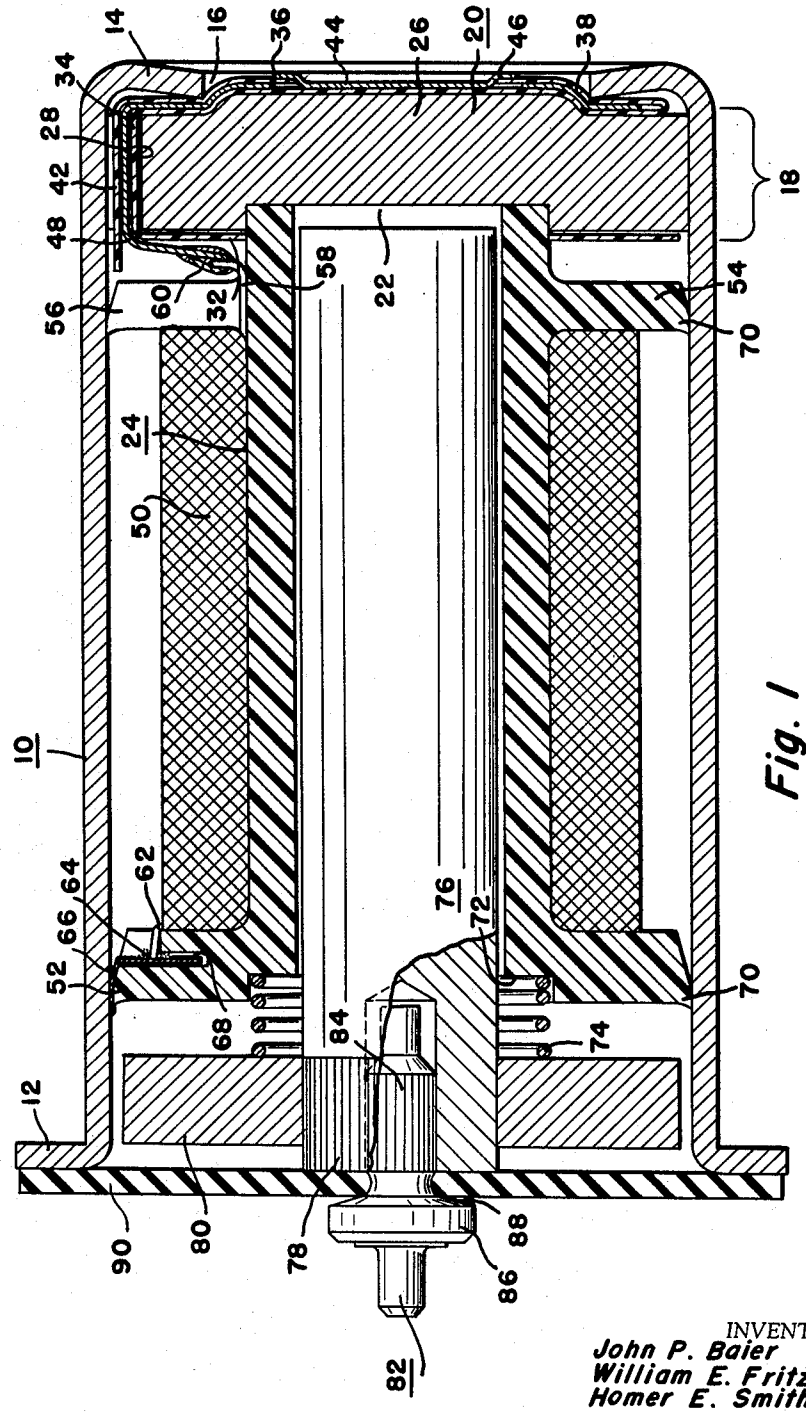



Fig. 1

INVENTORS
John P. Baier
William E. Fritz
Homer E. Smith

BY W. E. Finken
Their Attorney

July 28, 1964 J. P. BAIER ETAL 3,142,790

HERMETICALLY SEALED SOLENOID ASSEMBLY

Filed July 5, 1962 2 Sheets-Sheet 2

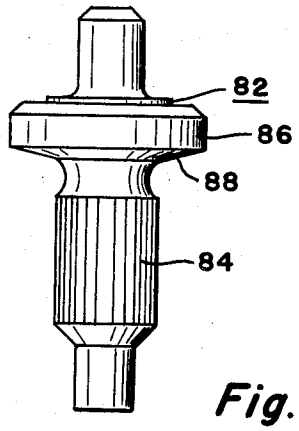



Fig. 2

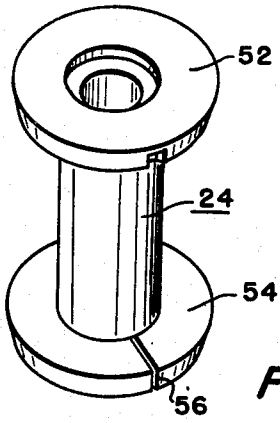



Fig. 3

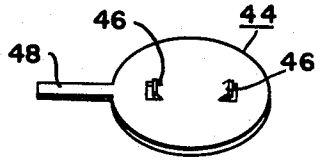



Fig. 4

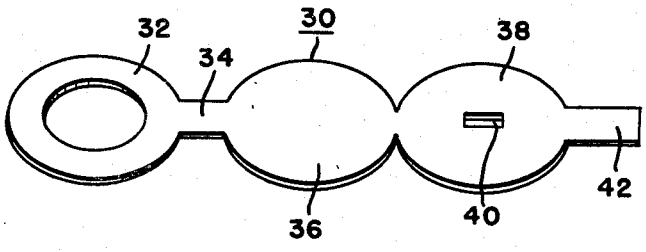



Fig. 5

INVENTORS
John P. Baier
William E. Fritz
Homer E. Smith

BY W. E. Finken
Their Attorney

United States Patent Office 3,142,790 Patented July 28, 1964



3,142,790

# HERMETICALLY SEALED SOLENOID ASSEMBLY

John P. Baier, William E. Fritz, and Homer E. Smith, Rochester, N.Y., assignors to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Filed July 5, 1962, Ser. No. 207,727
13 Claims. (Cl. 317—191)

This invention pertains to solenoids, and particularly to a hermetically sealed solenoid assembly for use in a hydraulic atmosphere.

At the present time some automotive vehicles are equipped with automatic transmissions having mechanical governor operated shifter valves. Electric speed control systems for automotive vehicles have been proposed to replace mechanical governors, and such systems will require the use of solenoid actuators for operating the shifter valves, which solenoid actuators will be located within the transmission housings and thus require a hermetic seal due to the presence of hydraulic fluid therein. The present invention relates to a small, simplified solenoid construction embodying a hermetic seal. Accordingly, among our objects are the provision of a hermetically sealed solenoid assembly adapted for use in a hydraulic atmosphere; the further provision of a solenoid assembly with external terminal means having sealed connections with an internal energizing coil; and the still further provision of a simplified solenoid assembly wherein the several component parts are designed for assembly with interference fits so as to eliminate the necessity of close manufacturing tolerances.

The aforementioned and other objects are accomplished in the present invention by providing a sealed shell assembly for the solenoid, and wherein the stationary components have interference, or press, fits with the shell. Specifically, the improved solenoid assembly includes a shell which encloses coaxially arranged pool and plunger assemblies. The spool supports an energizing coil, one terminal end of which is connected to the shell and the other terminal end of which is connected to an externally exposed contact. The plunger is normally held in spaced relation to a stop by a coil spring and carries an externally exposed tip which secures a sealing diaphragm to the plunger.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

FIGURE 1 is an enlarged, longitudinal, sectional view of the improved solenoid assembly.

FIGURE 2 is an enlarged, side view, in elevation, of the plunger tip.

FIGURE 3 is a perspective view of the spool.

FIGURE 4 is a perspective view of the end contact.

FIGURE 5 is a perspective view of the insulator.

With particular reference to FIGURE 1, the improved solenoid assembly includes a substantially tubular thin walled steel case, or shell, **10** having an outwardly extending radial flange **12** at one end and an inwardly extending flange **14** at its opposite end defining a circular opening **16**. The flange **14** is bent towards the front of the shell **10**, as indicated in FIGURE 1, and the inner diameter of the shell at the rear in the area **18** is slightly less than the nominal inner diameter of the case. Stated another way, the shell **10** is slightly tapered towards its rear end such that the inner diameter of the case in the area **18** is less than the nominal diameter of a steel base **20** which is pressed thereinto. The shell **10** may be expanded slightly to accommodate the base as it is assembled therewith. In this manner an interference, or



press, fit is established between the base **20** and the shell **10** to securely retain the base in assembled relation therewith. The base **20** is formed with a cylindrical depression **22** for receiving the end of a nylon spool **24**. The depression **22** in the base **20** is preferably formed by a stamping operation to produce a substantially cylindrical projection **26** at the opposite side of the base. In addition, the base **20** is formed with a radial notch **28**.

Referring to FIGURE 5, a base insulator **30** is shown comprising an annulus **32** connected by a tab **34** to an imperforate disc section **36** which is interconnected with a perforate disc section **38** having a diametrical slot **40** and a radially extending tab **42**. The annulus **32** is adapted to fit around the core of the spool **24** with the tab **34** extending through the slot **28** in the base. The imperforate disc section **36** lies against the opposite side of the base **20**, and a metal terminal **44**, having prongs **46** and a tab **48** as shown in FIGURE 4, is arranged on top of the disc section **36**.

The insulator **30** is assembled with the base **20**, spool **24** and terminal **44** by initially attaching terminal **44** to the perforate disc section **38** by deforming the prongs **46** thereover. The perforate disc section **38** is then folded over the imperforate disc section **36** to obtain a crease at the juncture of the disc sections and confine the terminal **44** therebetween. The ring section, or annulus, **32** is then placed over the core extension of the spool **24**, after which the base **20** is assembled with the spool. Finally, the insulator tabs **34** and **42**, with the terminal tab **48** interposed therebetween, are folded through the notch **28** in the base.

The spool **24** carries a coil **50** between end flanges **52** and **54**. The end flange **54** has a raidal notch **56** through which one lead **58** of the coil **50** extends and is connected to the tab **48** of the terminal **44** by crimping and soldering at **60**. The other end leads **62** of the coil **50** is soldered at **64** to a terminal strip **66**. The terminal strip **66** has an end portion situated in a radial slot **68** of the end flange **52** and extends over the lip of the flange **52** for effecting an electrical connection with the shell **10** by wedging engagement therewith. It is to be noted that the lips of the end flanges **52** and **54** are tapered, or frusto conical, as seen in FIGURES 1 and 3 so that during assembly with the shell **10** an interference, or press, fit will be established therebetween. The forward edges of the tapered lips on the flanges **52** and **54** are of greater nominal diameter than the inner diameter of the shell **10**, such that when the spool **20** is pressed thereinto the trailing outer edges will be "rolled" at **70** to accommodate the interference fit and securely hold the spool in position within the shell **10**. The spool, coil, base and terminal assembly is pres fitted into the case as a unit to form the field assembly of the solenoid.

The end flange **52** is formed with a counter bore **72** constituting an integral spring seat for one end of a coil spring **74** surrounding a rod-type plunger **76**. The plunger **76** is coaxially disposed within the core of the spool **24**. The opposite end of the plunger **76** is formed with an external straight knurl **78** for receiving an annulus **80** which is press-fitted thereon. The annulus **80** constitutes the armature and is directly engaged by the other end of the spring **74**. The plunger **76** is formed with an axial bore within which a nonmagnetic tip **82** having a knurled end **84** is press-fitted. The tip **82** has a shoulder **86** with a conical surface **88**, as shown in FIGURE 2. An elastomeric diaphragm **90** is clamped between conical surface **88** of the tip **82** and the end of the plunger **76**. The elastomeric diaphragm **90** is bonded, or otherwise suitably secured, to the flange **12** of the case **10** so as to coaxially support the reciprocable plunger assembly with respect to the spool and coil, and effect a gas-tight seal therebetween. A gas-tight seal

also exists at the rear end of the solenoid assembly by virtue of the insulator 30 being clamped between the base 20 and the forwardly extending flange 14. The terminal 44 is exposed to the central opening 16 and thus constitutes one solenoid terminal while the shell 10 constitutes the other solenoid terminal.

When the coil 50 is deenergized, the spring 74 maintains the plunger assembly comprising the armature 84 and the plunger 76 in the position depicted in FIGURE 1. Upon energization of the coil 50, the magnetic flux causes movement of the plunger 76 and the armature 80 to the right until the end of the plunger 76 engages the base 20 which constitutes a stop, thereby compressing spring 74. The elastomeric seal 90 will, of course, be flexed inwardly upon energization of the coil 50 due to movement of the plunger assembly to the right.

While the embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. A solenoid assembly including, a shell, a base press-fitted in said shell and constituting a stop, a coil assembly press-fitted in said shell in juxtaposition to said base, a reciprocable plunger assembly mounted in said shell coaxial with said coil assembly for movement toward and away from said base, resilient means constantly acting on said plunger assembly for maintaining said plunger assembly in spaced relation to said base when said coil assembly is deenergized, and flexible means attached to said plunger assembly and secured to said shell to effect a seal therebetween and coaxially support said plunger assembly within said coil assembly.

2. A solenoid assembly including, a metal shell, a base press-fitted in said shell adjacent one end thereof and constituting a stop, a spool press-fitted in said shell in juxtaposition to said base, a coil on said spool, one end of said coil being electrically connected to said shell and the other end being connected to an exposed terminal carried by said base, a reciprocable plunger assembly mounted in said shell coaxial with said spool for movement toward and away from said base, resilient means acting constantly on said plunger assembly for maintaining said plunger assembly in spaced reltaion to said base when said coil is deenergized, and an elastomeric diaphragm attached to said plunger assembly and secured to said shell for coaxially supporting said plunger assembly within said spool.

3. A solenoid assembly comprising, a metal shell having an inwardly extending flange at one end, a metal base press-fitted in said shell adjacent said one end and constituting a stop, an insulator disposed between said base and said flange and constituting a seal therebetween, a plastic spool press-fitted in said shell in juxtaposition to said base, a coil on said spool having one end connected to a terminal wedged between said spool and said shell and its other end connected to an exposed terminal carried by said insulator, a reciprocable plunger assembly mounted within said shell coaxial of said spool for movement toward and away from said base, resilient means constantly acting on said plunger assembly for maintaining said plunger assembly in spaced relation to said base when said coil is deenergized, an elastomeric diaphragm attached to said plunger assembly and secured to said shell to effect a seal therebetween and coaxially support said plunger assembly within said spool.

4. A solenoid assembly comprising, a metal shell having an inwardly extending flange at one end and an outwardly extending flange at its other end, a metal base press-fitted in said shell adjacent said one end, an insulator clamped between said base and said inwardly extending flange to effect a seal therebetween, a plastic spool press-fitted in said shell in juxtaposition to said base, a coil on said spool having one end connected to a terminal wedged between said spool and said shell and its other end connected to an exposed terminal carried by said



insulator, a reciprocable plunger assembly mounted in said shell coaxial with said spool for movement toward and away from said base, resilient means acting constantly on said plunger assembly for maintaining said plunger assembly in spaced relation to said base when said coil is deenergized, and an elastomeric diaphragm attached to said plunger assembly and secured to the outwardly extending flange of said shell to effect a seal therebetween and coaxially support said plunger assembly within said spool.

5. A solenoid assembly comprising, a thin-walled sheet metal shell having an inwardly extending flange at one end and an outwardly extending flange at its other end, a metal base press-fitted in said shell adjacent said one end, an insulator clamped between said base and said inwardly extending flange to effect a seal therebetween, a plastic spool press-fitted in said shell in juxtaposition to said base, a coil on said spool having one end connected to a terminal wedged between said spool and said shell and its other end connected to an exposed terminal carried by said insulator, a reciprocable plunger assembly mounted within said shell coaxial of said spool for movement toward and away from said base, resilient means acting between said spool and said plunger assembly for maintaining said plunger assembly in spaced relation to said base when said coil is deenergized, and an elastomeric diaphragm attached to said plunger and secured to the outwardly extending flange of said shell to effect a seal therebetween and coaxially support said plunger assembly within said spool.

6. The solenoid assembly set forth in claim 5 wherein said base has a radial notch, and wherein said insulator comprises an annulus disposed on one side of said base, said annulus being connected by a tab to an imperforate disc on the other side of said base, said imperforate disc being connected to a perforate disc which is folded back upon the imperforate disc and has a radially extending tab, said tabs being disposed in the radial notch in said base.

7. The solenoid assembly set forth in claim 6 wherein the terminal carried by said insulator comprises a metal disc arranged between said imperforate and perforate discs having a pair of upstanding prongs arranged to project through said perforate disc and crimped thereover, and a radially extending tab which is sandwiched between the tabs on said insulator and extends in the radial notch of said base.

8. The solenoid assembly set forth in claim 5 wherein said spool comprises a tubular core with spaced end flanges having tapered peripheral edges adapted for deformation when said spool is press-fitted in said shell.

9. The solenoid assembly set forth in claim 8 wherein one of the end flanges on said spool has a radial slot and wherein the terminal wedged between said spool and said shell comprises a metal strip having one end disposed in said slot and the other end overhanging the peripheral edge of said flange.

10. The solenoid assembly set forth in claim 5 wherein said plunger assembly includes a rod which extends into said spool and carries an armature disposed within said shell and arranged between said diaphragm and said spool, and wherein said resilient means comprises a coil spring having one end seated in a counterbore of said spool and the other end engaging said armature.

11. A hermetically sealed solenoid assembly comprising, a sheet metal shell, a field assembly press fitted in said shell including a base and a coil assembly, a reciprocable plunger assembly disposed within said shell coaxially of said field assembly, resilient means constantly acting on said plunger assembly for maintaining said plunger assembly in spaced relation to said base when the coil assembly is de-energized, and an elastomeric diaphragm attached to said plunger assembly and secured to said shell to effect a seal therebetween and coaxially support said plunger assembly within said coil assembly.

12. The solenoid assembly set forth in claim 11 wherein said shell is open at both ends and has an outwardly extending flange at one end and an inwardly extending flange at the other end, and an insulator clamped between said base and the inwardly extending flange, said diaphragm being secured to the outwardly extending flange.

13. The solenoid assembly set forth in claim 12 wherein one lead of said coil assembly is electrically connected to said shell, and an exposed terminal supported by said insulator and electrically connected to the other lead of said coil assembly.



**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 2,449,438 | Wisegarver | Sept. 14, 1948 |
| 2,853,660 | Immel | Sept. 23, 1958 |
| 3,098,635 | Delaporte et al. | July 23, 1963 |