Oct. 4, 1966 E. L. LAST ETAL 3,276,760

ANTI-SURGE COIL SPRING ASSEMBLY

Filed March 2, 1964

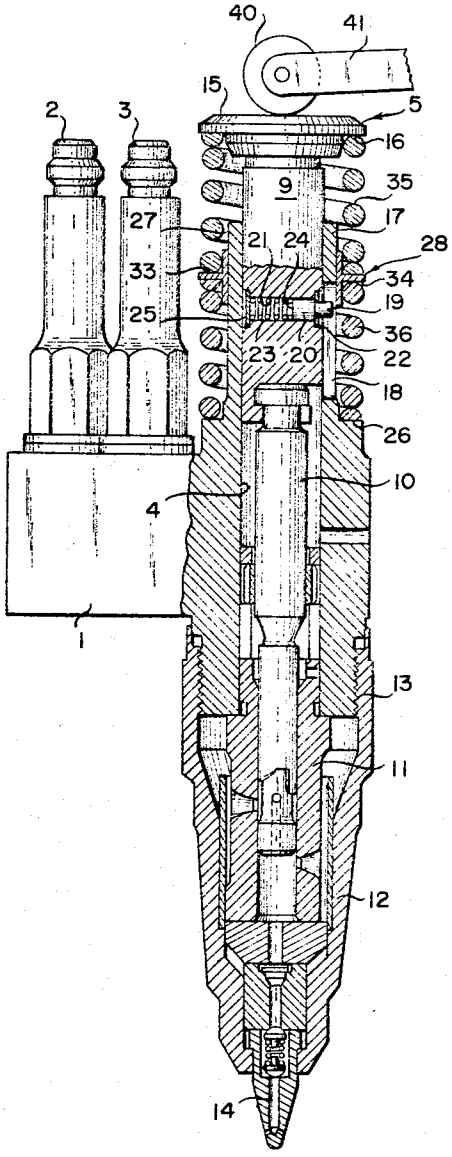

Fig. 1

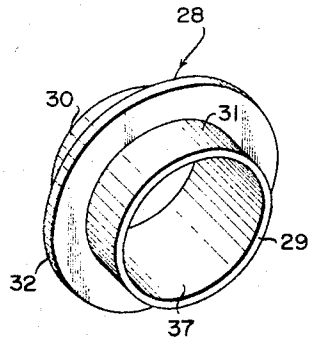

Fig. 2

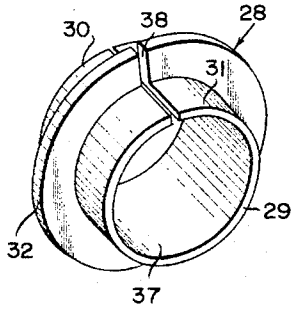

Fig. 3

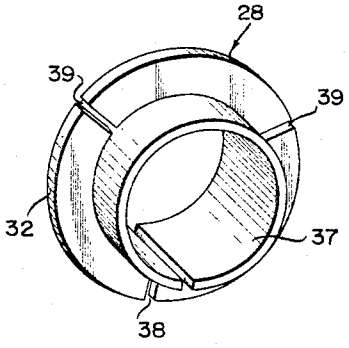

Fig. 4

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United States Patent Office 3,276,760 Patented Oct. 4, 1966

3,276,760

ANTI-SURGE COIL SPRING ASSEMBLY

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Filed Mar. 2, 1964, Ser. No. 348,329
3 Claims. (Cl. 267—1)

This invention relates generally to fuel injection apparatus for internal combustion engines, and particularly to the fuel injector plunger return spring assembly.

In fuel injection units it is a common practice to use a coil spring to return the fuel metering plunger to a retracted position after the plunger has been actuated and fuel injected into the combustion chamber of an engine. It will be appreciated that when an impulse is imparted to such a coil spring as the plunger is retracted, the impulse travels the length of the spring and is reflected back. If the natural frequency of the spring is low, one such impulse will not be materially dampened before one or more succeeding impulses are imparted to the spring with the result that the spring is caused to surge. Such surging materially effects the position of fuel metering grooves in the plunger assembly with a resultant decrease in efficiency of the unit.

It is the primary purpose of this invention to overcome such heretofore encountered difficulties by providing a spring damping means which dampens or attenuates spring vibrations that may develop during operation of a spring assembly.

It is a more specific object of this invention to provide a damping means which is disposed between two coil springs and provides a frictional damping force therebetween.

It is a further object of this invention to provide a spring damping means employing a sliding friction member which may be adjusted to vary the damping rate without requiring additional machining of any of the parts comprising the damping assembly.

Other objects and advantages of the present invention will be more clearly understood from the following description having reference to the drawing wherein:

FIGURE 1 is a sectional view of a portion of a housing member of an internal combustion engine and its fuel injection apparatus showing the components of the subject invention in an assembled relationship.

FIGURE 2 is a perspective view of the spring separating ring shown in FIGURE 1 illustrating one embodiment of the present invention.

FIGURE 3 is a perspective view of a further embodiment of the separating ring of FIGURE 2.

FIGURE 4 is a perspective view illustrating another embodiment of the separating ring of FIGURE 3.

Referring now in detail to the drawing, and first to FIGURE 1, a fuel injection device embodying the subject invention incorporates a housing member **1** to which is secured fuel supply connections **2** and **3** in the conventional manner. The housing member **1** includes a chamber **4** which receives a reciprocating plunger designated generally as **5**.

A slide piece **9** forms the upper portion of the reciprocating plunger **5** and transmits its motion to an injector member **10**. The lower end of the injector member **10** slidably reciprocates in a pump cylinder **11** which is rigidly secured in the housing member **1** by a nut **12** threaded to the housing as at **13**. The structure and operation of the lower pumping cylinder **11** to effect discharge of fuel from a spray tip **14** is similar to that shown in Patent No. 2,997,994 to R.F. Falberg and forms no part of this invention.

The upper end of the slide piece **9** has an outer end surface **15** formed thereon. A shoulder **16** is formed on the underside of the upper end of slide piece to seat a coil spring as hereinafter described.

A guide means **17**, integral with the housing **1**, has a slot **18** therein which receives the end **19** of a guide pin **20**. The guide pin is slidably positioned in a chamber **21** of the slide piece **9** and is biased against a retaining ring **22** by a spring **23** disposed between the end surface **24** of the guide pin and a retaining ring **25** secured to the slide piece.

A shoulder or spring seat **26** is provided on the housing member **1** adjacent the guide means **17** to receive a coil spring as hereinafter described. The outer surface **27** of the guide means is adapted to receive a separating ring, designated generally by the numeral **28**, in sliding relation.

The separating ring, as illustrated more clearly in FIGURE 2, has an axially extending sleeve **29**. A radially extending flange **32** formed integral with the axially extending sleeve **29**, is disposed intermediate the ends of the axially extending sleeve and divides it into two end portions **30** and **31**. Surfaces **33** and **34**, shown in FIGURE 1, of the radially extending flange **32** act as spring seats for the coil springs **35** and **36**, respectively, when the separating ring is in its assembled position. The inner surface **37** of the axially extending sleeve **29** is formed to a dimension which provides a sliding frictional contact with the outer surface **27** of the guide means **17**.

The coil spring **35** in interposed between the shoulder **16** of the slide piece **9** and the separating ring **28**, with one end of the spring abutting the shoulder **16** and the other end abutting the surface **33** of the radially extending flange **32**. The coil spring **36** is interposed between the shoulder **26** on the housing member **1** and the separating ring **28** with one end of the spring abutting the shoulder **26**, and the other end seating against the surface **34** of the radial flange **32**. The end portions **30** and **31** of the axially extending sleeve **29** are received within the inner diameters of the coil springs **35** and **36**, respectively. The springs **35** and **36** may have either equal or different spring rates.

FIGURES 3 and 4 illustrate further embodiments of the separating ring. FIGURE 3 shows the separating ring **28** having a radial slot **38** through both the radially extending flange **32** and the axially extending sleeve **29** to form a discontinuous ring. FIGURE 4 illustrates a radially extending flange **32** having a plurality of slots **39** therein with one of the slots **38** passing through both the radial flange and the axial sleeve.

Referring again to FIGURE 1, a contact wheel **40**, rotatably mounted on a lever **41**, contacts the outer surface **15** of the slide piece **9** and imparts axial motion to the plunger member **5** from an external source in the conventional manner.

In operation, axial motion is imparted to the plunger member **5** through the contact wheel **40** and the lever **41**. Downward motion of the slide piece **9** causes the coil springs **35** and **36** to be compressed, resisting downward movement of the plunger member. The separating ring **28**, being interposed between the ends of the springs **35** and **36** will also be moved downwardly as the springs are compressed. The inner surface **37** of the separating ring **28** illustrated in FIGURE 2, having been formed to provide a sliding friction fit when in engagement with the outer surface **27** of the guide means **17**, will create a friction force tending to oppose movement of the separating ring.

When the plunger member has reached its predetermined maximum downward position, upward movement of the lever **41** will allow the springs **35** and **36** to return the plunger member **5** to its outermost position, main-

taining the outer surface **15** of the slide piece **9** in contact with the wheel **40**. Expansion of the springs **35** and **36** during retraction of the plunger member causes the separating ring **28** to return to its original position with the frictional force created by sliding contact of the surface **37** on the guide member **17** tending to oppose such movement.

It can be readily understood that as the plunger member **5** reciprocates at a high rate and the springs **35** and **36** are compressed and relaxed, the separating ring **28** will undergo reciprocating motion on the guide means **17**. The frictional force created between the inner face **37** of the separating ring and the outer surface **27** of the guide means will always be in a direction tending to oppose movement of the separating ring, thus acting to dampen axial vibrations induced in the coil springs and prevent surging of the plunger member.

Using a separating ring as shown in FIGURE 3, which constitutes one embodiment of the present invention, the frictional force between the inner riding surface **37** of the axially extending sleeve **29** and the outer surface **27** of the guide means **17** may be controlled through radial adjustment of the separating ring, such adjustment being readily allowable by provision of the slot **38**. An increase in friction force would be desirable when the injection apparatus is to be operated at a high frequency where the danger of the springs surging would be increased.

In the event that the injection apparatus is to be operated under conditions where adjustment of the separating ring to vary the aforementioned friction force is desirable, the slots **39** provided in the radially extending flange **32**, as shown in FIGURE 4, will allow radial adjustment of the separating ring without distortion of the radially extending flange. Such distortion is undesirable in that it would affect the seating of the coil springs **35** and **36** on the surfaces **33** and **34**, respectively, of the radially extending flange with a resultant cocking or tilting of the separating ring, thereby reducing the rings effectiveness in damping vibration.

It is appreciated that various minor changes in the construction and arrangement of the parts may be made without departing from the spirit and scope of the invention as hereinafter defined.

What is claimed is:

1. In a fuel injection device including a housing member having a chamber therein receiving a reciprocating plunger, a guide means integral with said housing member, said plunger being disposed within said guide means, a separating ring slidably disposed about said guide means, said separating ring including an axially extending sleeve and a radially extending flange intermediate the ends of said axially extending sleeve and integral therewith, a first coil spring interposed between the outer end of said plunger and said radial flange, and a second coil spring interposed between said housing member and said radial flange, said separating ring frictionally engaging said guide means to attenuate vibration of said springs.

2. In a fuel injection device including a housing member having a chamber therein receiving a reciprocating plunger, a guide means integral with said housing member, said plunger being disposed within said guide means, a separating ring slidably disposed about said guide means, said separating ring including an axially extending sleeve and a radially extending flange intermediate the ends of said axially extending sleeve and integral therewith, a first coil spring interposed between the outer end of said plunger and said radial flange, and a second coil spring interposed between said housing member and said radial flange, said separating ring frictionally engaging said guide means and having a slot therethrough to form a discontinuous ring which may be radially adjusted to vary the frictional force between said ring and said guide means to change the dampening effect of said separating ring.

3. A device as described in claim **2** wherein said radially extending flange has a plurality of slots therein to allow radial adjustment of said separating ring without distortion of said radially extending flange.

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