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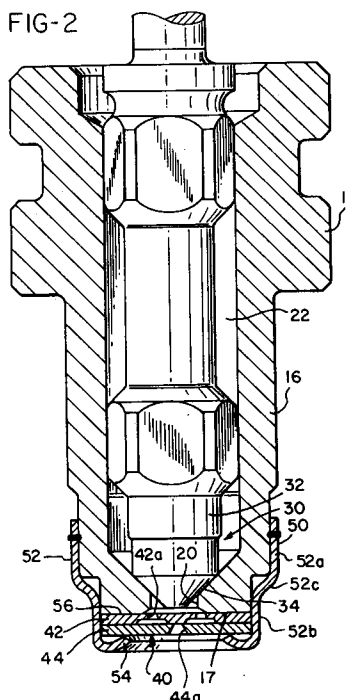
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Leigh on Sea, Essex SS9 18N(GB)(54) **Fuel injector with a silicon nozzle.**

(57) A fuel injector for use in an internal combustion engine is provided and comprises an injector body (12) having a first portion (14) with an inlet (18) for communicating with a fuel source, a second portion (16) having an outlet (20) for ejecting fuel from the body, and an inner passageway (22) which communicates with the inlet and the outlet. A fuel valve (30) is located within the inner passageway (22) for controlling fuel ejection from the outlet. A silicon nozzle (40) is positioned adjacent to the second portion (16) for metering and dispersing fuel as it is ejected from the outlet. A retainer (50) is connected to the injector body (12) for retaining the nozzle (40) against the second portion (16). The retainer (50) includes a side portion (52) and a base portion (54) extending at an angle relative to the side portion (52) for applying a spring-biased force against the nozzle (40) to retain the nozzle (40) against the second portion (16), thereby substantially sealing the interface between the nozzle (40) and the second portion (16) from fuel leakage.

FIG-2

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The present invention relates generally to a fuel injector having a silicon nozzle, and more particularly, to such a fuel injector which includes a retainer for applying a spring-biased force against the silicon nozzle to retain the same against the body of the fuel injector.

Fuel injectors employing silicon nozzles for metering and dispersing fuel as it is ejected are known in the prior art. Retainers for securing silicon nozzles onto fuel injector bodies are also known in the art. For example, U.S. Patent No. 4,768,751 discloses a retainer which threadedly engages with a fuel injector body for retaining a valve plate and a nozzle plate against a bottom portion of the injector body. A Belleville washer is provided within the retainer for applying an upwardly directed force upon the valve plate and the nozzle plate. Since the retainer threadedly engages with the injector body, it is very difficult to determine precisely when the retainer is properly positioned on the injector body to ensure that it is applying the appropriate upwardly directed force upon the valve plate and the nozzle plate. Consequently, this retainer is not very practical from a manufacturing standpoint. Additionally, required use of a Belleville washer increases the cost of the fuel injector.

It is also known to employ a retainer having a side wall and a bottom wall which extends 90° to the side wall for retaining a silicon nozzle against an injector body. The bottom wall retains the silicon nozzle against the injector body without applying a spring-biased force against the silicon nozzle. Consequently, when fuel is ejected from the injector, the pressure of the fuel upon the silicon nozzle tends to separate the silicon nozzle from the injector body, thereby causing fuel leakage at the interface between the silicon nozzle and the injector body. Part variability and temperature changes may also cause the silicon nozzle to move away from the injector body, again resulting in fuel leakage at the interface between the nozzle and the injector body.

Accordingly, there is a need for an improved retainer which can be easily and precisely formed at a low cost, which can be easily and precisely connected to an injector body during manufacturing, and which prevents fuel leakage at the interface of the injector body and the silicon valve.

This need is met by a silicon nozzle retainer in accordance with the present invention which includes a side wall and a bottom wall extending at an acute angle relative to the side wall. The bottom wall is deformed against the silicon nozzle when initially fitted onto the fuel injector's body. This enables the bottom wall to apply a spring-biased force against the silicon nozzle to retain the same against the injector body, thereby substantially sealing the interface between the silicon nozzle and

the injector body from fuel leakage.

In accordance with one aspect of the present invention, a fuel injector for use in an internal combustion engine is provided and comprises an injector body including a first portion having an inlet for communicating with a fuel source, a second portion having an outlet for ejecting fuel from the body, and an inner passageway which communicates with the inlet and the outlet. Fuel valve means are located within the inner passageway for controlling fuel ejection from the outlet. Nozzle means are positioned adjacent to the second portion for metering and dispersing the fuel as it is ejected from the outlet. Retainer means are connected to the injector body for retaining the nozzle means against the second portion. The retainer means has a side portion and a base portion extending at an angle relative to the side portion for applying a spring-biased force against the nozzle means to retain the nozzle means against the second portion, thereby substantially sealing the interface between the nozzle means and the second portion from fuel leakage.

Preferably, the nozzle means comprises at least one silicon nozzle plate having a substantially square shape and one or more openings therein.

The base portion of the retainer means preferably extends at an acute angle relative to the side portion of the injector body for applying the spring-biased force against the nozzle means. The base portion of the retainer means is deformed against the nozzle means before the retainer means is connected to the injector body to generate the spring-biased force. The retainer means may be weldably connected to the injector body, crimped or snap-fitted onto the injector body.

In a first embodiment of the present invention, the side portion of the retainer means comprises a substantially cylindrical upper section having a first inner diameter, a substantially cylindrical lower section having a second inner diameter, and an intermediate interconnecting section interposed therebetween. The silicon nozzle plate is located within the cylindrical lower section and the second inner diameter of the lower section is substantially equal to each diagonal of the silicon nozzle plate. As a result, the silicon nozzle plate is maintained in proper position below the second portion of the injector body and is substantially prevented from moving laterally within the retainer means.

In a second embodiment of the present invention, the second portion of the injector body includes a recess formed therein for receiving the silicon nozzle plate. The base portion of the injector body serves to retain the nozzle plate in the recess by applying the spring-biased force against the nozzle plate.

In a second aspect of the present invention, a

fuel injector is provided and comprises an injector body including a first portion having an inlet for communicating with a fuel source, a second portion having an outlet for ejecting fuel from the body and an inner passageway which communicates with the inlet and the outlet. Fuel valve means are located within the inner passageway for controlling fuel ejection from the outlet. Silicon nozzle means are positioned adjacent to the second portion of the injector body for metering and dispersing fuel as it is ejected from the outlet. Retainer means are connected to the injector body for retaining the silicon nozzle means against the second portion. The retainer means has a side portion and a base portion extending at an angle relative to the side portion for applying a spring-biased force against the nozzle means to retain the nozzle means against the second portion, thereby substantially sealing the interface between the nozzle means and the second portion from fuel leakage.

The side portion of the retainer means may comprise an upper section, a lower section, and an intermediate interconnecting section interposed therebetween as discussed above with respect to the first embodiment of the first aspect of the present invention. Alternatively, the second portion of the injector body may include a recess formed therein for receiving the silicon nozzle plate as discussed above with respect to the second embodiment of the first aspect of the present invention.

According to preferred embodiments, it is an object of the present invention to provide a retainer which can be easily and precisely connected to an injector body during manufacturing. It is a further object of the present invention to provide a retainer for applying a spring-biased force against a silicon nozzle to retain the silicon nozzle against a fuel injector body, thereby substantially sealing the interface between the silicon nozzle and the injector body from fuel leakage. It is an additional object of the present invention to provide a retainer having a side wall which has a lower section with an inner diameter which is substantially equal to the diagonals of the silicon nozzle to maintain the silicon nozzle in proper position below the injector body and substantially prevent lateral movement of the silicon nozzle within the retainer.

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which :

Fig. 1 a side view, partially in section, of a first embodiment of a fuel injector of the present invention;

Fig. 2 is an enlarged view of the second portion of the injector body shown in Fig. 1;

Fig. 3 is a top plan view of the retainer shown in Fig. 1 including the silicon nozzle means located

therein;

Fig. 4 is a cross-sectional view taken generally along section line 4-4 in Fig. 3, but with the silicon nozzle means removed from the retainer;

Fig. 5 is side view, partially in cross-section, of a lower portion of a second embodiment of a fuel injector of the present invention;

Fig. 6 is a top plan view of the retainer shown in Fig. 5;

Fig. 7 is a cross-sectional side view taken generally along line 7-7 in Fig. 6; and

Fig. 8 is a plan view of the silicon nozzle means shown in Fig. 5.

A first embodiment of a fuel injector of the present invention, generally designated by the reference numeral 10, is shown in Fig. 1. The fuel injector 10 comprises an injector body 12 having a first, upper portion 14 and a second, lower portion 16. The first portion 14 includes an inlet 18 for communicating with a fuel source (not shown). The second portion 16 includes a substantially planar bottom wall 17, and an outlet 20 for ejecting fuel from the body 12. The injector body 12 further includes an inner passageway 22 which communicates with the inlet 18 and the outlet 20.

Positioned within the inner passageway 22 of the injector body 12 is a needle valve 30, which serves to control the amount of fuel ejected from the outlet 20. The needle valve 30 comprises a needle 32 and a seat 34, upon which the needle 32 sits while located at its closed position. A well-known solenoid-type actuator and spring return means (not shown) is included within the injector body 12 to move the needle 32 upwardly and downwardly within the inner passageway 22 to allow fuel to be ejected from the outlet 20. Alternatively, piezoelectric drive means, such as disclosed in U.S. Patent No. 4,907,748, the disclosure of which is hereby incorporated by reference, may be employed in place of the solenoid drive means for displacing the needle 32 within the passageway 22.

As shown in Figs. 1 and 2, a silicon nozzle means 40, comprising two silicon nozzle plates 42 and 44 which are bonded together, is retained against the bottom wall 17 of the injector body 12 for metering and dispersing fuel into a spray as it is ejected from the outlet 20. The top plate 42 includes four orifices 42a therein, while the bottom plate 44 includes a single orifice 44a. The orifices 42a and 44a serve to guide the fuel as it flows through the nozzle plates 42 and 44. The silicon nozzle plates 42 and 44 are substantially similar to those disclosed in U.S. Patent No. 4,828,184, the disclosure of which is hereby incorporated by reference. It is further contemplated by the present invention, that a single nozzle plate may be employed in place of the two nozzle plates 42 and 44.

A retainer 50 is provided for retaining the silicon nozzle plates 42 and 44 against the lower wall 17 of the injector body 12. The retainer 50 comprises a side portion 52 and a base portion 54 extending at an acute angle / relative to the side portion 52 (see Fig. 4). Preferably, the retainer 50 is die punched from stainless steel. However, the retainer 50 may also be made from beryllium-copper or formed from a polymeric material. The retainer 50 is mounted and connected to the injector body 12 under an applied load. The retainer 50 may be weldably connected to the injector body 12, as shown in Fig. 2, or may be crimped or snap-fitted thereon. Because the retainer 50 is mounted under a load, the base portion 54 deforms against the bottom silicon plate 44, resulting in a spring-biased force being applied against the silicon plates 42 and 44 by the base portion 54. Deformation of the base portion 54 also results in the angle / increasing slightly. Since the base portion 54 extends at an acute angle / relative to the side portion 52 and the retainer 50 is mounted to the injector body 12 under a load, the spring-biased force is maintained upon the plates 42 and 44 at substantially all times, thereby ensuring that the interface 56 between top plate 42 and the lower wall 17 is substantially sealed from fuel leakage.

The side portion 52 of the retainer includes a substantially cylindrical upper section 52a having a first inner diameter D1, a substantially cylindrical lower section 52b having a second inner diameter D2, and an intermediate interconnecting section 52c interposed therebetween. The silicon nozzle plates 42 and 44 are located within the cylindrical lower section 52b, as shown in Figs. 1-3. The second inner diameter D2 of the lower section 52b is substantially equal to the diagonals L of the silicon nozzle plates 42 and 44. Consequently, the lower section 52b of the retainer 50 acts to maintain the silicon nozzle plates 42 and 44 in proper position below the second portion 16 of the injector body 12 and prevents the nozzle plates 42 and 44 from moving laterally within the retainer 50.

Referring now to Figs. 5-7, a second embodiment of a fuel injector of the present invention, generally designated by the reference numeral 10', is shown. The fuel injector 10' comprises an injector body 12' which is substantially similar to the injector body 12 shown in Figs. 1 and 2. The second portion 16' of the injector body 12', however, includes a recess 19 for receiving nozzle means 40' therein. The nozzle means 40' serves to meter and disperse the fuel into a spray as it is ejected from the outlet 20'. The nozzle means 40', as best shown in Fig. 8, comprises a single nozzle plate 42' having at least one orifice 42a' therein. The nozzle means 40' may alternatively comprise two nozzle plates as described above with respect

to the first embodiment of the present invention.

A retainer 50' is provided for retaining the silicon nozzle plate 42' in the recess 19. The retainer 50' comprises a substantially cylindrical side portion 52' and a base portion 54' extending at an acute angle / relative to the side portion 52' (see Fig. 7). The retainer 50' is mounted and connected to the injector body 12' under an applied load. The retainer 50' may be weldably connected to the injector body 12', as shown in Fig. 5, or crimped or snap-fitted thereon. Because the base portion 54' extends at an acute angle / relative to the side portion 52' and the retainer 50' is mounted to the injector body 12' under a load, an applied force is maintained against the plate 42' at substantially all times, thereby ensuring that the interface 56' between the plate 42' and the lower wall 17' of the injector body 12' is substantially sealed from fuel leakage.

By the present invention a fuel injector is provided which includes a silicon nozzle retainer for applying a spring-biased force against a silicon nozzle to retain the same against the injector's body. The retainer can be easily formed at a low cost and can be easily and precisely connected to the injector's body during manufacturing. Because the retainer applies a spring-biased force against the silicon nozzle to retain the same against the injector's body, the interface between the silicon nozzle and the injector body is substantially sealed from fuel leakage.

Claims

1. A fuel injector for use in an internal combustion engine comprising:
 - an injector body (12) including a first portion (14) having an inlet (18) for communicating with a fuel source, a second portion (16) having an outlet (20) for ejecting fuel from said body, and an inner passageway (22) which communicates with said inlet and said outlet;
 - fuel valve means (30) located within said inner passageway for controlling fuel ejection from said outlet;
 - nozzle means (40) positioned adjacent to said second portion for dispersing fuel as it is ejected from said outlet; and
 - retainer means (50) connected to said injector body (12) for retaining said nozzle means (40) against said second portion, said retainer means having a side portion (52) and a base portion (54) extending at an angle relative to said side portion (52) for applying a spring-biased force against said nozzle means (40) to retain said nozzle means (40) against said second portion, thereby substantially sealing the interface between said nozzle means

(40) and said second portion (16) from fuel leakage.

2. A fuel injector for use in an internal combustion engine as claimed in claim 1, wherein said nozzle means comprises at least one silicon nozzle plate having one or more openings therein. 5
3. A fuel injector for use in an internal combustion engine as set forth in claim 2, wherein said at least one silicon nozzle plate has a substantially square shape. 10
4. A fuel injector for use in an internal combustion engine as set forth in claim 3, wherein said side portion of said retainer means comprises a substantially cylindrical upper section having a first inner diameter, a substantially cylindrical lower section having a second inner diameter, and an intermediate interconnecting section interposed therebetween, said at least one silicon nozzle plate being located within said cylindrical lower section and said second inner diameter of said lower section being substantially equal to each diagonal of said at least one silicon nozzle plate, thereby maintaining said at least one silicon nozzle plate in proper position below said second portion of said injector body and substantially preventing said at least one silicon nozzle plate from lateral movement within said retainer means. 15
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5. A fuel injector for use in an internal combustion engine as set forth in claim 2, wherein said second portion of said injector body includes a recess formed therein for receiving said at least one silicon nozzle plate, and said base portion of said injector body serves to retain said at least one nozzle plate in said recess by applying said spring-biased force against said nozzle plate. 35
40
6. A fuel injector for use in an internal combustion engine as set forth in claim 1, wherein said nozzle means comprises two silicon nozzle plates, each having one or more openings therein. 45
7. A fuel injector for use in an internal combustion engine as set forth in claim 1, wherein said base portion of said retainer means extends at an acute angle relative to said side portion for applying said spring-biased force against said nozzle means. 50
55
8. A fuel injector for use in an internal combustion engine as set forth in claim 1, wherein said

base portion of said retainer means is deformed against said nozzle means prior to said retainer means being connected to said injector body to generate said spring-biased force.

9. A fuel injector for use in an internal combustion engine as set forth in claim 1, wherein said retainer means is weldably connected to said injector body.
10. A fuel injector for use in an internal combustion engine as set forth in claim 1, wherein said retainer means is snap-fitted onto said injector body.

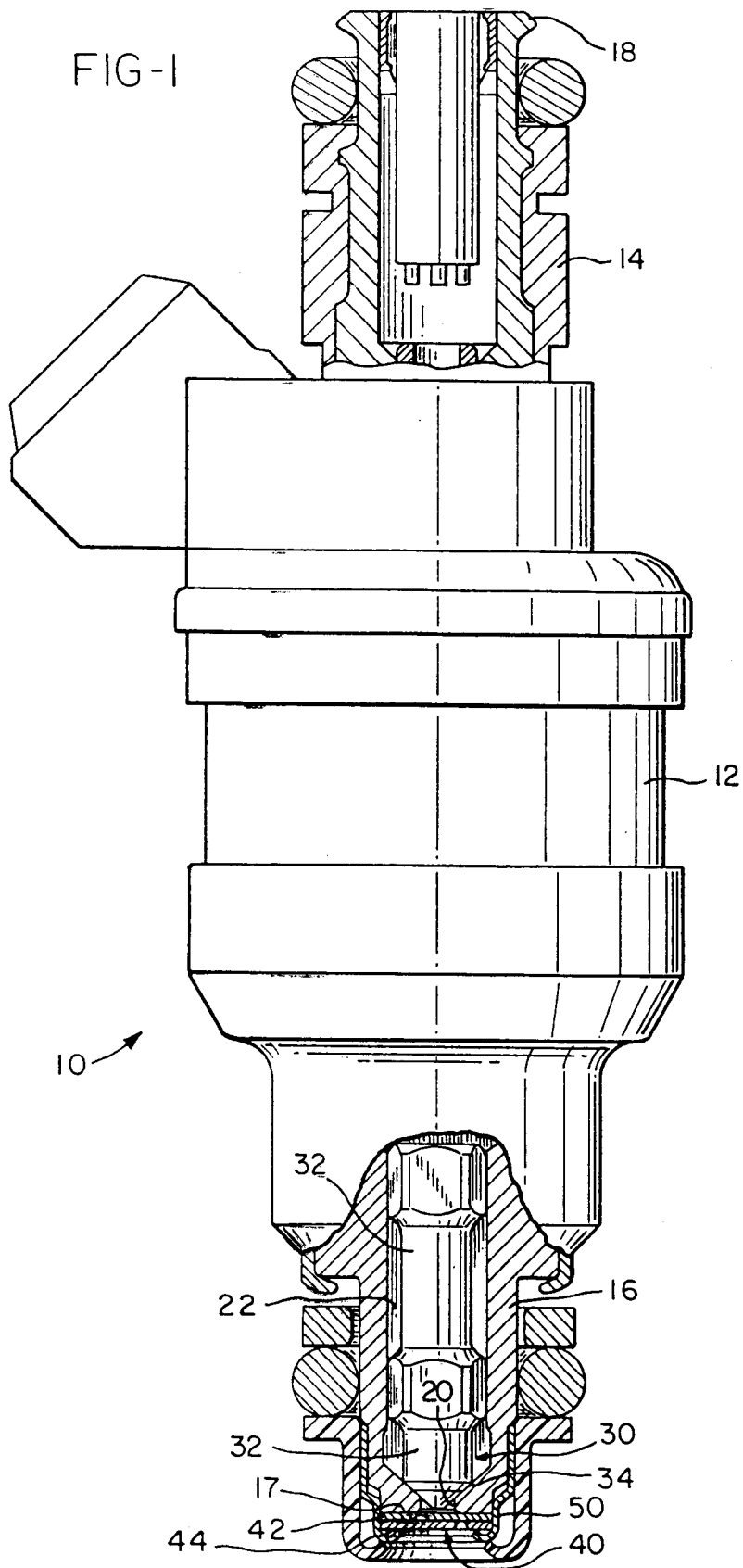


FIG-2

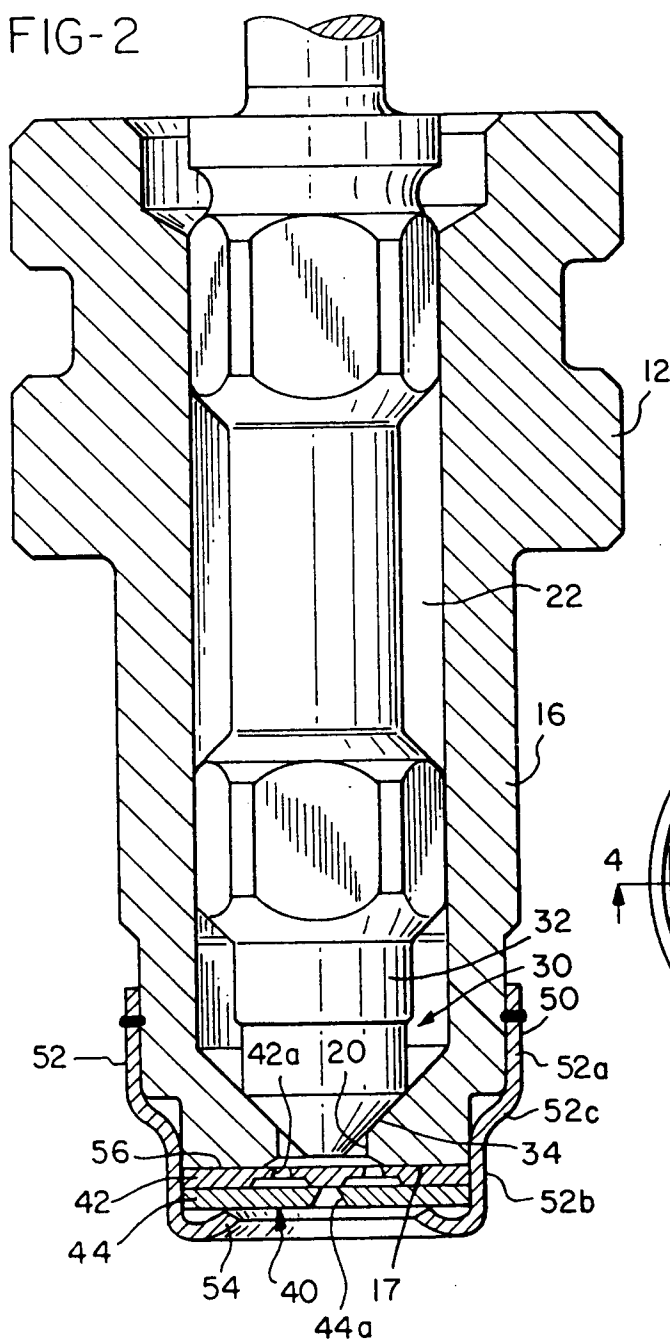


FIG-3

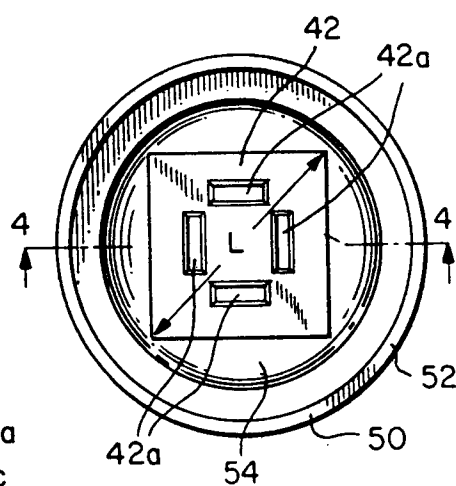


FIG-4

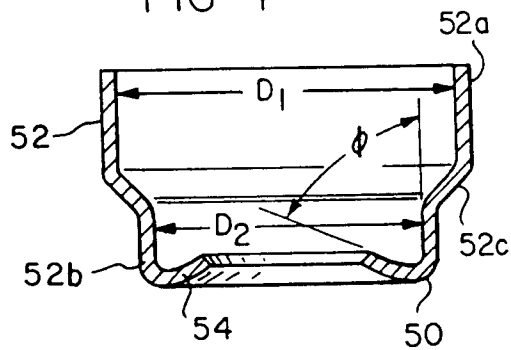


FIG-5

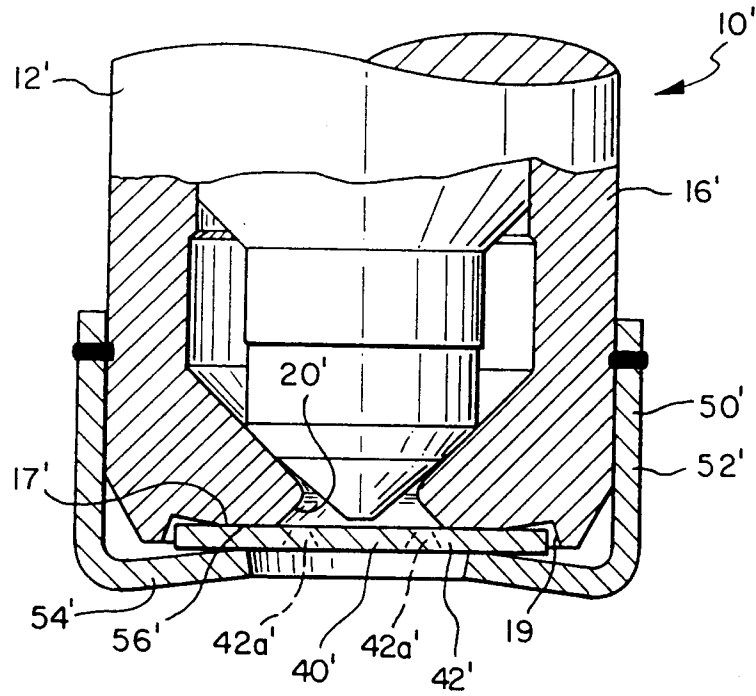


FIG-6

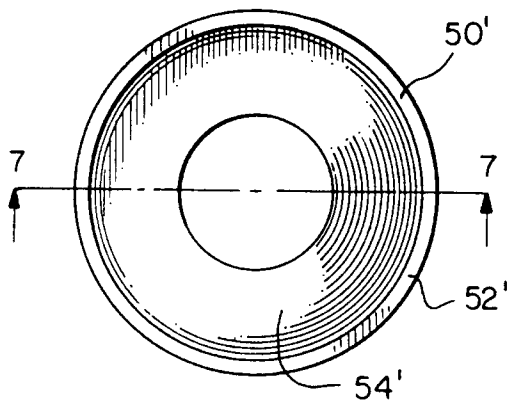


FIG-7

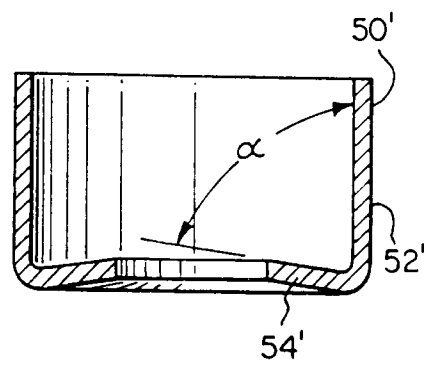


FIG-8

