United States Patent [19]

Kolchinsky et al.

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[54] **SOLENOID VALVE**

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[73] Assignee: **Imperial Clevite Inc.**, Glenview, Ill.

[21] Appl. No.: **680,419**

[22] Filed: **Dec. 11, 1984**

Related U.S. Application Data

[63] Continuation of Ser. No. 392,382, Jun. 28, 1982, abandoned.

[51] **Int. Cl.**[3] **F16K 31/02**

[52] **U.S. Cl.** **251/129.15;** 137/315; 411/531; 411/546; 335/261; 335/278

[58] **Field of Search** 251/129; 137/315; 411/531; 335/255, 261, 278, 281

[56] **References Cited**

U.S. PATENT DOCUMENTS

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2,383,411	8/1945	Obszarny	335/261
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4,055,823	10/1977	Anderson	335/278 X
4,341,241	7/1982	Boher	251/129 X

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Assistant Examiner—John C. Fox
Attorney; Agent, or Firm—Russell E. Baumann

[57] **ABSTRACT**

A cartridge solenoid poppet valve (**10**) arranged to use a single size pilot valve (**31**) with any one of a set of a plurality of different size sets of valve seat members (**14**) and poppet valves (**24**). Pilot guides (**175**) are provided having different transverse extents to accommodate such different size valve members. The valve further includes a flatted pilot guide (**32**) defining flow passages communicated between a transfer chamber (**35**) and a pilot valve chamber (**30**) in which the pilot valve (**31**) is disposed. A T-slot (**58**) is provided in the solenoid plunger (**38**) extending fully diametrically thereacross and the pilot valve includes a T-shaped connecting head (**71**) received therein. The plunger (**38**) and plug (**41**) define cooperating stop surfaces (**67,70**) for maintaining a small spacing between the plunger and plug at all times. Solenoid structure (**53**) includes a parallelepiped frame (**46**) defining a space with the solenoid coil (**44**) received therein. The portion of the coil space not occupied by the coil is filled with a set synthetic resin. The structure includes a nut (**52**) threaded to a connecting portion (**79**) of a plug (**41**) to bear forcibly against a flange (**51**) on a washer (**50**) urging the washer axially outwardly against the solenoid frame (**46**) and thereby urging the frame outwardly against an adapter (**11**) arranged to be threaded to a port (**73**). The outer housing (**49**) is a configuration generally similar to the external configuration of the frame.

8 Claims, 6 Drawing Figures

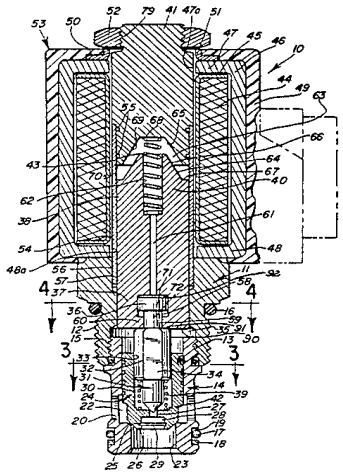


FIG. 1

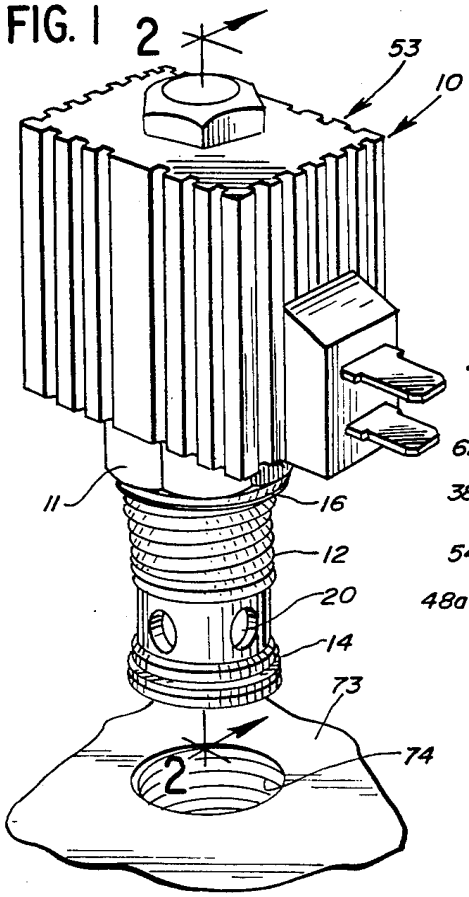
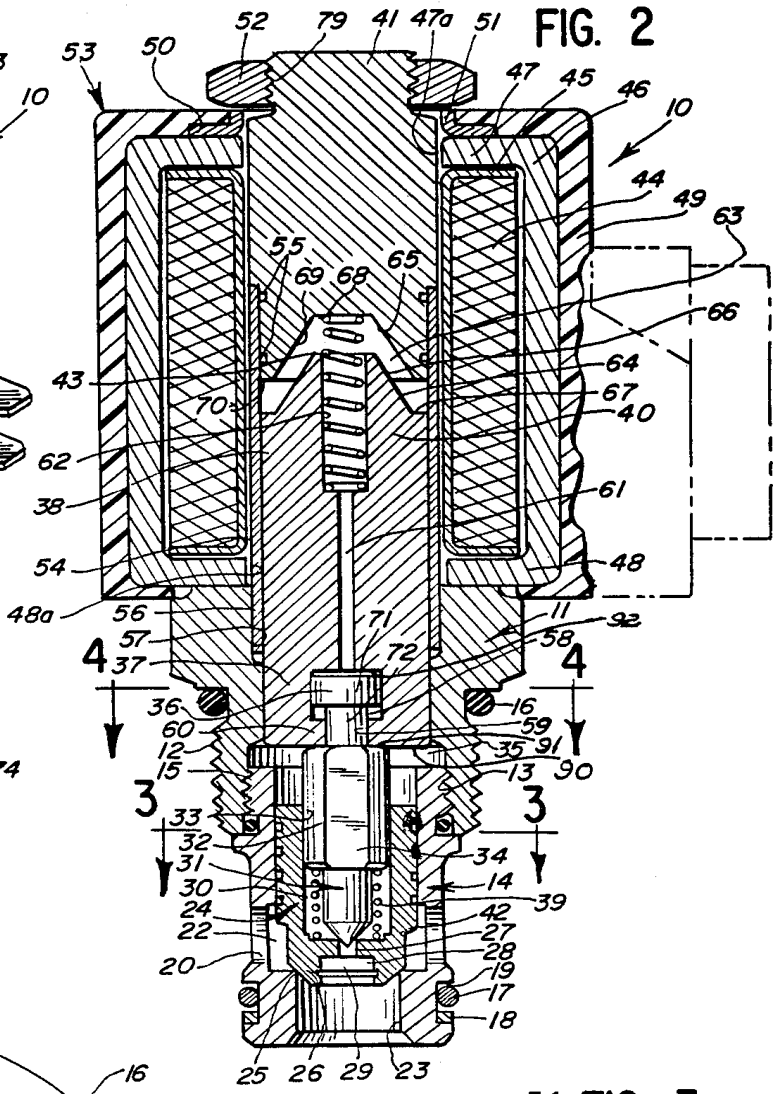


FIG. 2



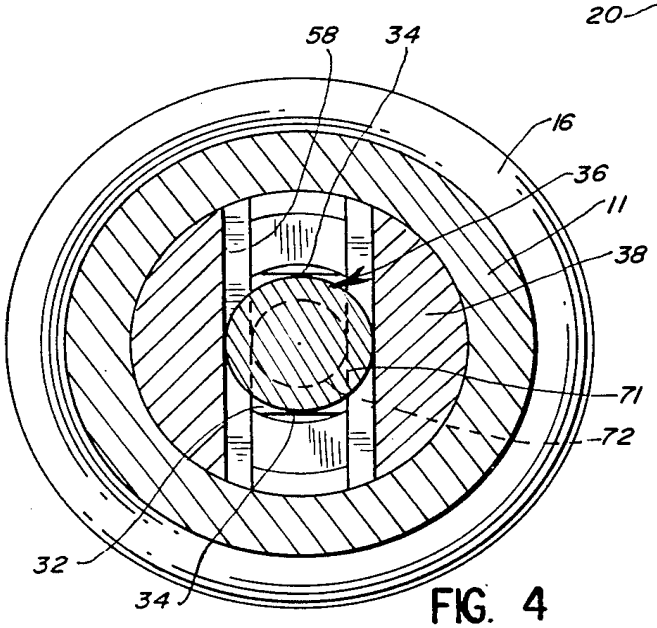


FIG. 4

FIG. 3

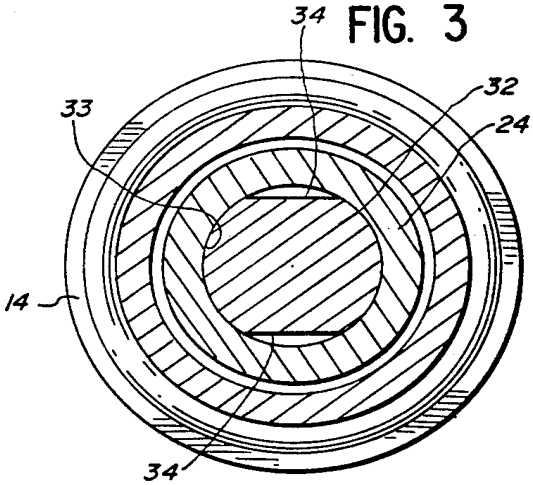
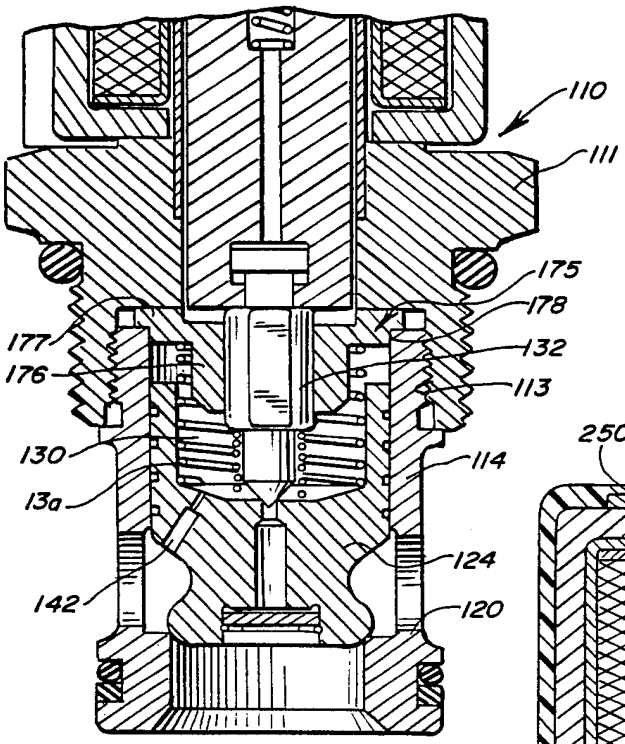


FIG. 5



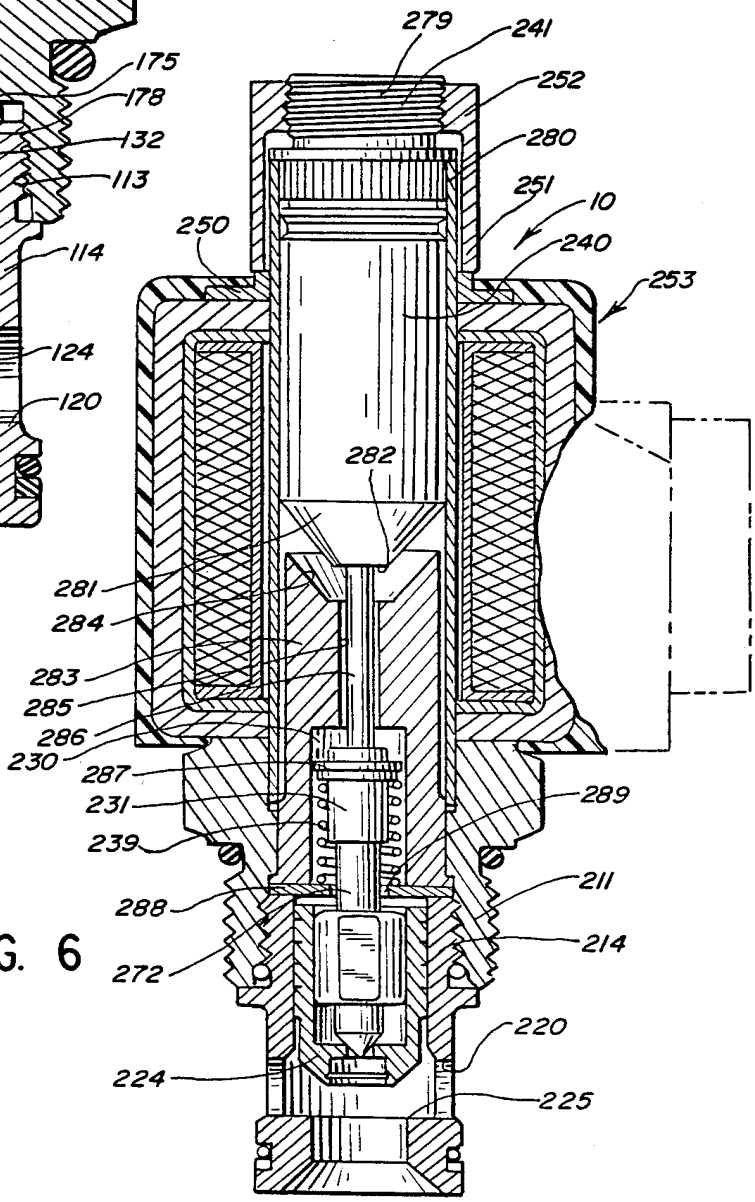


FIG. 6

SOLENOID VALVE

This is a continuation of application Ser. No. 392,382 filed June 28, 1982, now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to valves and in particular to solenoid-operated cartridge valves.

2. Description of the Prior Art

In one form of fluid flow control valve, a poppet is seated against a valve seat to close the valve. The poppet is provided with a through bore which is selectively closed by a pilot valve. The poppet is spring-biased to the closed position with fluid pressure acting on opposite sides of the poppet so as to permit the spring biasing to maintain the poppet closed. When the pilot valve is raised from the valve seat, the fluid pressure behind the poppet is relieved to the through bore, thus permitting the fluid pressure acting upwardly on the poppet to move the poppet from the valve seat and thereby permit flow through the valve.

In one form, the pilot valve is operated by a suitable solenoid having a plunger connected to the pilot valve for selective positioning thereof in effecting the desired fluid flow control.

Such valves are provided in a wide range of sizes depending on the flow capacity desired.

It is further conventional to provide such valves in the form of cartridges, including both the valve and the solenoid operator in a single assembly which, illustratively, may be connected to suitable ports by a threaded adapter portion thereof.

In U.S. Pat. No. 2,951,133 of James E. Davies et al., a hermetically sealed electromagnetic contactor and the like is disclosed wherein a drawn metal member is provided with a central opening through its upper end, which is encircled by an upstanding flange portion extending through an opening in a superjacent cup-shaped housing member.

Arthur J. Foley et al., in U.S. Pat. No. 3,215,902, show a solenoid actuated mechanism wherein the electrical assembly is located between a flux plate and an upper flux plate, with central apertures of the three elements being aligned and mounted upon a cylindrical protruding portion of the core support.

In U.S. Pat. No. 3,446,473, George E. Barker shows a solenoid valve wherein the solenoid housing is threaded to the valve body.

Alfred J. Ludwig, in U.S. Pat. No. 3,593,241, discloses a solenoid valve having a slotted flux sleeve for nesting the winding leads. The magnetic flux path includes a portion established by a pair of magnetizable end members disposed adjacent the opposite end surfaces of the solenoid coil, with a magnetizable center leg defining the end plug.

In U.S. Pat. No. 3,818,398, William J. Barbier et al. disclose an electromagnetic coil assembly wherein a T-shaped tubular shroud formed of ferrous material is press-fitted into each end of the spool supporting the solenoid coil.

In U.S. Pat. No. 4,074,700 of Thomas H. Engle, a valve assembly is disclosed wherein the coil housing provides a flux return path extending toriodally from the coil through an upper portion of a plunger guide, through the plunger, across a working air gap, through a pole piece, through a coil support flange, and up through a coil housing. The coil housing includes an axially extending lip which is sized diametrically to fit closely to the plunger and axially to provide an increased area for flux transfer. The plunger guide is made as thin as practical so that magnetic losses are minimized.

SUMMARY OF THE INVENTION

The present invention comprehends an improved performance and economy of manufacture.

The invention comprehends the provision in a fluid flow control valve having a movable valve member of an improved solenoid structure selectively positioning the valve member.

More specifically, the invention comprehends such an improved solenoid structure including an annular coil, means defining frame elements each having a sidewall and inturned end walls defining an inwardly opening recess, the recesses opening toward each other, the coil being disposed in the recesses, a guide tube coaxially of the coil, a magnetic plunger slidable axially within the guide tube and radially within the coil connected to the valve, an adapter having an axially inwardly facing surface abutting the inturned end walls at an outer end of the frame means, a securing element, plug means extending inwardly from the inner end of the guide and having an axially inner end projecting through the annular element and defining an external connecting portion, and a housing enclosing the assembled structure, the securing element being secured to the connecting portion to bear forcibly against the annular element and urge the annular element axially outwardly against the frame means, and the frame means against the adapter surface to lock the structure in coaxially assembled relationship.

The housing, in the illustrated embodiment, is molded of a synthetic resin and extends peripherally about the abutment of the adapter surface and inturned end walls at the outer end of the frame elements.

The inturned ends of the frame elements, in the illustrated embodiment, are spaced apart a distance substantially equal to the other diameter of the guide tube.

In the illustrated embodiment, the guide tube is brazed to the plug means and to the adapter.

More specifically, the invention comprehends the provision of such a solenoid structure including an annular coil, a pair of opposed spaced frame elements each having a substantially planar sidewall and inturned end walls defining an inwardly opening C-section, said C-sections opening toward each other, the coil being centered therebetween to extend axially parallel to the sidewalls, a guide tube coaxially with the coil, a magnetic plunger slidable axially within the guide tube and being connected to the valve, an adapter having an axially inwardly projecting annular boss abutting the inturned end walls at an outer end of the frame elements, an annular washer abutting the inturned end walls at the other end of the frame elements, and having an annular axially inturned, radially inner flange, a nut, threaded plug means secured to the inner end of the guide tube and having an axially inner end projecting through the washer and defining an externally threaded connecting portion, the nut being threaded to the connecting portion to bear forcibly against the flange and urge the washer axially outwardly against the adapter boss to lock the structure is coaxially assembled relationship, and a housing enclosing the assembled structure.

In the illustrated embodiment, the frames define axially inwardly opening parallelepiped spaces, with the portions of the spaces unoccupied by the coil being filled with a set synthetic resin.

In the illustrated embodiment, the housing comprises a parallelepiped housing generally similar to the external configuration defined by the spaced frame elements.

The fluid flow control valve solenoid structure of the present invention is extremely simple and economical of construction while yet providing the highly desirable features discussed above.

BRIEF DESCRIPTION OF THE DRAWING

Other features and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawing wherein:

FIG. **1** is a perspective view of a cartridge valve embodying the invention;

FIG. **2** is an enlarged diametric section thereof;

FIG. **3** is a transverse section taken substantially along the line **3—3** of FIG. **2**;

FIG. **4** is a transverse section taken substantially along the line **4—4** of FIG. **2**;

FIG. **5** is a diametric section of a modified form of cartridge form embodying the invention having a pilot guide adapted for use with different size poppet and seat members; and

FIG. **6** is a diametric section of a cartridge valve generally similar to the cartridge valve of FIGS. **1–5**, but arranged for normally open operation.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the illustrative embodiment of the invention as disclosed in the drawing, a cartridge solenoid poppet valve generally designated **10** includes an adapter **11** having a threaded portion **12** adapted to be threaded into a fluid port. The adapter includes a threaded end **13**. A seat member **14** is provided with a threaded end **15** threaded to the adapter end **13** so as to be received within the fluid port.

A first sealing ring **16** is provided on the adapter and a second sealing ring **17** is provided on the seat member for sealing the valve assembly within the fluid port.

As shown in FIG. **2**, a backup ring **18** may be associated with the sealing ring **17** in a suitable outwardly opening, annular recess **19** of the seat member.

The seat member is provided with a pair of diametrically opposite inlet openings **20** and **21**, which open radially inwardly into a valve chamber **22** within the seat member. An outlet opening **23** opens axially from the valve chamber **22** and is normally closed by a valve member **24** seating on an annular seat **25** of the seat member at the inner end of the outlet port **23**.

Thus, when installed in a suitable port member, fluid pressure between seals **16** and **17** is applied through the inlet ports **20** and **21** against the valve member **24**. In the illustrated embodiment, valve member **24** comprises a poppet valve having a lower seating portion **26** engaging the valve seat **25** and provided with an axial bore **27** having an outer counterbore **28** receiving a check valve **29**. The check valve prevents fluid pressure in the outlet port **23** from causing a reverse flow through the bore **27** into a pilot valve chamber **30** within the valve member **24**.

Bore **27** is normally closed by a pilot valve **31** having a guide portion **32** slidably received in an upper cylindrical recess **33** of the valve member **24**. The slide portion **32** is provided with a pair of diametrically opposite flats **34** for providing fluid communication between a transfer chamber **35** and the pilot valve chamber **30**.

Slide portion **32** acts as a pilot guide and defines an upper end **36** abutting a lower end **37** of a solenoid plunger **38** in the normally closed arrangement of the valve. A helical coil spring **39** extends between the guide portion **32** and the seating portion **26** of valve member **24** to bias the poppet valve downwardly relative to the guide portion **32**. As shown in FIG. **2**, however, when plunger **38** is in the lowermost position with portion **37** thereof abutting the upper end **36** of the pilot guide portion **34**, the plunger urges both the pilot valve and the poppet valve **24** downwardly into the seated arrangements of FIG. **2**.

In the normally closed arrangements of the solenoid valve **10**, the plunger is biased downwardly by a helical coil spring **43** acting between an upper end portion **40** of the plunger and a plug **41**. Spring **43** has a strength greater than spring **39** and, thus, overcomes the spring **39** to arrange the valve components in the normally closed position of FIG. **2**.

As further illustrated in FIG. **2**, valve member **24** is provided with a bleed passage **42** providing communication between the inlet **20** and the pilot valve chamber **30** at all times. Thus, in the normally closed position wherein the pilot valve **31** is closing the pilot opening **27**, fluid pressure at the inlet openings **20** is transmitted through the bleed passage **42** into the pilot valve chamber **30** and acts to maintain the poppet valve member **24** in the closed position illustrated in FIG. **2**, in cooperation with the springs **43** and **39**.

Pilot valve **31** is moved from the seated position illustrated in FIG. **2** by suitable longitudinal movement of plunger **38** toward plug **41** under the control of a solenoid coil **44**. In the illustrated embodiment, the coil **44** is carried in a suitable bobbin **45** mounted within a generally tubular frame **46** having a first, inner end **47** and a second, opposite outer end **48**. The frame is encapsulated in an outer housing **49** which may be formed of a suitable synthetic resin. The space within the frame receiving the coil is filled with a suitable synthetic resin, such as an epoxy resin.

A washer **50** is provided in the housing surrounding the upper end of plug **41**, and is provided with an axially turned inner end portion **51** extending outwardly to the outer surface of the housing to be engaged by a nut **52** threaded to the distal threaded end **53** of the plug **41**.

End **48** of the frame abuts the adapter **11** radially inwardly of the housing **49** and, thus, nut **52** acting through washer **50** and frame **46** effectively clamps the solenoid structure, generally designated **53**, to the adapter.

As further illustrated in FIG. **2**, a slide tube **54** is secured to the plug **41** as by brazing **55** to extend inwardly of the bobbin **45** and includes a lower end portion **56** received in a suitable recess **57** in the adapter **11**. Plunger **38** is reciprocably slidable in the tube **54** between the normally closed position of the valve illustrated in FIG. **2**, and an open position of the valve wherein the plunger is raised into abutment with plug **41**.

Upper end **36** of pilot valve **31** defines a cylindrical head received in a T section transverse slot **58** provided in the lower end **37** of the plunger **38**. The stem portion **59** of the slot is relatively short so as to provide high strength in the end portion **60** of plunger **38** confronting the transfer chamber **35**.

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