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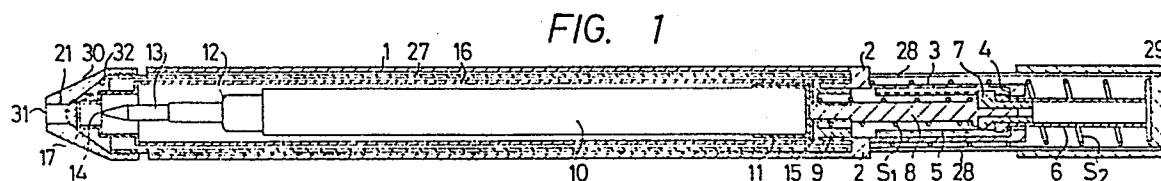
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54 Writing instrument.

57 A writing instrument comprises a barrel (1), a slidable tube (27) slidably housed in said barrel (1), an inner tube (16) housed in said slidable tube (27) and having an opening (18) defined in a distal end thereof, said inner tube (16) being coupled to said barrel (1), a writing member (10) disposed in said inner tube (16) and having a writing tip (14) on a distal end thereof. Between the slidable tube (27), the barrel (1) and the writing member (10) a mechanism is interposed for allowing said writing member (10) to move forward with a time delay

with respect to advance of said slidable tube (27) when the latter is moved forwardly. A sealing body (21) is disposed in the slidable tube (27) in the vicinity of a front end thereof, said sealing body (21) being pressable by an inner surface of a front end of said slidable tube (27) into said opening (18) in said inner tube (16) to seal said opening (18) when said slidable tube (27) is in a most retracted position. Between the writing member (10) and the inner tube (16) a seal is disposed at a position behind said sealing body (21).



WRITING INSTRUMENT

The present invention is applicable to a variety of writing instruments such as a fountain pen, a fabric-tip pen, a ball-point pen or the like, but is especially most effective when incorporated in writing instruments such as
5 a fabric-tip pen and a water-ink ball-point pen.

The applicant has already filed applications on various writing instruments in which a seal cap or a seal ball is movable into and out of a sealing position in response to a knocking or turning motion for sealing a
10 writing tip or unsealing the same in readiness for writing (as disclosed by Japanese patent application Nos. 102238/1981 and 137779/1981, Japanese Utility model application Nos. 167109/1981, 167110/1981, 52578/1982 and 55014/1982. These prior writing instruments have an air vent hole
15 defined in the vicinity of a tip end portion of a cartridge to seal the writing tip near the tip end portion. This structural limitation prevents such prior arrangements from being incorporated in writing members or ink cartridges generally available on the market or those with
20 small modifications. Therefore, the prior inventions have required ink cartridges to be constructed as a whole with special design.

It is an object of the present invention to provide a

writing instrument which can be constructed by utilizing a commercially available writing member or ink cartridge or such an existing writing member with a small modification.

In the accompanying drawings:

5 Figs. 1, 4, 5 and 6 are cross sectional view of a writing instrument according to a first embodiment of the present invention, the views showing steps of operation;

Fig. 2 is a fragmentary exploded perspective view of the writing instrument of the first embodiment;

10 Fig. 3 is a perspective view of the assembled parts shown in Fig. 2;

Fig. 7 is a cross-sectional view of a second embodiment;

15 Fig. 8 is a cross-sectional view of a third embodiment;

Fig. 9 is a fragmentary perspective view of a fourth embodiment;

Fig. 10 is a fragmentary perspective view of a fifth embodiment;

20 Fig. 11 is a fragmentary cross-sectional view of the fifth embodiment;

Figs. 12 and 13 are fragmentary cross-sectional views of a sixth embodiment, showing steps of operation;

25 Figs. 14, 15, 16 and 17 are fragmentary cross-sectional views of a seventh embodiment, showing steps

of operation;

Figs. 18, 19 and 20 are fragmentary cross-sectional views of eighth, ninth and tenth embodiments, respectively;

Figs. 21, 23 and 24 are fragmentary cross-sectional
5 views of an eleventh embodiment, showing steps of operation;

Fig. 22 is a fragmentary perspective view of the eleventh embodiment;

Fig. 25 is a fragmentary cross-sectional view of a twelfth embodiment;

10 Figs. 26 and 27 are fragmentary perspective views of the twelfth embodiment;

Figs. 28, 29, 30, 31 and 7A are fragmentary cross-sectional views of thirteenth, fourteenth, fifteenth, sixteenth and seventeenth embodiments;

15 Fig. 7B is a cross-sectional view of an eighteenth embodiment of the present invention;

Figs. 32, 34, 35 and 36 are cross-sectional views of a nineteenth embodiment;

20 Fig. 33 is a perspective view of a seal body used in the nineteenth embodiment;

Figs. 37 and 38 show a twentieth embodiment;

Figs. 39 and 40 show a twenty-first embodiment;

Figs. 41 and 42 show a twenty-second embodiment;

Fig. 43 shows a twenty-third embodiment;

25 Figs. 44, 49, 50 and 51 are cross-sectional views of

a writing instrument according to a 24th embodiment, the views showing steps of operation;

Fig. 45 is a fragmentary exploded perspective view of the writing instrument of the first embodiment;

5 Fig. 46 is a fragmentary perspective view of the writing instrument of the 24th embodiment;

Fig. 47 is a perspective view of the writing instrument as assembled of Fig. 45;

Fig. 48 is a cross-sectional view taken along line
10 XLVIII-XLVIII of Fig. 47;

Figs. 52, 53 and 54 are cross-sectional views of writing instruments according to 25th, 26th and 27th embodiments, respectively;

Fig. 55 is a perspective view of the 27th embodiment;

15 Fig. 56 is a fragmentary exploded perspective view of a 28th embodiment;

Fig. 57 is a fragmentary cross-sectional view of the 28th embodiment;

Figs. 58, 59, 60 and 61 are cross-sectional views
20 showing a 29th embodiment of the invention;

Fig. 61 shows a 30th embodiment;

Fig. 62 shows a 31st embodiment;

Figs. 63, 64, 65 and 66 show a 32nd embodiment of the invention;

25 Figs. 67 to 70 show a 33rd embodiment;

Figs. 71 to 73 show a 34th embodiment of the invention;
Figs. 74, 75 and 76 show 35th, 36th and 37th embodiments
of the invention; and
Figs. 77 and 78 show a 38th embodiment of the invention.

The present invention will now be described with reference to the drawings.

Fig. 1 shows in cross section a writing instrument according to a first embodiment of the present invention. A
5 cylindrical barrel or casing 1 has on a rear end thereof a pair of diametrically opposite legs 2, 2 extending radially inwardly toward an axial center of the barrel 1. The legs 2, 2 have inner ends formed integrally with an outer periphery of a cylinder 3 adjacent to a front end thereof.
10 The cylinder 3 has a rear end including a radially inwardly extending edge which provide a step 4. The cylinder 3 also has a cam wall 5 on an inner peripheral surface thereof, the cam wall 5 having axial groove and oblique locking edges at a front end thereof. The barrel 1, the legs 2, 2, and the
15 cylinder 3 are integrally molded, but may be separately molded and then assembled together as by adhesive bonding.

A cylindrical pusher rod 6 is fitted in the cylinder 3 and has a front end of a larger diameter engageable with the step 4 of the cylinder 3 to prevent the pusher rod
20 6 from being pulled rearwardly out of the cylinder 3. The larger front end of the pusher rod 6 has ridges fitted respectively in the axial grooves in the cam wall 5. The pusher rod 6 has an oblique front surface. The substantial portion of the pusher rod 6 normally projects rearwardly
25 through the rear opening in the cylinder 3. A rotary cam 7

is disposed in a front end portion of the pusher rod 6 and has on an outer periphery thereof ridges fitted respectively in the grooves in the cam wall 5. The rotary cam 7 has an oblique rear surface and a central hole. A rod 8 is positioned in front of the rotary cam 7 and has a rear end portion fitted in the central hole in the rotary cam 7. Thus, the rod 8 and the rotary cam 7 are coupled to each other. A bushing 9 is fitted in the cylinder 8 at a front end portion thereof. The rod 8, the rotary cam 7 and the pusher rod 6 are normally urged toward a rear position under the force of a spring S1 disposed between the bushing 9 and a rear flange of the rod 8.

A separate writing member 10 such as an ink cartridge is housed in the barrel 1. A connector 11 has a front larger-diameter cylindrical portion and a rear smaller-diameter cylindrical portion. The ink cartridge 10 has a rear end portion removably fitted in the front larger-diameter cylindrical portion of the connector 11, and a rear end portion fixedly fitted over a front end portion of the rod 8. Accordingly, the ink cartridge 10 is positioned in front of and coupled to the rod 8. The ink cartridge 10 has a front air vent hole 12 and a smaller-diameter front end portion 13 having a writing tip 14 on its front end. A packing 15 is attached to a front end

surface of the bushing 9 and has an outer peripheral edge dimensioned to be resiliently pressed against an inner peripheral surface of an inner cylindrical tube 16.

The inner cylindrical tube 16 is housed in the barrel
5 1 and accommodates therein the ink cartridge 10. The inner tube 16 has a rear end detachably fitted over the front end portion of the cylinder 3, and a smaller-diameter front end portion 17 having a distal opening 18. As shown in FIG. 2, the smaller-diameter front end portion 17 has a pair of
10 lugs 19, 19 with small apertures 20, 20 formed respectively therein. A substantially disk-shaped sealing body 21 is pivotably attached to the front end portion 17 and has a size large enough to close the opening 18. More specifically, the sealing body 21 has a rounded front
15 surface with a sealing member 22 attached to a rear surface thereof. The sealing body 21 has a pair of lugs 23, 23 having respective small apertures 24, 24. For assembly, a spring 25 is placed between the lugs 19, 19, and the lugs 19, 19 are sandwiched between the lugs 23, 23, followed by
20 insertion of a pin 26 through the small apertures 20, 20, 24, 24 and a hole in the spring 25. The sealing body 21 is now pivotably mounted on the distal end of the inner tube 16 as shown in FIG. 3. The sealing body 21 is normally

urged by a small force of the spring 25 in a direction to open away from the opening 18. The sealing body 21 can be angularly moved in against the force of the spring 25 into abutment against the inner tube 16, thereby closing and sealing the opening 18 in the inner tube 16. A spring or a magnet may be employed to normally bias the sealing body 21 to close and seal the opening 18 in the inner tube 16 as described later.

A cylindrical slidable tube 27 is also housed in the barrel 1 and fitted over the inner tube 16. The slidable tube 27 has a pair of diametrically opposite slits 28, 28 defined in a rear end portion thereof. For assembly, the slidable tube 27 is inserted in a rearward direction between the barrel 1 and the inner tube 16 until the rear end portion of the slidable tube 27 projects rearward through the rear opening of the barrel 1 with the legs 2, 2 disposed respectively in the slits 28, 28. A push cap 29 is then fitted over the rear end portion of the slidable tube 27 with a spring S2 placed between the legs 2, 2 and a bottom of the push cap 29. In the embodiment shown in Fig. 1, a small space is provided between the rear end of the pusher rod 6 and an inner bottom surface of the push cap 29. The spring S2 normally urges the slidable tube 27 in a rearward direction away from the barrel 1. Thereafter, a conical front cap 30 is threaded over a front end of the slidable tube

27. The writing instrument is thus assembled as illustrated in Fig. 1. The conical front cap 30 is tapered with a distal opening 31 defined in a front end thereof and has a conical inner surface 32.

5 FIG. 1 shows the writing instrument as placed in a sealed condition. More specifically, the slidable tube 27 is retracted under the bias of the spring S2 to enable the conical inner surface 32 in the conical front cap 30 to push the sealing body 21 backward until it closes and seals
10 the opening 18 in the inner tube 16. Where the sealing body 21 is normally biased by the spring or magnet to close the opening 18, the sealing body 21 may not necessarily be pushed backward by the conical inner surface 32. With the packing 15 providing a seal between the rear end portion of
15 the inner tube 16 and the rear end of the ink cartridge 10, the writing tip 14 and the air vent hole 12 of the ink cartridge 10 are sealed from the exterior. At this time, the pusher rod 6 is displaced rearward and the rotary cam 7 is in the rear position on the cam wall 5.

20 To actuate the writing instrument from the sealed condition into an unsealed condition in readiness for

writing, the push cap 29 is pushed to move the slidable tube 27 and hence the front conical cap 30 while compressing the spring S2 after the cap 29 is advanced by a short distance between the rear end of the pusher rod 6 and the bottom surface of the cap 29. As the front conical cap 30 moves forwardly, the sealing body 21 is angularly moved under the resiliency of the spring 25 to uncover the opening 18 in the inner tube 16. At the same time, depression of the push cap 29 causes the pusher rod 6, the rotary cam 7 and the rod 8 to move the ink cartridge 10 in a forward direction through the position shown in Fig. 4 to the position of Fig. 5, in which the small-diameter front end portion 13 of the ink cartridge 10 projects through the opening 18. At this time, the rotary cam 7 is positioned slightly ahead of the front edge of the cam wall 5 with the spring S1 kept under compression. When the push cap 29 is released in the position of Fig. 5, the slidable tube 27 is moved back under the force of the spring S2. At this time, the rotary cam 7 is also moved back as it slightly turns into engagement with the front edge of the cam wall 5, thus preventing the ink cartridge 10 from being moved back. The tip end portion of the ink cartridge 10 now remains projecting through the opening 31 in the conical front piece 30 as illustrated in Fig. 6. The writing instrument is now in the writing position.

25 For bringing the writing instrument from the

writing position back to the sealed position, the push cap 29 is pushed again in the position of Fig. 6. The push cap 29 is moved forward to cause the pusher rod 6 to move the rotary cam 7 slightly forward. When the push cap 29 is released at such time as the rotary cam 7 is slightly shifted off the front edge of the cam wall 5 as shown in Fig. 5, the rotary cam 7 is slightly turned and then moved back along the cam wall 5 under the force of the spring S1. The ink cartridge 10 is also moved back until the rear end thereof abuts against the packing 15 attached to the front end of the bushing 9. At this time, the ink cartridge 10 is bodily stored in the inner tube 16. Simultaneously, the slidable tube 27 returns under the force of the spring S2 and so does the conical front cap 30 with its conical inner surface 32 pushing the sealing body 21 into engagement with the distal end of the inner tube 16, thereby closing and sealing the opening 18. The writing instrument is now in the sealed condition.

A writing instrument according to a second embodiment will be described with reference to Fig. 7. According to the second embodiment shown in Fig. 7 in which the same reference numerals are used to designate the same components shown in Figs. 1 to 6, the slidable tube 27 and the ink cartridge 10 move forward at the same time in response to the push cap 29 being pushed. With the first embodiment,

the rear end of the pusher rod 6 is slightly spaced from the bottom of the push cap 29 in the sealed condition. When the push cap 29 is pushed, the slidable tube 27 is first moved forwardly, and after the push cap 29 hits the rear end of the pusher rod 6, the ink cartridge 10 is moved forwardly. The writing instrument of the second embodiment can operate in substantially the same manner as that of the writing instrument of the first embodiment. According to the first embodiment, the ink cartridge 10 can be positioned relatively forward of the ink cartridge 10 of the second embodiment by the distance equal to the spacing between the rear end of pusher rod 6 and the bottom of the push cap 29.

Fig. 8 illustrates a writing instrument according to a third embodiment of the invention. The push cap 29 has a central through hole 33. The pusher rod 6, which is longer than the pusher rods according to the first and second embodiments, projects rearward through the hole 33 in the push cap 29 in the sealed condition. In the sealed condition, the tip end of the ink cartridge 10 is spaced from the sealing member 22 by a distance greater than the length of the pusher rod 6 which projects rearward beyond the bottom of the push cap 29. For bringing the writing instrument from the sealed position to the writing position, the pusher rod 6 is pushed to move the ink cartridge 10 at first. After the rear end of the pusher rod 6 lies flush with the rear

end of the push cap 29, the pusher rod 6 and the push cap 29 are moved together to advance the ink cartridge 10 and the slidable tube 27 at the same time. The writing instrument of the third embodiment can thus operate in substantially the same manner as those of the writing instruments according to the first and second embodiments.

FIG. 9 illustrates a fourth embodiment of the present invention. A sealing body 21 is integrally molded with the distal end of the inner tube 16 through an integral hinge 34.

According to a fifth embodiment shown in FIGS. 10 and 11, a sealing body 21 and a ring 35 are integrally molded of a resilient material through an integral hinge 34, and the ring 35 is fitted over the smaller-diameter portion of the inner tube 16 and attached in position by a retaining ring 36 fitted over the ring 35.

FIGS. 12 and 13 show a writing instrument constructed according to a sixth embodiment of the present invention. With the sixth embodiment, a pair of sealing bodies 21 is hinged to the distal end of the inner tube 16 and can swing open away from each other.

According to a seventh embodiment illustrated in FIGS. 14 through 17, a spherical sealing body 21 is employed instead of the disk-shaped sealing body 21. The slidable tube 27 is tapered at its distal end and has an opening 37 defined in the tapered end, the tapered end having an inner inclined surface 38. Therefore, no conical

front piece 30 is mounted on the slidable tube 27. The sealing body 21 is slightly greater than the opening 37 in the slidable tube 27 and the opening 18 in the inner tube 16. In the sealed condition shown in FIG. 14, the sealing
5 body 21 is clamped between the opening 37 in the slidable tube 27 and the opening 18 in the inner tube 16 to thereby close the opening 18 for sealing the writing tip 14. When it is desired to unseal the writing tip 10, the push cap is pushed while the writing instrument is held
10 substantially horizontally or the tip end thereof is slightly raised. As the slidable tube 27 is advanced, the sealing body 21 drops out of engagement with the slidable tube 27 and the inner tube 16 and is brought off the opening 37 in the slidable tube 27 into the position of
15 FIG. 16. The push cap is then released to keep the writing instrument in the writing position shown in FIG. 16. For sealing the writing tip 14 again, the knock cap is depressed while the writing tip 14 is being directed downwardly. The slidable tube 27 now advances to allow the
20 sealing body 21 to close the opening 37 in the slidable tube 27 as shown in FIG. 17. Thereafter, the push cap is free to bring the writing instrument back into the sealed condition as illustrated in FIG. 14.

An eighth embodiment of the present invention will
25 now be described with reference to FIG. 18. The writing instrument of the eighth embodiment is a small modification of that of the seventh embodiment. A conical front cap 30

threaded over the slidable tube 27 and has a disk-shaped flange 39 secured therein for accommodating a spherical sealing body 21 in the conical front cap 30. This arrangement makes it difficult for the sealing body 21 to drop off when the conical front cap 30 is removed for the replacement of the ink cartridge 10.

FIG. 19 illustrates a writing instrument according to a ninth embodiment of the invention. In the first embodiment, the rear end portion of the ink cartridge 10 is sealed in the vicinity of the rear end thereof. According to the ninth embodiment, a seal ring 40 is retained by an inner peripheral surface of the inner tube 16 to seal a portion of the ink cartridge 10 behind the air vent hole 12. The air vent hole 12 in the ink cartridge 10 may be located anywhere forward of the seal ring 40 in the sealed condition shown in FIG. 19. The seal ring 40 may be mounted on an outer peripheral surface of the ink cartridge 10.

FIG. 20 illustrates a tenth embodiment of the present invention. While in the ninth embodiment the elongated inner tube 16 is employed, an inner tube 16 according to the tenth embodiment is comparatively short. The inner tube 16 has a pair of legs 41, 41 on an outer peripheral surface adjacent to a rear end thereof, the legs 41, 41 projecting outwardly through the slits 28, 28 in the slidable tube 27. The legs 41, 41 have outer ends fitted respectively in front grooves defined in an inner surface

of the barrel 1. A seal ring 40 is retained by an inner surface of the inner tube 16 in the vicinity of a rear end thereof. The seal ring 40 may be mounted on an outer periphery of the ink cartridge 10 in contact with an inner
5 periphery of the short inner tube 16.

An eleventh embodiment of the invention will be described with reference to FIGS. 21 through 24. As better shown in FIG. 22, a sealing body 21 according to the eleventh embodiment has a round portion 42 projecting
10 rearward and including a recess 43 defined in a rear surface thereof. The sealing body 21 has an outer periphery which can be held in intimate contact with the front edge of the inner tube 16. As illustrated in FIGS. 23 and 24, as the ink cartridge 10 advances, it fits in the
15 recess 43 and lifts the sealing body 21 while the inclined surface of the distal end portion of the ink cartridge 10 is in contact with shoulders of the recess 43. Where no spring is used to normally urge the sealing body 21 in an opening direction, or the seal body 21 is normally urged to
20 close the opening 18 in the inner tube 16, the writing tip 14 is protected from direct contact with the sealing body 21 when the inclined surface of the distal end portion of the ink cartridge 10 pushes the sealing body 21 aside. Therefore, there is no tendency of the sealing body 21 to
25 get smeared with ink from the writing tip 14 or the writing tip 14 to be damaged from contact with the sealing body 21.

FIGS. 25 through 27 are illustrative of a twelfth

embodiment of the present invention. A sealing body 21 according to the twelfth embodiment has a flat and straight recess 43 formed in a rear surface thereof, as better shown in FIG. 26. As illustrated in FIG. 27, the distal end of
5 the inner tube 16 has a projection 44 sized to snugly fit in the recess 43. The operation and advantages of the writing instrument according to the twelfth embodiment can readily be understood from the description of eleventh embodiment and FIG. 25.

10 A thirteenth embodiment of the invention will be described with reference to FIG. 28. In the first embodiment, the conical front cap 30 is held against the sealing body 21 which is in contact with the ink cartridge 10 in the writing condition. Thus, the slidable tube 27 is
15 prevented from moving back by the ink cartridge 10 through the sealing body 21. With the thirteenth embodiment, the opening 31 of the conical front cap 30 has an inner edge held against a step 45 on the smaller-diameter portion 13 of the ink cartridge 10, so that the slidable tube 27 is
20 prevented from moving back directly by the ink cartridge 10.

FIG. 29 shows a writing instrument according to a
fourteenth embodiment of the present invention. In the second embodiment, the spring S2 for urging the slidable
25 tube 27 rearward can be seen through the slits 28, 28 in the slidable tube 27. According to the fourteenth embodiment, however, the spring S2 is accommodated within

the pusher rod 6 and cannot be seen from the exterior.

According to a fifteenth embodiment illustrated in FIG. 30, a pusher rod 6 and a push cap 29 are integrally molded. The cam wall 5 of the cylinder 3 extends to the rear end thereof so that the rotary cam 7 can be inserted into the cylinder 3 from the rear end thereof at the time of assembly.

A sixteenth embodiment of the invention will be described with reference to FIG. 31. A push cap 29 is elongated to the extent that it entirely conceals the slits 28, 28 in the slidable tube 27.

FIG. 7A shows a writing instrument according to a seventeenth embodiment of the present invention. The spring S1 for urging the ink cartridge 10 backward is disposed between a step of the inner tube 16 near its front end and a step of the ink cartridge 10 near its front end. The ink cartridge 10 has in its rear end a recess in which there is fitted an attachment 46 fitted over the front end of the rod 8. Thus, the ink cartridge 10 is removably attached by the attachment 46 to the front end of the rod 8.

FIG. 7B illustrated a writing instrument according to an eighteenth embodiment of the present invention. The slidable tube 27 has long slits 28, 28 extending from the front end thereof so that the slidable tube 27 is inserted into the barrel 1 from the rear end thereof at the time of assembly. A ring 47 is fitted in the front end of the

slidable tube 27 to reinforce the latter. The ring 47 may be fitted in the conical front cap 30 to provide reinforcement against radially inward bending of the slidable tube 27.

Although various embodiments of the present invention
5 have been illustrated, the present invention is not limited to the foregoing embodiments only. For example, the invention is applicable to rotary type writing instruments. While the ink cartridge 10 can be locked in the advanced position or moved back to the retracted position by the cam mechanism
10 disposed between the barrel 1 and the ink cartridge 10, the ink cartridge 10 may similarly be actuated by a screw-driven feed mechanism. In the first and other embodiments, the rear seal is provided by the packing 15. However, bushing 9 may be constructed of a resilient material to provide a desired seal
15 rather than using the packing 15. In the first and other embodiments, furthermore, the seal member 22 is attached to the rear surface of the sealing body 21. However, the sealing body 21 itself may be made of a resilient material so that the seal member 22 may be dispensed with. Instead
20 of employing the seal member 22, a seal ring or the like made of a resilient material may be attached to the distal end of the inner tube 16, or the inner tube 16 itself may be formed of a resilient material. Where the sealing body

21 is spherical in shape, it may be made of a resilient material. Where the distal end of the slidable tube 27 is rendered transparent, it allows visual inspection of movements of the internal mechanism.

5 With the writing instrument of the invention, as described above, the slidable tube 27 and the ink cartridge 10 should be moved forward to bring the writing instrument from the sealed condition into the writing condition. When the slidable tube 27 is moved forward, the sealing body 21
10 that has closed the opening 18 in the inner tube 16 is no longer pressed and the ink cartridge 10 is advanced until the writing tip 14 projected out of the opening 18 in the inner tube 16. When the slidable tube 27 is thereafter retracted, the writing tip 14 projects through the distal
15 end of the slidable tube 27, whereupon the writing instrument is in the writing condition. When the ink cartridge 10 is unlocked from the advanced position, the ink cartridge 10 is moved back into the inner tube 16, and the inner surface of the front end of the slidable tube 27
20 as it returns presses the sealing body 21 into the opening 18 in the inner tube 16, thus closing and sealing the opening 18. Since there is a seal means for providing a seal between the ink cartridge 10 and the inner tube 16 behind the opening 18, the writing tip 14 and the air vent
25 hole 12 are both sealed at the same time. The writing instrument can be brought from the writing condition to the sealed condition or vice versa simply by advancing and

retracting the slidable tube 27 and the ink cartridge 10. Therefore, the entire operation is quite simple. The seal in the sealed condition is provided between the position of the opening 18 in the inner tube 16 and the

5 intermediate or rear position of the ink cartridge 10.

This makes it possible to utilize commercially available ink cartridges 10 or small modifications thereof. When the ink cartridge 10 runs short of ink, it can simply be replaced with a new one.

10 The foregoing embodiments have various advantages but has some disadvantages. That is, as clearly shown in Fig. 1, there is always an annular concave step between the front end of the barrel 1 and the rear end of the conical member 1, which would adversely affect the aesthetic design of the
15 writing instrument and would degrade its writing feeling because the writer's fingers would contact with the annular concave step. The following embodiments remedy this disadvantage and more over provides a floating type writing instrument in which the writing tip may be slightly retracted in a
20 writing state when an excessive writing pressure is applied thereto. The embodiments will now be described in detail.

Fig. 32 is a cross-sectional view of a writing instrument according to a nineteenth embodiment of the present invention. The writing instrument comprises a cylindrical
25 barrel or casing 101 having a pair of axial slits 102, 102 formed in a rear end portion thereof in diametrically opposite

relation. A slidable tube 103 is fitted in the barrel 101 for back-and-force sliding movement therein. The slidable tube 103 also has a pair of axial slits 104, 104 formed in a rear end portion in diametrically opposite relation. A
5 conical front cap 105 is threaded over a front end of the slidable tube 103. The conical front cap 105 is tapered at its front end with an opening 106 defined in a distal end thereof, and has an inner inclined surface 107.

An inner tube 108 is fitted in the conical front cap
10 105 and the slidable tube for back-and-forth sliding movement therein. The inner tube 108 has a smaller-diameter front end portion 109 including an intermediate step and an opening 110 defined in a distal end thereof. A separate sealing body 111 as shown in Fig. 33 is made of a resilient material such
15 for example as rubber. The sealing body 111 includes a ring-shaped attachment 112 and an L-shaped tongue 113 extending therefrom, the L-shaped tongue 113 having a seal member 114 at a distal end thereof. The seal member 114 has a semi-spherical upper surface and a flat lower surface. For
20 attachment, the attachment 112 is fitted onto the small-diameter portion 109 of the inner tube 108 and held against the step on the small-diameter portion 109. The attachment 112 may be bonded or simply left fitted over the small-diameter portion 109.

25 A writing member 115 such as an ink cartridge is fitted

in the inner tube 108. The ink cartridge 115 has a front air vent hole 116 and includes a front smaller-diameter portion 117 having a writing tip 118 on a distal end thereof. Some writing instruments, however, do not require such an
5 air vent hole 116. A separate connector 119 is composed of a front larger-diameter cylindrical portion and a rear smaller-diameter cylindrical portion. A rear end portion of the ink cartridge 115 is removably fitted in the front larger-diameter cylindrical portion. The rear smaller-
10 diameter cylindrical portion is fitted over a front end portion of a rod 120. Thus, the rod 120 is connected to the rear end of the ink cartridge 115.

A cylinder 121 is fitted in a rear end of the inner tube 108, and has a rear end including a radially inward
15 edge which provide a step 122. The cylinder 121 has an inner peripheral surface serving as a cam wall 123 having axial grooves and a front inclined locking edge. The cylinder 121 also has a pair of diametrically opposite legs 124, 124 projecting radially outwardly and fitted in the
20 slits 104, 104 in the slidable tube 103 and the slits 102, 102 in the barrel 101.

A bushing 125 is fitted in the rear end of the inner tube 108 and the front end of the cylinder 121, with a seal ring 126 interposed between the bushing 125 and the
25 cylinder 121. Another seal ring 127 is bonded to a front

surface of the bushing 125,

A spring S1 is disposed between a step formed on an inner surface of the bushing 125 and a step formed on an outer peripheral surface of the rod 120 near its rear end, and normally biases the rod 120 and the ink cartridge 115 to move in the rearward direction. A rotary cam 128 has a central hole in which there is fitted a smaller-diameter rear end portion of the rod 120. The rotary cam 128 is fitted in the cam surface 123 of the cylinder 121. The rotary cam 128 has on its outer periphery ridges fitted respectively in grooves in the cam wall 123. The rotary cam 128 has a rear inclined surface.

A pusher rod 129 is disposed behind the rotary cam 128. The pusher rod 129 is tubular in shape with a rear end portion of the rotary cam 128 fitted in a front end portion of the pusher rod 129. The front end portion of the pusher rod 129 has a larger front end engageable with the step 122 of the cylinder 121 to prevent the pusher rod 129 from being pulled rearward out of the cylinder 121. The larger front end of the pusher rod 129 has ridges fitted respectively in the grooves in the cam wall 123. The pusher rod 129 has a front inclined surface. The substantial portion of the pusher rod 129 projects rearward out of a rear opening in the cylinder 121.

A bearing ring 130 is fitted over the rear end of

the slidable tube 103. A spring S 2 is interposed between the legs 124, 124 of the cylinder 121 and the bearing ring 130, and a spring S3 is interposed between the rear end of the barrel 101 and the bearing ring 130. The bearing ring 130 has a central circular hole which is internally threaded. A cap 131 is fitted over the bearing ring 130 and the rear end portion of the barrel 101. For assembly, an attachment ring 133 of a clip 132 is held against a rear surface of the cap 131, and then an externally threaded central projection of a disk-shaped push member 134 is threaded into the internally threaded hole in the bearing ring 130 through central holes in the attachment ring 133 and the cap 131. The cap 131 and the clip 132 are now attached to the bearing ring 130.

Fig. 32 shows the writing instrument in a sealed condition. Since the slidable tube 103 and the conical front cap 105 are urged to move rearward under the force of the spring S2 acting between the legs 124, 124 and the bearing ring 130, the semispherical upper surface of the seal member 114 of the sealing body 111 with its attachment 112 mounted on the smaller-diameter portion 109 of the inner tube 108 is pressed by the inner inclined surface 107 of the conical front cap 105, thus preventing the conical front cap 105 and the slidable tube 103 from being retracted. The opening 110 in the inner tube 108 is completely sealed by the seal member 114. At this time, the barrel 101 is urged forward

under the force from the spring S3 acting between the rear end of the barrel 101 and the bearing ring 130, so that the front end of the barrel 101 is kept in intimate contact with the rear end of the spring S3 is much weaker than the force of the spring S2. The spring S3 may be dispensed with.

In the rear portion of the writing instrument, the seal ring 127 bonded to the front surface of the bushing 125 provides a seal between the latter and the connector 119 attached to the rear end of the ink cartridge 115, and the seal ring 126 provides a seal between the bushing 125 and the cylinder 121. accordingly, the ink cartridge 115 is completely sealed. In the sealed position, the pusher rod 129 is retracted back, and the rotary cam 128 is also retracted back in the cam wall 123.

To bring the writing instrument from the sealed condition into a writing condition, the barrel 101 is gripped and the push member 134 is pushed. When the push member 134 is pushed, the slidable tube 103 and the conical front cap 105 are slightly moved forward while compressing the springs S2, S3. After the front surface of the push member 134 hits the rear end of the pusher rod 129, the push member 134 causes the pusher rod 129, the rotary cam 128, the rod 120 and the connector 119 to advance the ink cartridge 115. The inner tube 108 is slightly advanced under the force of the spring S2 acting on the legs 124, 124, and then

is prevented from moving forward after the legs 124, 124 have reached front edges of the slits 102, 102 in the barrel 101. As the conical front cap 105, the slidable tube 103 and the ink cartridge 115 move further forward, the front end
5 of the inner surface of the conical front cap 105 is spaced from the front end of the inner tube 108. At this time, the sealing body 111 springs forward under its own resiliency to open the opening 110 in the smaller-diameter portion 109 of the inner tube 108 as shown in Fig. 34. As the push member
10 134 is continuously pushed, the smaller-diameter portion 110 of the ink cartridge 115 projects through the opening 110 in the inner tube 108 as illustrated in Fig. 35. During movement from the position of Fig. 32 to the position of Fig. 35 through the position of Fig. 34, the writing tip 118
15 of the ink cartridge 115 does not contact the seal member 111. In the position of Fig. 35, the rotary cam 128 is positioned slightly forward of the front edge of the cam wall 123 while keeping the spring S1 under compression. When the push member 134 is released of a push, the conical front cap 105
20 and the slidable tube 103 are retracted under the bias of the spring S2. The ink cartridge 115 is prevented from moving back when the rotary cam 128 is pushed back by the spring S2 and slightly turned to engage the front edge of the cam wall 123. Therefore, the distal end portion of the ink cartridge
25 115, including the writing tip 118, remains projecting out

of the opening 106 of the conical front cap 105. The writing instrument is now in the writing position as shown in Fig. 36. At this time, the inner surface of the front end portion of the conical front cap 105 is kept in abutment
5 against the front end of the inner tube 108, so that the conical front cap 105 and the slidable tube 103 are prevented from being retracted. There is no gap between the conical front cap 105 and the barrel 101 under the force of the spring S3 as in the condition shown in Fig. 32. The writing
10 instrument is now in readiness for writing operation.

In the writing condition, writing pressure acting on the ink cartridge 115 is borne by the spring S2 through the rod 120, the rotary cam 128, the pusher rod 129, the cylinder 121. Since any excessive writing force imposed on the ink
15 cartridge 115 is taken up by the spring S2, the writing tip 118 is prevented from being damaged due to such an excessive writing force.

To bring the writing instrument from the writing condition back into the sealed condition, the push member
20 134 is pushed in the position of Fig. 36. The push member 134 is advanced to hit the pusher rod 129 and move the rotary cam 128 slightly forward. When the rotary cam 128 is advanced slightly off the front edge of the cam wall 123 as shown in Fig. 35, the push member 134 is released. Then,
25 the rotary cam 128 is slightly turned and thereafter retracted

along the cam wall 123 under the force of the spring S1. The ink cartridge 115 is also retracted until the rear end of the connector 119 abuts against the seal ring 127 in front of the bushing 125. By this time, the ink cartridge 115 is
5 stored in the inner tube 108. The conical front cap 105 and the slidable tube 103 are also retracted under the force of the spring S2. As the conical front cap 105 moves back, the seal member 114 of the sealing body 111 is progressively moved toward the opening 106 in the conical front cap 105
10 while the semicylindrical upper surface of the seal member 114 is slid along the inner inclined surface 107 of the conical front cap 105, until the seal member 114 is eventually positioned behind the opening 106. Continued retraction of the conical front cap 105 causes the inner surface thereof
15 to press the seal member 114 against the distal end of the inner tube 108, thus closing the opening 110 in the inner tube 108. The writing instrument is now brought back to the sealed condition as shown in Fig. 32.

The rear end of the conical front cap 105 and
20 the front end of the barrel 101 are normally kept in close contact with each other with no gap left therebetween under the force of the spring S3. This is to prevent an unsightly appearance which would otherwise be occasioned by such a gap, and prevent the barrel 1 from wobbling back and forth.

25 Fig. 37 shows a twentieth embodiment of the invention.

In this embodiment, a cylindrical attachment 112 is made of elastic material and is to be press-fitted in the smaller diameter portion of the inner tube 108, so that the attachment 112 may be held on the outer periphery of the inner tube 108
5 without adhesives.

A twenty-first embodiment of the invention will now be described with reference to Figs. 39 and 40. In this embodiment, a cylindrical member 135 made of elastic material is inserted into the smaller-diameter portion 109 of the
10 inner tube 108 as shown in Fig. 39. The cylindrical member 135 has at its front end a radially outwardly extending flange 136 which is to be positioned at the front end of the smaller-diameter portion 109. With such an arrangement, it is possible to satisfactorily seal the interior of the
15 inner tube 108 even if the seal member 114 of the sealing body . 111 is not made of elastic material.

A twenty-second embodiment of the invention will now be described with reference to Figs. 41 and 42 in which the cylindrical member 135 is fitted to around the outer
20 periphery of the inner tube 108 and has at its front end a radially inwardly extending flange 137 which is to be positioned at the front end of the smaller diameter portion 109. With such a construction, substantially the same effect as in the twenty-first embodiment may be obtained.

25 A twenty-third embodiment of the invention will now

be described with reference to Fig. 43. In the nineteenth embodiment, there is a fear that it would be somewhat difficult to insert the legs 124, 124 of the cylinder 121 into the slits 102, 102 of the barrel 101. In the twenty-third embodiment, 5 the slits 102, 102 are formed in a curvilinear shape as shown in Fig. 43, so that in assembling, an additional work in which the barrel 101 and the cylinder 121 are rotated relative to each other is carried out. With such a construction, the barrel 101 may be prevented from being pulled apart from the 10 mechanism.

Fig. 44 is a cross-sectional view illustrative of a writing instrument according to another embodiment (24th) of the present invention. The writing instrument comprises a cylindrical front barrel 201 including a smaller-diameter 15 front end portion 202 having a front opening 203. As shown in Fig. 45, the smaller-diameter front end portion 202 has a pair of lugs 204, 204 having small apertures 205, 205, respectively. A substantially disk-shaped sealing body 206 is sized to close the opening 203 in the front barrel 201. 20 The sealing body 206 has a curved front surface with one groove 207 defined therein. The sealing body 206 also has a pair of lugs 208, 208 having respective small apertures 209, 209. As better illustrated in Fig. 46, in which the sealing body 206 is seen from the rear side, a seal ring 210 25 is attached to a rear peripheral edge of the sealing body

206. The seal ring 210 is dimensioned so as to be equal in shape to a front edge of the smaller-diameter portion 202 of the front barrel 201. The sealing body 206 has on a rear surface thereof a substantially disk-shaped projection 211 with a central recess 212 formed therein.

A spring 213 in the form of a single wire has a front portion curved in the shape of a C and a rear coil portion. For assembly, the lugs 204, 204 on the smaller-diameter portion 202 are sandwiched between the lugs 208, 208 on the sealing body 206, and the sealing body 206 is held against the front end of the smaller-diameter portion 202. The C-shape front portion of the spring 213 is fitted into the groove 207 in the sealing body 206 while the coil portion of the spring 213 is positioned between the lugs 204 204. Thereafter, a pin 214 is inserted through the small apertures 205, 205, 209, 209 in the lugs 204, 204, 209, 209 and the coil portion of the spring 213. The sealing body 206 is thus attached to the front barrel 201 as shown in Fig. 47. As shown in Fig. 48, the sealing body 206 is normally urged by the spring 213 toward the smaller-diameter portion 212 so that the seal ring 210 is held against the front edge of the smaller-diameter portion 202, enabling the sealing body 206 to close and seal the opening 203 in the smaller-diameter portion 202.

A conical front cap 215 having a tapered front end is fitted over a front end portion of the front barrel 201.

The front end of the conical front cap 215 has an opening 216. The conical front cap 215 has a space therein for allowing the sealing body 206 mounted on the front end of the front barrel 201 to swing forward.

5 A spring S1 is disposed in the front barrel 201 at its front end portion, and a writing member 217 such as an ink cartridge is inserted in the spring S1 from a rear end thereof. The spring S1 is interposed between a step formed in the front end of the front barrel 201 and a step formed on an outer
10 periphery of the ink cartridge 217 at a front end portion thereof. The ink cartridge 217 has a front air vent hole 218 and includes a small-diameter front end portion 219 having a writing tip 220 at a distal end thereof.

 A rear barrel 221 has a rear end including radially
15 inward edge which provides a step 222, the rear end having an opening 223 extending behind the step 222. The rear barrel 221 has a cam wall 224 on an inner periphery in a rear end portion thereof. The cam wall 224 has axial grooves and a front inclined locking edge.

20 A push rod 225 is fitted in the rear barrel 221 and has a larger-diameter front end portion engageable with a step 222 of the rear barrel 221 to prevent the push rod 225 from being pulled rearward out of the rear barrel 221. The larger-diameter front end portion of the push rod 225 has
25 ridges fitted respectively in the axial grooves in the cam

wall 224. The front end of the knock rod 225 has an inclined edge. The push rod 225 includes a rear end portion projecting rearward through a rear opening 223 in the rear barrel 221.

A seal ring 226 is bonded to a rear surface of the larger-
5 diameter front end portion of the push rod 225. A rotary cam 227 is positioned in front of the push rod 225 and has on an outer periphery ridges fitted respectively in the axial grooves in the cam wall 224. The rotary cam 227 has a rear inclined surface and a central rear smaller-diameter portion
10 228 extending rearward and fitted in the push rod 225.

For assembly, the push rod 225 and then the rotary cam 227 are inserted into the rear barrel 221 from the front end thereof. Thereafter, a cylindrical spacer 229 is fitted in a front end portion of the rear barrel 221, and a seal
15 ring 230 is fitted in the rear barrel 221 in front of the spacer 229. Then, the front end of the rear barrel 221 is threaded over the rear end of the front barrel 201 to interconnect the front and rear barrels 201, 221. The writing instrument is thus assembled as shown in Fig. 44. As
20 assembled, the seal ring 230 is sandwiched under compression between the rear end of the front barrel 201 and the front end of the spacer 229 to provide a seal between the front and rear barrels 201, 221. The ink cartridge 217 is retracted under the force of the spring S1 and fully stored in the
25 front and rear barrels 201, 221. The rotary cam 227 is

also pushed back by the ink cartridge 217 along the cam wall 224 of the rear barrel 221. The push rod 225 is also pushed back by the rotary cam 227 along the cam wall 224 and kept in position against further retraction by the seal ring 226 held against the step 222 of the rear barrel 221. At this time, the substantial portion of the push rod 225 projects rearward out of a rear opening 223 in the rear barrel 221.

Fig. 44 shows the ink cartridge 217 in a sealed condition. The opening 203 in the front barrel 201 is sealed by the seal ring 210 pressed against the front end of the smaller-diameter portion 202 by the sealing body 206 under the resiliency of the spring 213. The connected ends of the front and rear barrels 201, 221 are sealed by the seal ring 230. The rear opening 223 in the rear barrel 221 is sealed by the seal ring 226 attached to the push rod 225 and pressed against the step 222 of the rear barrel 221. Therefore, the ink cartridge 217 is completely sealed from the exterior.

For bringing the writing instrument from the sealed condition into a writing condition, the push rod 225 is pushed. When the push rod 225 is pushed, the ink cartridge 217 is moved forward while compressing the spring S1. As the ink cartridge 217 advances, the writing tip 220 on the front end of the ink cartridge 217 is fitted in the recess 212 in the sealing body 206 and a front inclined surface of

the ink cartridge 217 abuts against shoulders of the recess 212. Consequently, the writing tip 220 is prevented from contacting the sealing body 206. As shown in Fig. 49, the writing tip 220 advances while pushing the sealing body 206
5 aside until the smaller-diameter portion 219 of the ink cartridge 217 projects through the front opening in the conical front cap 215 as illustrated in Fig. 50. At this time, the rotary cam 227 is moved forwardly to a position slightly ahead of the front edge of the cam wall 224 and
10 slightly turned along the front inclined surface of the push rod 225. When the push rod 225 is then released, the ink cartridge 217 and the rotary cam 227 are slightly retracted under the force of the spring S1. However, the rotary cam 227 is engaged by the front edge of the cam wall
15 224 against further retraction, and the ink cartridge 217 is also prevented by the rotary cam 227 from being moved back. The writing instrument is now in the writing position as shown in Fig. 51 in readiness for writing operation.

To bring the writing instrument from the writing
20 condition back to the sealed condition, the push rod 225 is pushed in the position shown in Fig. 51. As the push rod 225 is advanced, the rotary cam 227 is also moved forwardly. When the rotary cam 227 is shifted to the position slightly off the front edge of the cam wall 224 as

shown in Fig. 50, the push rod 225 is released of a push. Then, the rotary cam 227 is slightly turned and thereafter retracted along the cam wall 224 by the ink cartridge 217 as it is pushed back under the force of the spring S1. The
5 ink cartridge 217 is also retracted until the seal ring 226 attached to the push rod 225 abuts against the step 222 of the rear barrel 221. At this time, the ink cartridge 217 is bodily stored in the front and rear barrels 201, 221, and the opening 203 in the front barrel 201 is closed by the
10 sealing body 206. The writing instrument is now sealed as illustrated in Fig. 44. During movement from the position of Fig. 50 to the position of Fig. 44 via the position of Fig. 49, the ink cartridge 217 is retracted while its front inclined surface is being kept in contact with the shoulders
15 of the recess 212, so that the writing tip 220 is prevented from touching the sealing body 206.

A writing instrument according to another embodiment (25th) will be described with reference to Fig. 52. A front barrel 201 is much shorter than that of the first embodiment.
20 A seal ring 231 is retained by an inner periphery of the front barrel 201 near its rear end for providing a seal between the outer periphery of the ink cartridge 217 and the inner periphery of the front barrel 201. Accordingly, the writing tip 220 and the air vent hole 218 are sealed by both
25 the sealing body 206 at the opening 208 in the front barrel

201 and the seal ring 231.

With the embodiment, a spring S1 for normally urging the ink cartridge 217 backward is positioned in a rear portion of a rear barrel 221. A rotary cam 227 has a central hole in which there is fitted a rear end portion of a rod 232 located forward of the rotary cam 227. A connector 233 is composed of a front larger-diameter cylindrical portion and a rear smaller-diameter cylindrical portion. A rear end portion of the ink cartridge 217 is fitted in the front larger-diameter cylindrical portion of the connector 233 with its rear smaller-diameter cylindrical portion fitted over a front end portion of the rod 232. Thus, the ink cartridge 217 is coupled to the rod 232 in front thereof. The ink cartridge 217 is removably fitted in the connector 233. A bushing 234 is fitted in the rear end portion of the rear barrel 221. A spring S1 is interposed between the bushing 234 and a radially outward flange of the rod 232 for enabling the rod 232 to bias the ink cartridge 217, the rotary cam 227 and the push rod 225 backwardly.

Fig. 53 illustrates a writing instrument according to another embodiment (26th) of the present invention. In this embodiment, no conical front cap 215 is employed, but a front barrel 201 has a tapered front end having an opening 216 therein. An inner tube 235 having substantially the same length as that of the front barrel 201 is inserted into

the front barrel 201 from a rear end thereof. The inner tube 2 has a front smaller-diameter portion 236 with a sealing body 206 pivotably mounted thereon at a front end thereof. A cylindrical connector 233 is integral with a front end of a rotary cam 227, and the ink cartridge 217 has a rear end removably fitted in the connector 233. A spring S1 is disposed between a rear end of the inner tube 235 and a front end of the connector 233 for normally biasing the ink cartridge 217 backward. A seal ring 230 is bonded to an inner periphery of a rear barrel 221 near its front end. When the front and rear barrels 201, 221 are interconnected through threaded engagement, the seal ring 230 is held against the rear end of the front barrel 201 to seal the connected portions of the front and rear barrels 201, 221.

Another embodiment (27th) of the present invention will be described with reference to Figs. 54 and 55. As shown in Fig. 55, a pair of sealing bodies 206 which can swing open away from each other is pivotably mounted on a front end of a front barrel 201. A rod 232 is interposed between an ink cartridge 217 and a rotary cam 227, the rod 232 being not coupled to the ink cartridge 217. A bushing 234 is fitted in a front end portion of a rear barrel 221. A spring S1 for normally urging the ink cartridge 217 rearward is interposed between a step of the front barrel 201 near its front end and a step of the ink cartridge 217 near

its front end. A spring S2 for normally biasing the rotary cam 227 and the push rod 225 backward is interposed between a bottom of the bushing 234 and a radially outward flange of the rod 232. A packing 237 is bonded to a front surface
5 of the bushing 234 for providing a rear seal for the ink cartridge 217 and a seal between the connected portions of the front and rear barrels 201, 221.

Another embodiment (28th) of the invention will be described with reference to Figs. 56 and 57. As shown in
10 Fig. 56, a sealing body 206 has a flat rear surface having a straight recess 212. The front end of the front barrel 201 has a projection 238 sized to neatly fit in the recess 212. A separate leaf spring 239 has a rear arcuate attachment 240. For assembly, as shown in Fig. 57, the leaf spring 239 is
15 bonded to a front surface of the sealing body 206 and the attachment 240 is fitted over the smaller-diameter portion 202 of the front barrel 201. Thereafter, an attachment ring 241 is fitted over the attachment 240 to mount the sealing body 206 so that it closes the opening 203 in the smaller-
20 diameter portion 202. As the sealing body 206 is attached in position, the projection 238 of the smaller-diameter portion 202 is neatly fitted in the recess 212 in the sealing body 206.

Fig. 58 is a cross-sectional view of a writing

instrument according to another embodiment (29th) of the present invention. The writing instrument includes a front barrel 301 having axial grooves defined in a cam wall 302 or an inner periphery of the front barrel 301 in the vicinity 5 of a central portion thereof, the cam wall 302 having a front inclined locking edge.

A slidable tube 303 is fitted in the front barrel 301 and has three axial slits 304, 304, 304 extending from a rear end thereof and angularly spaced at equal intervals. The 10 slidable tube 303 has a tapered front end having a through hole 305 in its distal end.

A seal tube 306 is fitted in a front portion of the slidable tube 303. The seal tube 306 has three legs 307, 307, 307 angularly spaced at equal intervals and extending 15 radially outwardly from a rear end of the seal tube 306. The three legs. 307, 307, 307 project respectively through the slits 304, 304, 304 in the slidable tube 303 radially outwardly of the slidable tube 303. A seal ring 308 is retained in an inner periphery of the seal tube 306 near 20 a rear end thereof. The seal tube 306 includes a smaller-diameter front end portion 309 having an opening 310 in a distal end thereof.

A sealing body 13 spring biased in its opening direction as described before is attached to the seal tube 25 306 in the vicinity of the distal end thereof.

A rotary cam 319 is fitted over the slidable tube 303 behind the legs 307, 307, 307 of the seal tube 306. The rotary cam 319 has axial ridges projecting on an outer periphery thereof and fitted respectively in the axial grooves in the cam wall 302. The rotary cam 319 has a rear inclined edge. A cam ring 320 is fixedly fitted over the slidable tube 30 rearward of the rotary cam 319. The cam ring 320 has ridges projecting on an outer periphery thereof and fitted respectively in the grooves in the cam wall 302. The cam ring 320 also has a front inclined edge. A spring S1 is disposed between the legs 307, 307, 307 of the seal tube 306 and a ring 321 threaded into a front end of the front barrel 301.

A writing member 322 such as an ink cartridge is stored in the seal tube 306 and the slidable tube 303. The ink cartridge 322 can be inserted from a rear end of the front barrel 301. As the ink cartridge 322 is inserted, the seal ring 308 fitted in the seal tube 306 is held in intimate contact with an outer periphery of the ink cartridge 322 to seal the space between the seal tube 306 and the ink cartridge 322. The ink cartridge 322 has a front air vent hole 323 and a smaller-diameter front end portion 324 with a writing tip 325 on its front end. A recess 326 is formed in a rear end of the ink cartridge 322.

A separate connector 327 has a front cylindrical

projection 328 fitted in the recess 326 of the ink cartridge 322. The connector 327 has three angularly equidistant legs 329, 329, 329 projecting on an outer periphery thereof and extending radially outwardly through the slits 304, 304, 5 304 respectively, in the slidable tube 303.

For assembly, a reinforcement ring 330 is fitted in the rear end of the slidable tube 303 and then a spring S2 is disposed between the connector 327 and a bottom of a push member 331, while at the same time a front end portion of 10 the push member 331 is threaded over a rear end portion of the slidable tube 303. Then, the legs 329, 329, 329 of the connector 327 are held against a rear end surface of the front barrel 301, and a rear barrel 332 is fitted over the push member 331 from behind. A front end portion of the rear 15 barrel 332 is threaded over a rear end portion of the front barrel 301. The legs 329, 329, 329 of the connector 327 are now fixedly clamped between the rear end surface of the front barrel 301 and a step formed on an inner periphery of the rear barrel 332 near the front end thereof. Thus, the 20 rear barrel 332 is coupled to the front barrel 301 at the rear end thereof. The writing instrument is thus assembled as shown in Fig. 58. At this time, the push member 331 is urged by the spring S2 to move backwardly and project rearward through a rear opening 333 in the rear barrel 332.

Fig. 58 shows the writing instrument in a sealed condition. The rotary cam 319 as in an advanced position with the spring S1 under compression and bears the legs 307, 307, 307 of the seal tube 306 to maintain the latter in an advanced position. At this time, the slidable tube 303 is urged backward under the force of the spring S2 to enable an inner surface of the slidable tube 303 at the front end thereof to push the sealing body 313 backwardly. The seal member 314 attached to the sealing body 313 closes and securely seals the opening 310 in the seal tube 306. The seal ring 308 provides a seal between the rear end of the seal tube 306 and the outer periphery of the ink cartridge 322. Accordingly, the air vent hole 323 and the ink cartridge 325 which are positioned forward of the seal ring 308 are sealed.

To bring the writing instrument from the sealed condition to a writing condition, the push member 331 is pushed, whereupon the slidable tube 303 is advanced while compressing the spring S2. As the slidable tube 303 is moved forwardly, the sealing body 313 is released and swings forward under the resiliency of the spring 317, thereby opening the opening 310 in the seal tube 306 as shown in Fig. 59.

On advancing movement of the slidable tube 303, the cam ring 320 attached to the slidable tube 303 also advances to push the rotary cam 319. The rotary cam 319 pushes the legs 307, 307, 307 to move the seal tube 306 forward while compressing

the spring S1 until the rotary cam 319 is positioned slightly ahead of the front edge of the cam wall 302 as shown in Fig. 60. At this time, the rotary cam 319 is slightly turned along the front inclined edge of the cam ring 320.

5 When the push member 331 is released of a push, the slidable tube 303 is retracted under the bias of the spring S2, and the cam ring S2 is also pushed back along the cam wall 302. The rotary cam 319 is also retracted along the cam wall 302 together with the seal tube 306 by being pushed by the legs
10 307 under the force of the spring S1, until the tip end of the ink cartridge 322 projects through the hole 305 in the slidable tube 303 as shown in Fig. 61. The writing instrument is now ready for writing operation.

To bring the writing instrument from the writing
15 condition back to the sealed condition, the push member 331 is pushed in the position shown in Fig. 61. When the push member 331 is pushed, the rotary cam 319 is advanced, and when the rotary cam 319 is positioned slightly ahead of the front edge of the cam wall 302 as shown in Fig. 60, the
20 push member 331 is released of a push. The rotary cam 319 is then slightly turned and then slightly pushed back by the legs 307 under the resilient force of the spring S1. The rotary cam 319 is then engaged by the front locking edge of the cam wall 302, thus preventing the seal tube 306
25 from being retracted. The slidable tube 303 is also retracted

under the force of the spring S2 to thereby enable the front inner surface of the slidable tube 303 to push the sealing body 313 until the latter closes and seals the opening 310 in the seal tube 306. Therefore, the writing instrument is
5 now in the sealed condition as shown in Fig. 58.

Another embodiment (30th) of the invention will now be described with reference to Fig. 61, in which a front barrel 301 and a rear barrel 332 are formed integrally with each other and further a connector 327 is formed integrally
10 with the rear barrel 332 via its three legs. Three associated slits 304, 304, 304 are formed on the front side of a slidable tube 303. A push member 331 is formed integrally with the slidable tube 303. A ring 308 is fitted in a rear end opening of the rear barrel. After a reinforcement
15 ring 330 is fitted in an interior of a tip member 335, the tip member with the reinforcement ring 330 is threadedly engaged with a front end portion of the slidable tube 303. The reinforcement ring 330 serves to reinforce the front portion of the slidable tube 303 having the three slits 304,
20 304, 304. The other constructions are the same as those shown in Fig. 58 to 61.

Another embodiment (31st) of the invention will now be described with reference to Fig. 62 in which the seal member 313 is composed of openable divided halves each having
25 on the rear side a straight groove 337. Such a seal member

313 is applicable to the foregoing embodiments.

Fig. 63 is a cross-sectional view of a writing instrument according to another embodiment (32nd) of the present invention. The writing instrument comprises a
5 cylindrical front barrel 401 including a tapered distal end portion having a through hole 402 formed in a distal end thereof for passage therethrough of a writing tip of a writing member described before.

A cylinder 403 is fixedly fitted in the front barrel
10 401 with an inner tube 404 attached to a front end of the cylinder 403. The inner tube 404 is made of a magnetic material. The inner tube 404 has a smaller-diameter front end portion 405 having an opening 406 in its distal end. As shown in Fig. 64, the smaller-diameter portion 405 has a
15 pair of lugs 407, 407 having small apertures 408, 408, respectively.

A separate sealing body 409 is substantially disk-shaped and sized to close an opening 406 in the inner tube 404. The sealing body 409 has a leg 410 having a small
20 aperture 411. A seal ring 412 is attached to a rear outer peripheral edge of the sealing body 409 and is of a size substantially equal to that of a front edge of smaller-diameter portion of the inner tube 404. The seal ring 412 is made of magnetic rubber. The sealing body 409 has on a
25 rear surface thereof a projection 413 having a central recess

414.

For assembly, the lug 410 on the sealing body 409 is brought between the lugs 407, 407 on the inner tube 404, and a single pin 415 is inserted through the small apertures 5 408, 408 in the lugs 407, 407 and the small aperture 411 in the leg 410. Thus, the sealing body 409 is pivotably mounted on the inner tube 404 in front thereof. When the sealing body 409 is angularly moved back, the seal ring 412 of magnetic rubber is attracted to the front edge of the inner tube 10 404 of magnetic material, and the sealing body 409 closes the opening 406 in the inner tube 404. When the sealing body 409 is turned forward, the opening 406 in the inner tube 404 is opened. Where there is no obstruction in the way, the sealing body 409 is attracted to the front end of the 15 inner tube 404 under the magnetic force of the seal ring 412.

A spring 417 is disposed between an inner step of the inner tube 404 and an step on an outer periphery of a writing member 416 such as an ink cartridge in the vicinity of a distal end thereof, the ink cartridge 416 being fitted 20 in the inner tube 404 and the cylinder 403. The ink cartridge 416 has a front air vent hole 418 and a smaller-diameter front end portion 419 with a writing tip 416 on its distal end. The air vent hole 418 may be formed in a tail end of the ink cartridge 416. The ink cartridge 416 25 has a rear end portion projecting backward beyond the rear

end of the front barrel 401. A cylinder 421 is fitted over the projecting end portion of the ink cartridge 416. The cylinder 421 has a rear end portion extending slightly rearward of a rear end of the ink cartridge 416.

5 A seal ring 422 is fitted over the cylinder 421 behind a flange on a front end of the cylinder 421. Another cylinder 423 is fitted over the cylinder 421, the cylinder 423 being assembled onto the cylinder 421 from a rear end thereof. The cylinder 423 has a larger-diameter front end portion 425
10 with a step 424 at a rear end thereof. A resilient seal ring 426 is fitted over the larger-diameter portion 425. After the seal ring 426 is mounted, the larger-diameter portion 425 is mounted with a force fit in the front barrel 401 near a rear end thereof. Another cylinder 427 is fitted
15 over a rear portion of the cylinder 423.

 A cylinder 428 is mounted in a rear end of the cylinder 423 by being fitted from the rear end thereof, the cylinder 428 having a radially outward projection 429. A guide tube 430 is fitted over a rear end portion of the cylinder
20 421 and has a rear end projecting behind the rear end of the cylinder 421. The guide tube 430 has an axial slit 431 with the projection 429 of the slider 428 fitted therein. The projecting rear end of the guide tube 430 has a circumferential slot 432.

25 A cam tube 433 is fitted over the guide tube 430 and

has an inner projection 434 fitted in the slot 432 in the guide tube 430. The cam tube 433 has a front inclined edge serving as a cam surface and including a locking edge which projects forwardly for a maximum interval.

5 A rear barrel 435 is fitted over the cam tube 433.

The rear barrel 435 is brought over the cam tube 433 from a rear end thereof. The rear barrel 435 has a front end held against a rear end of the front barrel 401. The front barrel 401 is removably fitted over and rotatable with the larger-
10 diameter portion 425 of the cylinder 423. The front and rear barrels 401, 435 constitute a body of the writing instrument.

Fig. 63 shows the writing instrument in a sealed condition. The tip end of the ink cartridge 416 is fully stored in the inner tube 404, and the seal ring 412 is
15 magnetically attracted to the front edge of the inner tube 404, with the sealing body 409 closing and sealing the opening 406 in the inner tube 404. The ink cartridge 416 is retracted under the force of the spring 417, and the seal ring 422 on the front end of the cylinder 421 is held against
20 the step 424 of the cylinder 423 to provide a seal between the cylinders 421, 423. The seal ring 426 fitted over the larger-diameter portion 425 of the cylinder 423 provides a seal between the front barrel 401 and the larger-diameter portion 425. The rear seals for the ink cartridge 416 are
25 therefore effected by the seal rings 422, 426. As a

consequence, the writing tip 420 and the air vent hole 418 are fully sealed. In this sealed condition, the projection 429 of the slider 428 is kept out of contact with a front edge of the cam tube 433.

5 To bring the writing instrument from the sealed condition to a writing condition, the rear barrel 435 is turned with respect to the front barrel 401. When the rear barrel 435 is turned, the cam tube 433 turns therewith, with the projection 434 of the cam tube 433 fitted in the slot 432
10 in the guide tube 430. As the cam tube 433 turns, the cam surface or the front edge of the cam tube 433 is brought into contact with the projection 429 of the slider 428. Thereafter, the cam surface pushes the projection 429 to move forward the ink cartridge 416 while compressing the
15 spring 417. The writing tip 420 of the ink cartridge 416 is fitted in the recess 414 in the sealing body 409 while at the same time a front inclined surface of the ink cartridge 416 abuts against shoulders of the recess 414. The writing tip 420 is therefore prevented from contacting the sealing
20 body 409. The writing tip 420 is advanced while the front inclined surface of the ink cartridge 416 pushes aside the sealing body 409, until the smaller-diameter portion 419 of the ink cartridge 416 projects through the hole 402 in the front barrel 401 as shown in Fig. 66. The writing
25 instrument is now in the writing condition. At this time,

the projection 429 of the slider 428 is engaged by the locking edge of the cam tube 423. The writing instrument is in readiness for writing operation.

For bringing the writing instrument from the writing
5 condition back to the sealed condition, the rear barrel 435 is turned in an opposite direction in the position of Fig. 66. The projection 429 is unlocked from the locking edge of the cam tube 433, and thereafter moves back along the cam surface of the cam tube 433 since the ink cartridge 416 is
10 urged backward under the force of the spring 417. The ink cartridge 416 also moves backward. When the seal ring 422 abuts against the step 424 of the cylinder 423, the ink cartridge 416 is prevented from being retracted. At this time, the tip end of the ink cartridge 416 is fully accommo-
15 dated in the inner tube 406 and sealed as shown in Fig. 63 by the sealing body 409 which closes the opening 406 in the inner tube 404 under the magnetic attraction between the seal ring 412 and the inner tube 404. During movement from the position of Fig. 66 to the position of Fig. 63 through
20 the position of Fig. 65, the ink cartridge 416 is retracted while the front inclined surface thereof is held against the shoulders of the recess 414 in the sealing body 409, so that the writing tip 420 is kept out of contact with the sealing body 409.

25 Another embodiment (33rd) of the invention will not

be described with reference to Figs. 67 to 70, in which an inner tube 404 is mounted on the front barrel 401. As shown in Fig. 68, a mounting member 436 in the form of a cap has in its central portion a hole into which the smaller-diameter portion 405 of the inner cylinder 404 may be just fitted. A pair of diametrically opposite slots are formed the hole formed in the mounting member 436 so that strips 437, 437 are formed extending from the slots. Also, another slot 438 is formed at a position between the strips 437 on the circumference of the hole. Lugs 407, 407 formed on the smaller-diameter portion 405 of the inner tube 404 are rendered to pass through the slot 438 and then the mounting member 436 is mounted on the larger-diameter portion of the inner tube 404. Thereafter, in the same manner as described above, the seal body 409 is mounted at the front portion of the smaller-diameter portion 405, but the front face end of the smaller-diameter portion is slightly tapered or slanted and the seal ring 412 mounted on the seal body 409 has an associated slanted rear face to obtain a positive sealing effect. Instead of the magnetic effect, coil springs 440, 440 are laid between extensions 439, 439 formed on the seal body 409 and the strips 437, 437 of the mounting member 436 to urge the seal body 409 rearwardly, that is, in its closing direction. The tip member 441 is mounted on a front end of the front barrel 401. The tip member 441 constitutes

a part of the barrel,

The operation of the embodiment shown in Figs. 67 to 70 is apparent from the foregoing and explanations therefor have been omitted.

5 Another embodiment (34th) of the invention will be described with reference to Figs. 71 to 73, in which a leaf spring 442 is mounted at one end to the inner surface of the front barrel 401 and at the other end to the front face of the seal body 409. It is possible to release the one end
10 of the leaf spring 442 from the inner surface of the front barrel 401. The operation is apparent from Figs. 71 to 73.

Another embodiment (35th) of the invention will be described with reference to Fig. 74, in which a projection 413 of the seal body 409 is rounded to reduce a possible
15 friction generated between the projection and the ink cartridge 414.

Another embodiment (36th) of the invention will be described with reference to Fig. 75, in which the seal body 409 is pivotally mounted on a ring member 443 fixedly
20 mounted in the inner surface of the front barrel 1 in the front portion of the inner tube 404. The seal body 409 is urged to rotate backwardly by a leaf spring 442.

Another embodiment (37th) of the invention will be described with reference to Fig. 76, in which a spring 417 for biasing the ink cartridge 416 rearwardly is disposed on the rear side of the writing barrel. In this embodiment, a
5 seal ring 426 is interposed between cylinders 403 and 423 fitted in the front barrel 401. The spring 417 is interposed between the rear end of the cylinder 423 and the slider 428 fitted in the rear end of the cylinder 421.

In this embodiment, it is necessary to firmly mount
10 the ink cartridge 416 on the cylinder 421 to have a sufficient holding force against a friction caused by the seal body 409 when the ink cartridge 416 is moved from the forward position to the rearward position.

Another embodiment (38th) of the invention will be
15 described with reference to Figs. 77 and 78, in which an end portion of lug 410 extending from the seal body 409 is formed in a ball and an associated space in the form of a ball is formed between lugs 407, 407 extending from the inner tube 404. Then, the end portion of the lug 410 is pressingly inserted into the space
20 defined between the the lugs 407, 407 of the inner tube 404.

CLAIMS:

1. A writing instrument characterized by a barrel (1),
a slidable tube (27) slidably housed in said barrel (1), an
inner tube (16) housed in said slidable tube (27) and
having an opening (18) defined in a distal end thereof,
5 said inner tube (16) being coupled to said barrel (1), a
writing member (10) disposed in said inner tube (16) and
having a writing tip (14) on a distal end thereof, a
mechanism interposed between said slidable tube (27), said
barrel (1) and said writing member (10) for allowing said
10 writing member (10) to move forward with a time delay with
respect to advance of said slidable tube (27) when the
latter is moved forwardly, a sealing body (21) disposed in
said slidable tube (27) in the vicinity of a front end
thereof, said sealing body (21) being pressable by an inner
15 surface of a front end of said slidable tube (27) into said
opening (18) in said inner tube (16) to seal said opening
(18) when said slidable tube (27) is in a most retracted
position, and a seal disposed between said writing member
(10) and said inner tube (16) at a position behind said
20 sealing body (21).

2. A writing instrument according to claim 1,
characterized in that the slidable tube (27) is disposed in
said barrel (1) as being movable back and forth therein,

the writing member (10) is disposed in said inner tube (16) as being movable back and forth therein, that a mechanism is interposed between said barrel (1) and said writing member (10) for locking said writing member (10) in an
5 advanced position and moving said writing member (10) back to a retracted position.

3. A writing instrument characterized by a barrel (101), a slidable tube (103) housed in said barrel (101) for
10 back-and-forth movement therein, an inner tube (108) housed in said slidable tube (103) and having an opening (110) defined in a distal end thereof, a writing member (115) disposed in said inner tube (108) for back-and-forth movement therein and having a writing tip (118) on a
15 distal end thereof, a mechanism interposed among said barrel (101), said inner tube (108) and said writing member (115) for allowing said writing member (115) to move forward to an advanced position and locking said writing

member (115) in said advanced position, and for retracting said writing member (115) toward a retracted position, a sealing body (111) disposed in the vicinity of an opening (110) in a distal end of said inner tube (108) and

5 swingable about a single point for opening and closing said opening (110), and seal means for providing a seal between said inner tube (108) and said writing member (115) behind said sealing body (111).

4. A writing instrument characterized by a barrel having a
10 front opening (203), a writing member (217) having a writing tip (220) on a front end thereof and disposed in said barrel for back-and-forth movement therein, a mechanism disposed between said barrel and said writing member (217) for locking said writing member (217) in an advanced position
15 and returning said writing member (217) in a retracted position, a sealing body (206) pivotable about a single point in the vicinity of said opening (203) for opening and closing said opening (203), bias means disposed between said sealing body (206) and said barrel for normally urging said
20 sealing body (206) to close said opening (203), means for pushing aside said sealing body (206) to open said opening (203) against a force tending to close the latter while preventing said writing tip (220) from contacting said sealing body (206) when said writing member (217) advances,
25 and seal means for providing a seal between said barrel and

said writing member (217) at a position behind said sealing body (216).

5. A writing instrument characterized by a barrel, a writing member (322) housed in said barrel and having a writing tip (325) on a distal end thereof, said writing member (322) being coupled to said barrel, a seal tube (306) fitted over said writing member (322) for back-and-forth movement thereof and having a opening (310) in a distal end thereof for passage therethrough of a tip end of said writing member (322), a sealing body (313) pivotable about a single point in the vicinity of said opening (310) for opening and closing said opening (310), and seal means for providing a seal between said seal tube (306) and said writing member (322) at a position behind said sealing body (313).

15 6. A writing instrument characterized by a body composed of a front barrel (401) and a rear barrel (435) which are relatively rotatable, a writing member (416) housed in said body and having a front writing tip (420), a transmission mechanism disposed between said body and said writing member (416) for moving said writing member (416) back and forth in response to relative rotation of said front and rear barrels (401), (435), an inner tube (404) mounted in said front barrel (401) and having an opening (406) defined in a distal end thereof, a sealing body (409) positioned adjacent to said opening (406) for opening and closing said

opening (406), bias means for normally urging said sealing body (409) to close said opening (406), means for pushing aside said sealing body (409) to open said opening (406) against a force tending to close the latter while preventing
5 said writing tip (420) from contacting said sealing body (409) when said writing member (416) advances, and seal means for providing a seal between said body and said writing member (416) at a position behind said sealing body (409).

FIG. 1

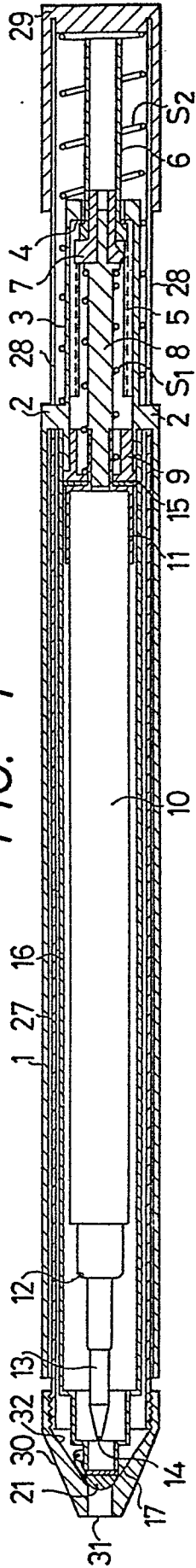


FIG. 4

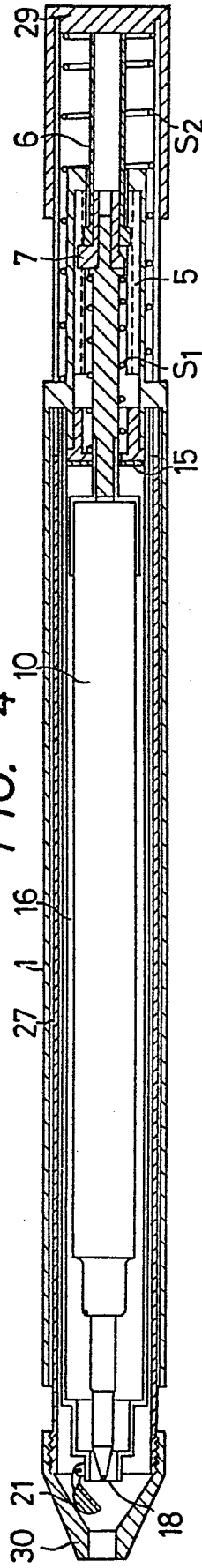


FIG. 5

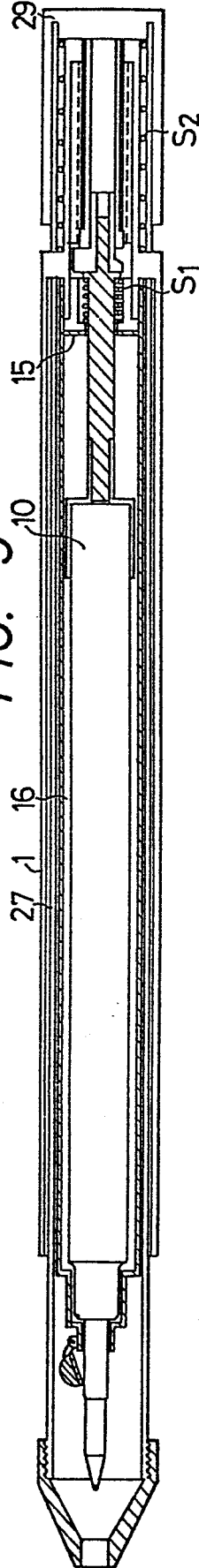


FIG. 6

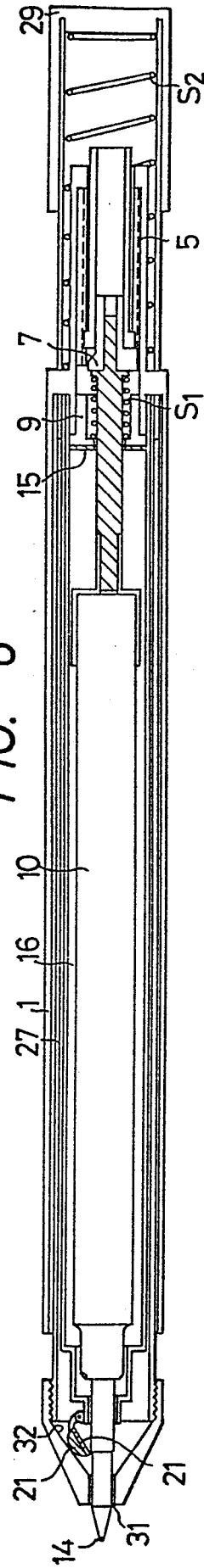


FIG. 3

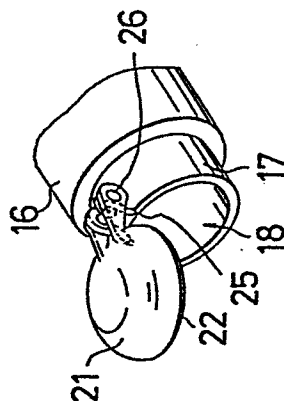
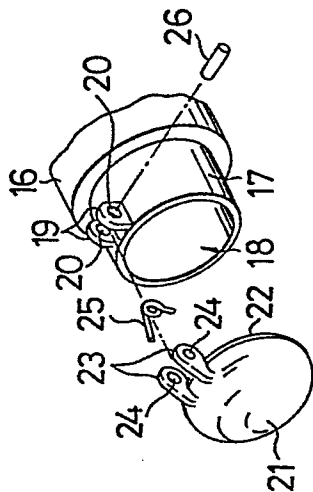


FIG. 8

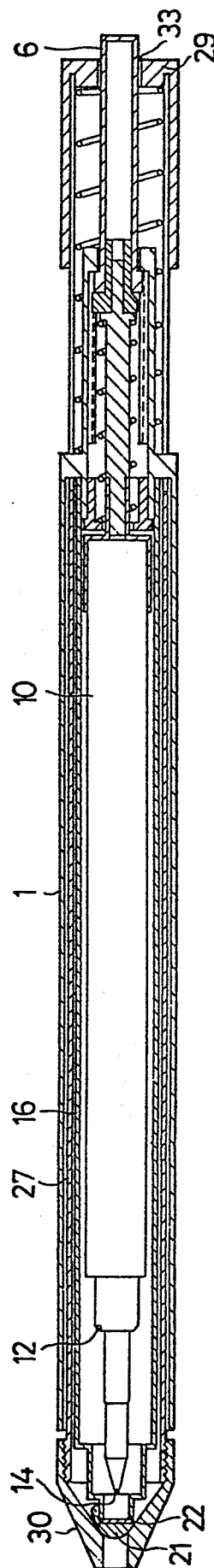


FIG. 9

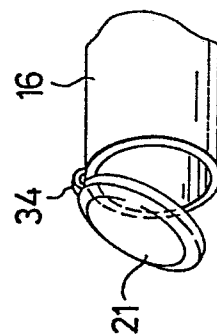


FIG. 10

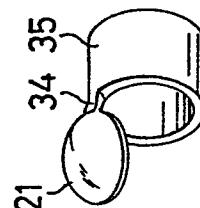


FIG. 11

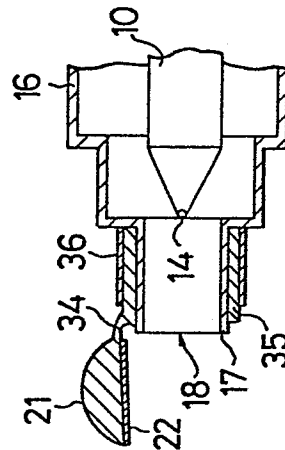


FIG. 7

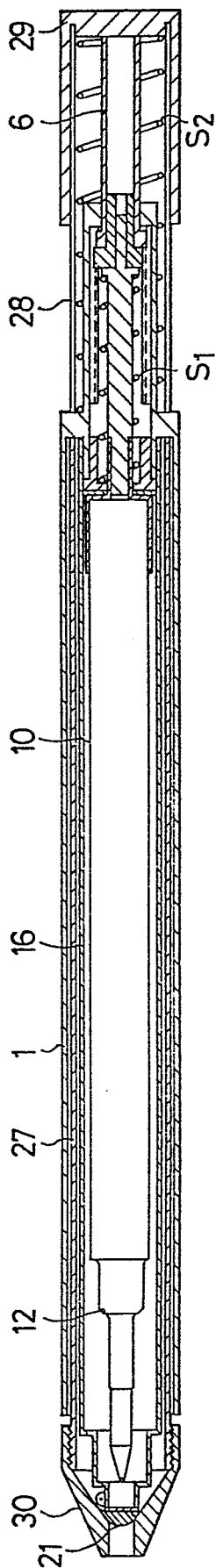


FIG. 7A

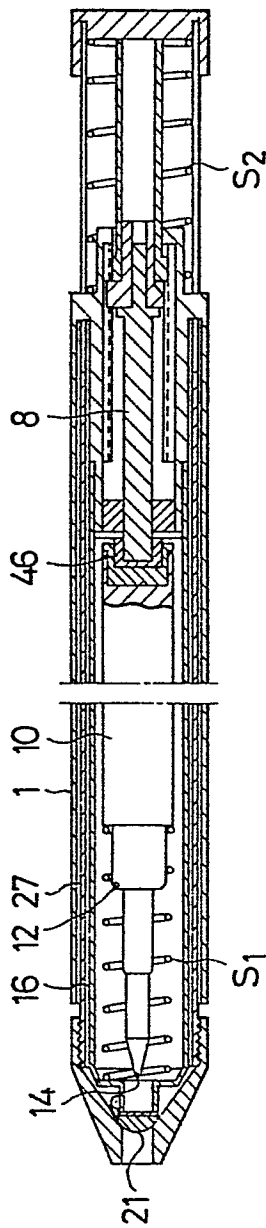


FIG. 7B

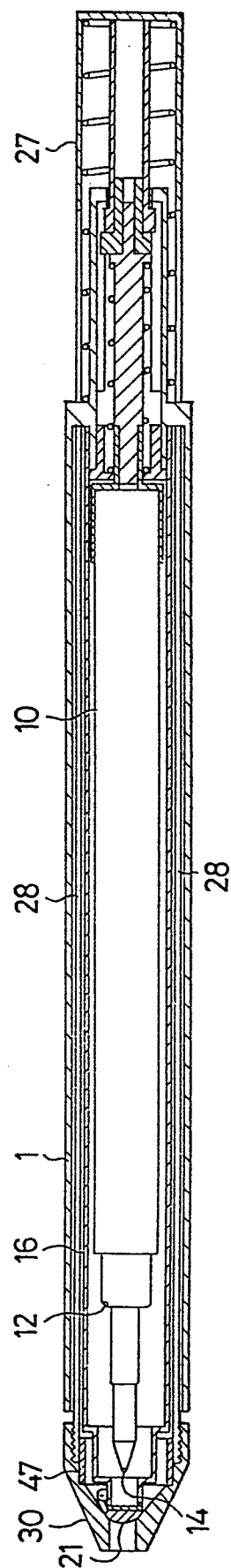


FIG. 12

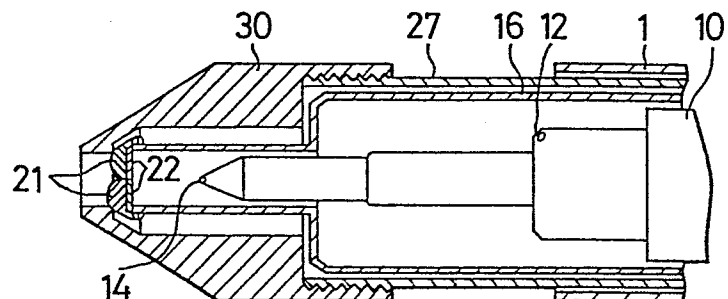


FIG. 13

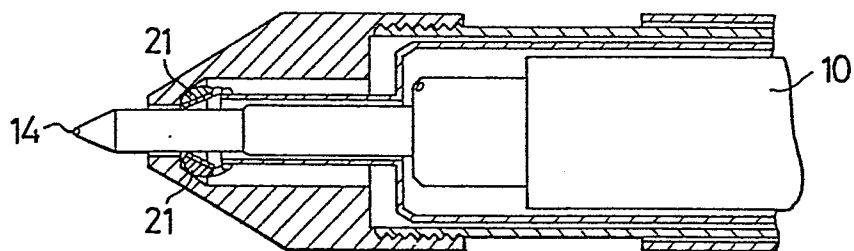


FIG. 14

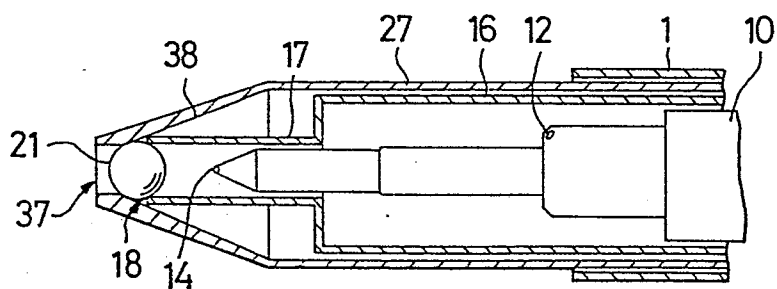


FIG. 15

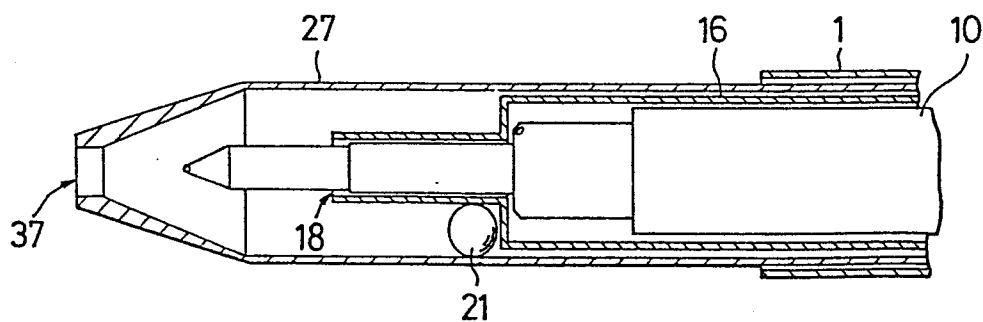


FIG. 16

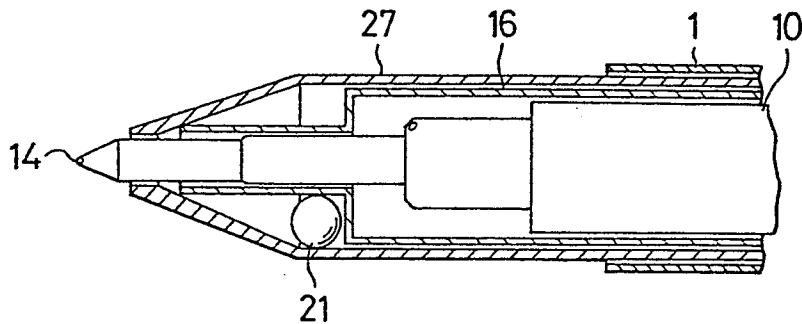


FIG. 17

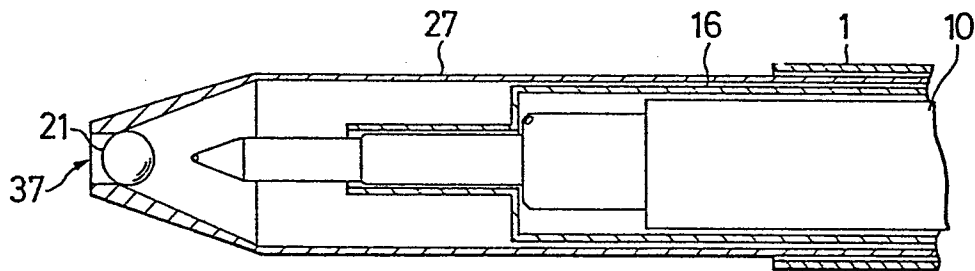


FIG. 18

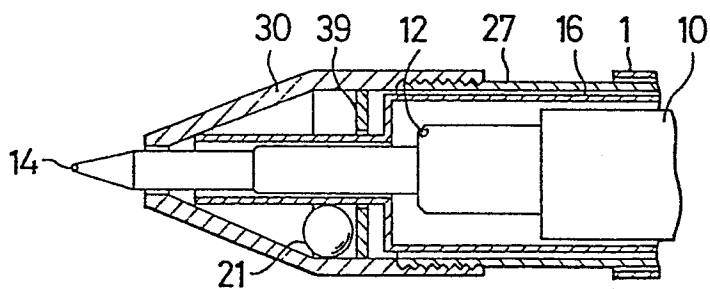


FIG. 19

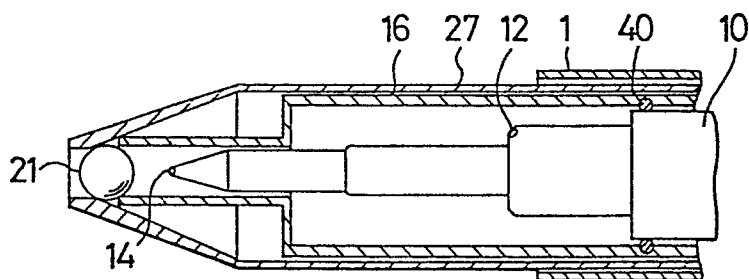


FIG. 20

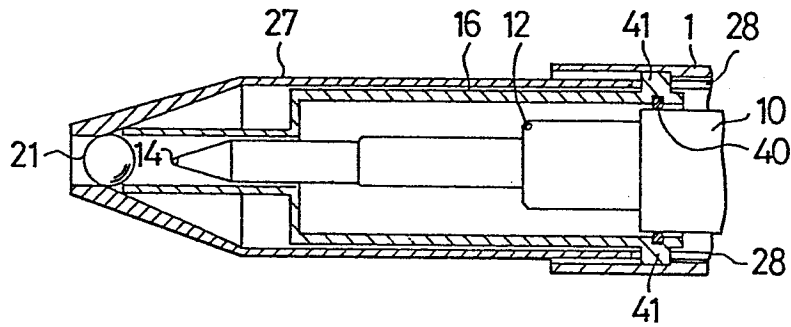


FIG. 21

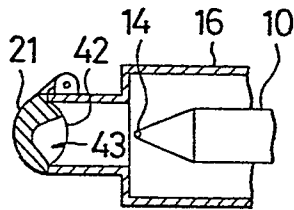


FIG. 22

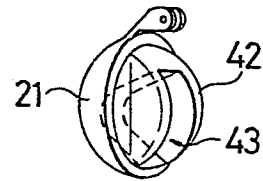


FIG. 23

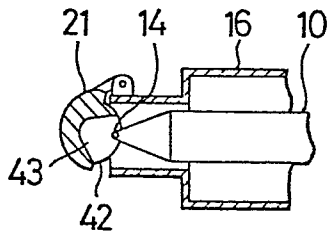


FIG. 25

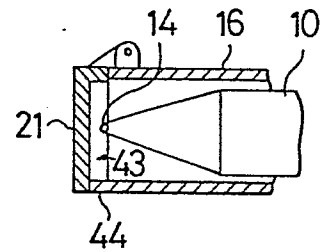


FIG. 24

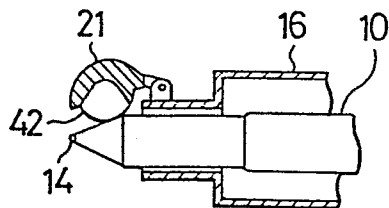


FIG. 26

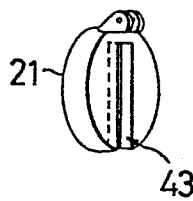


FIG. 27

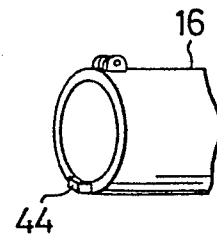


FIG. 28

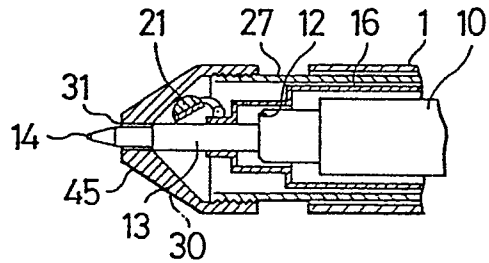


FIG. 29

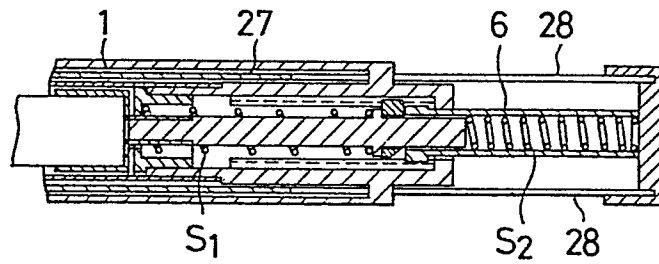


FIG. 30

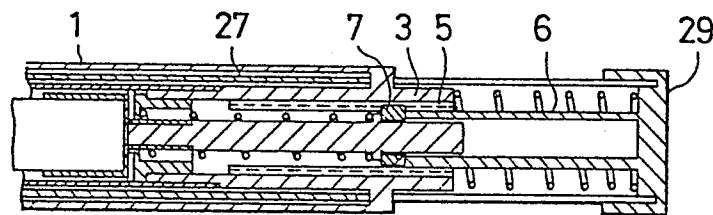
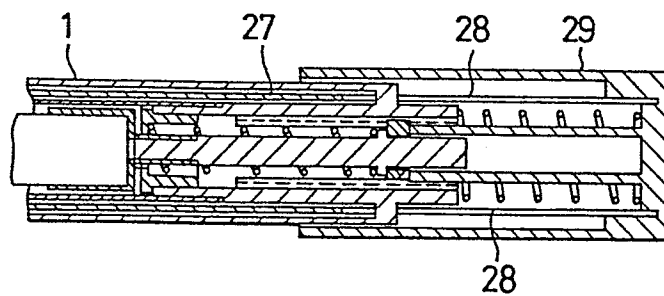


FIG. 31



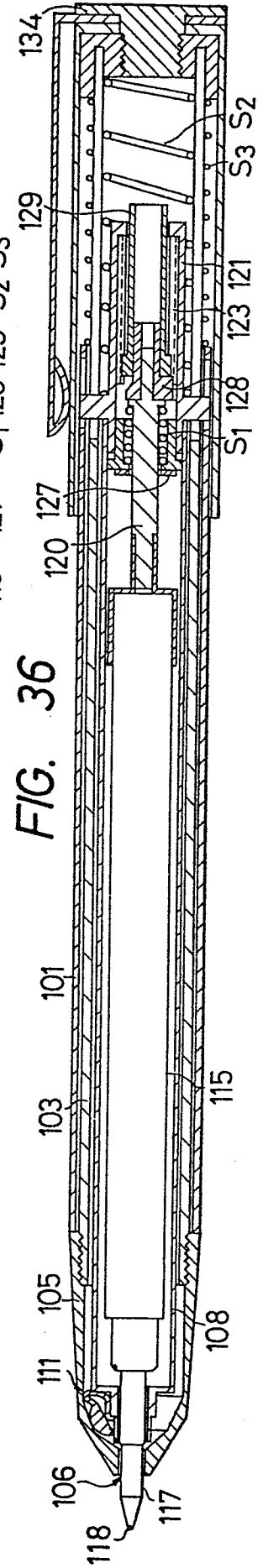
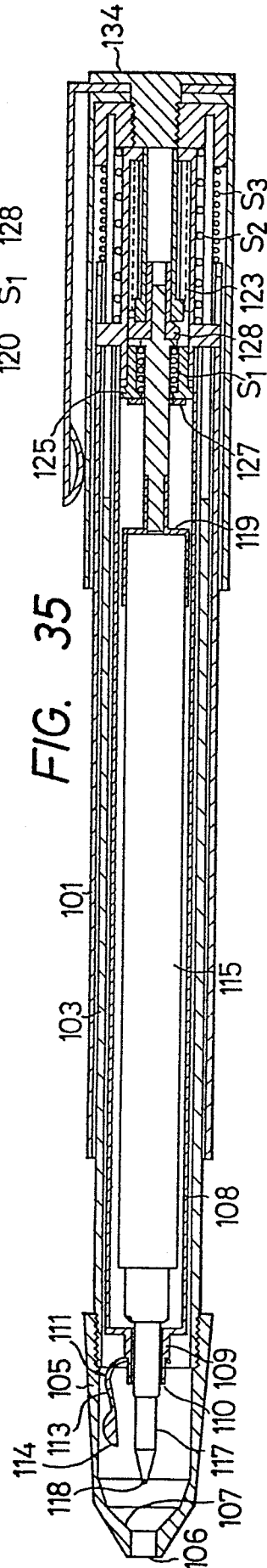
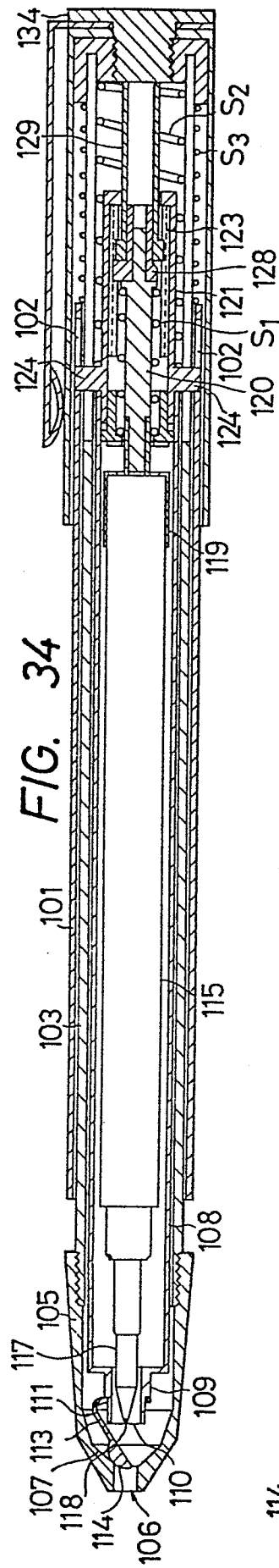
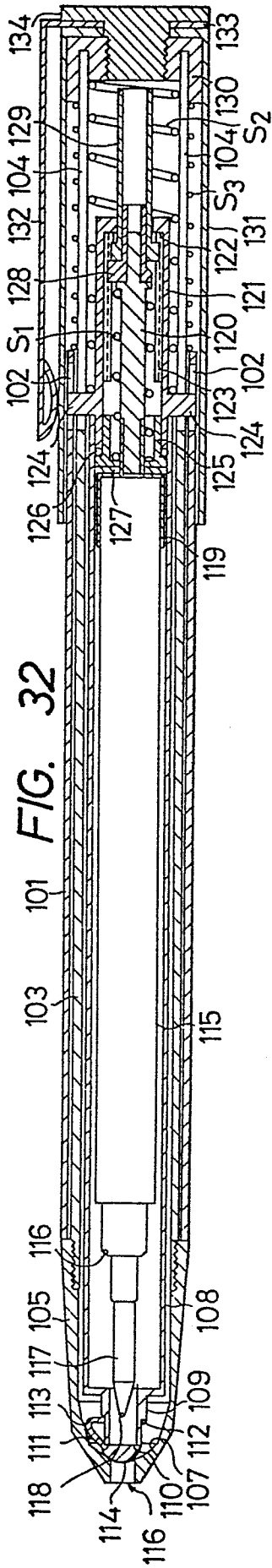


FIG. 33

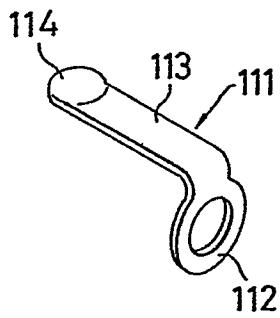


FIG. 37

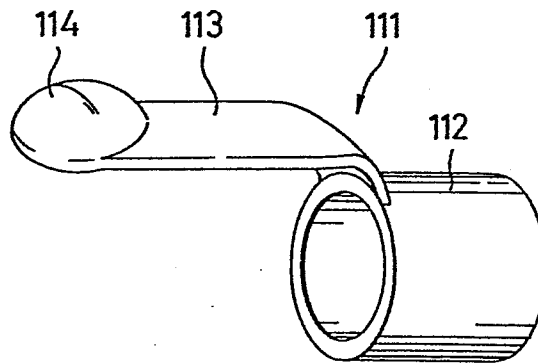


FIG. 38

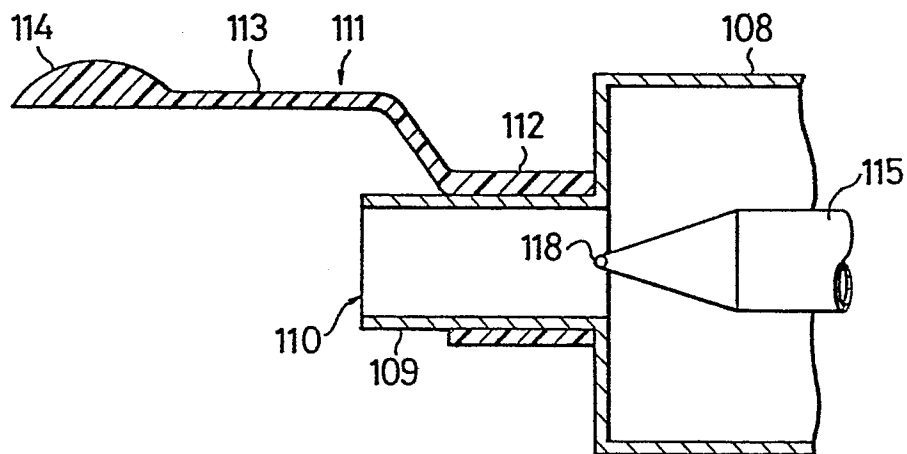


FIG. 40

FIG. 39

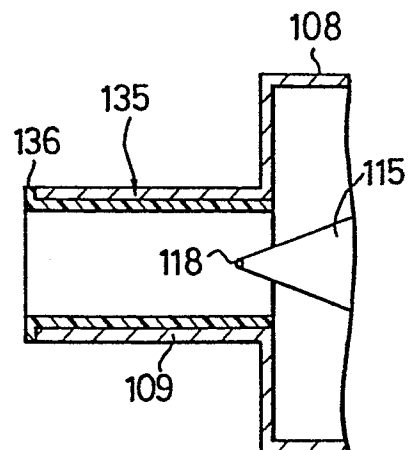
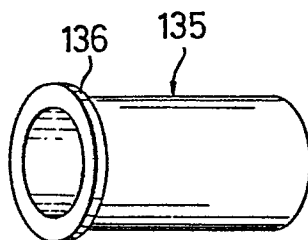


FIG. 41

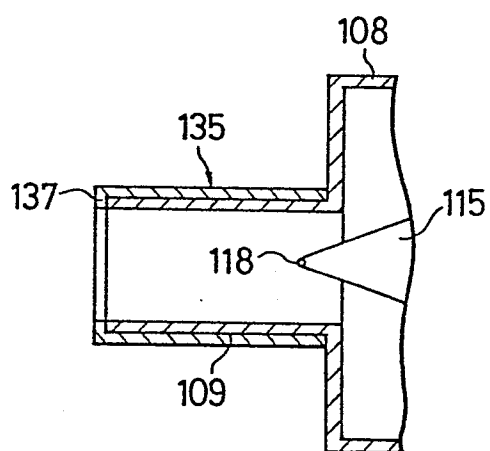
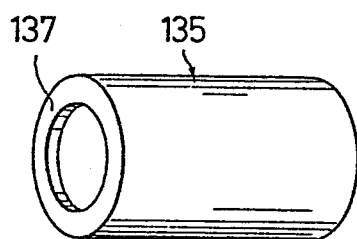


FIG. 43

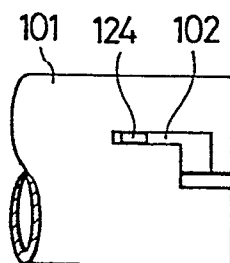


FIG. 44

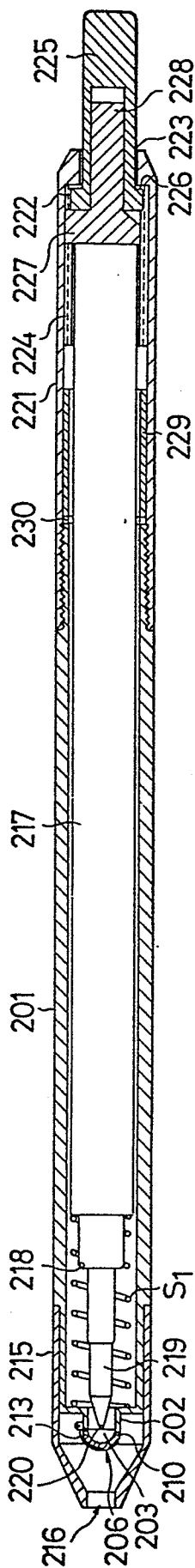


FIG. 49

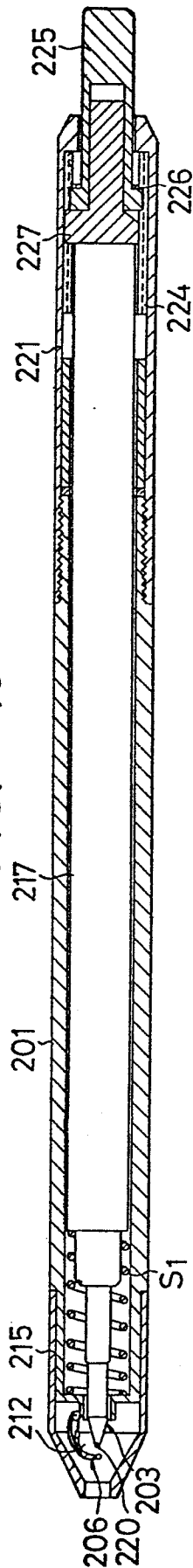


FIG. 50

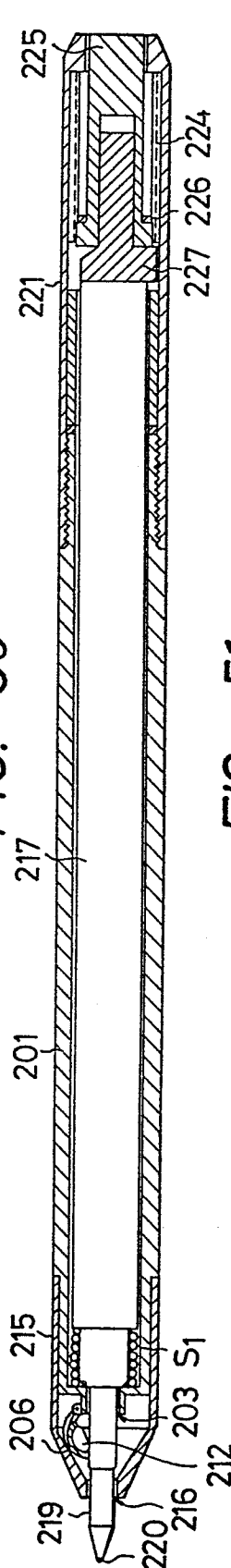


FIG. 51

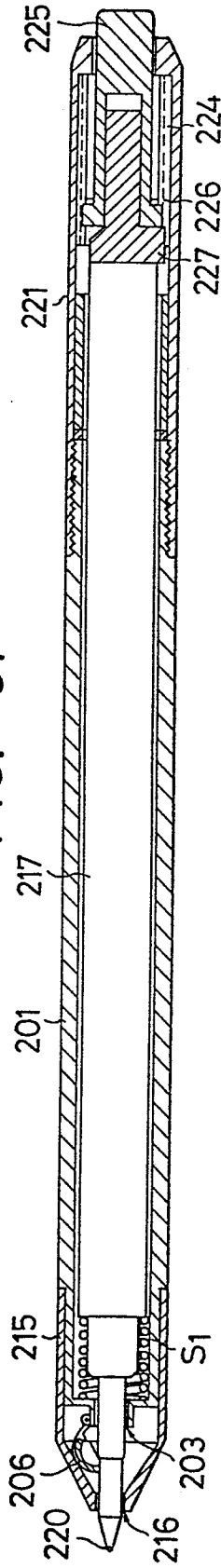


FIG. 45

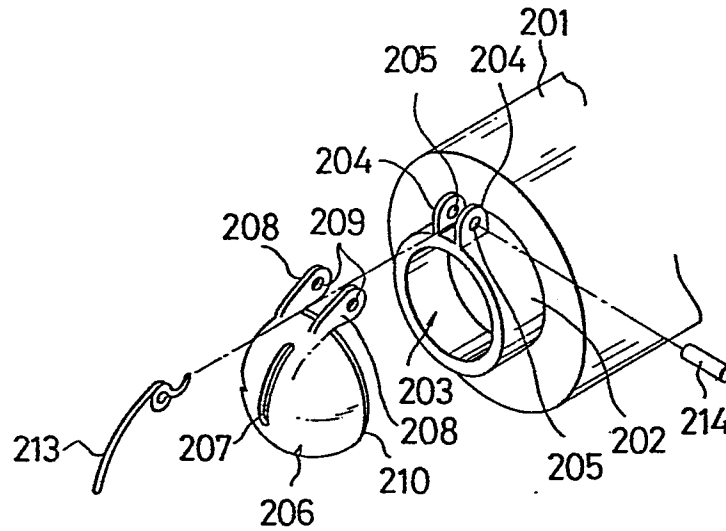


FIG. 47

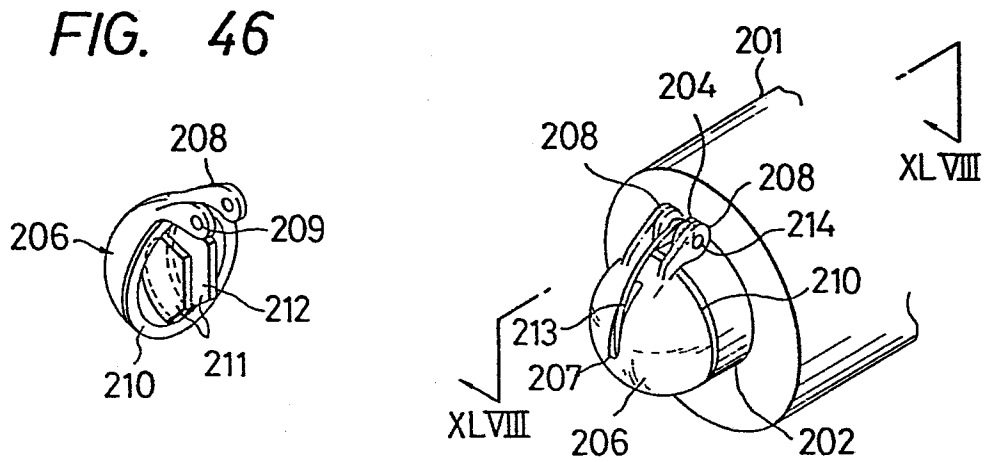


FIG. 46

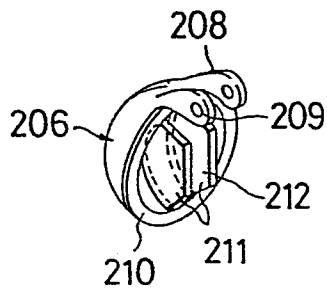


FIG. 48

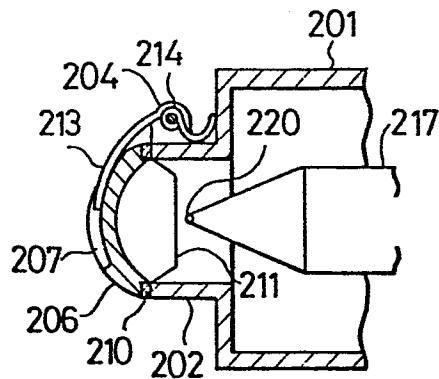


FIG. 52

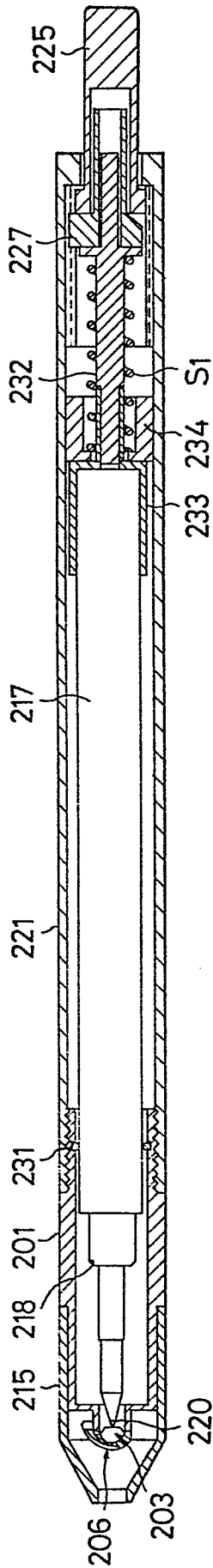


FIG. 53

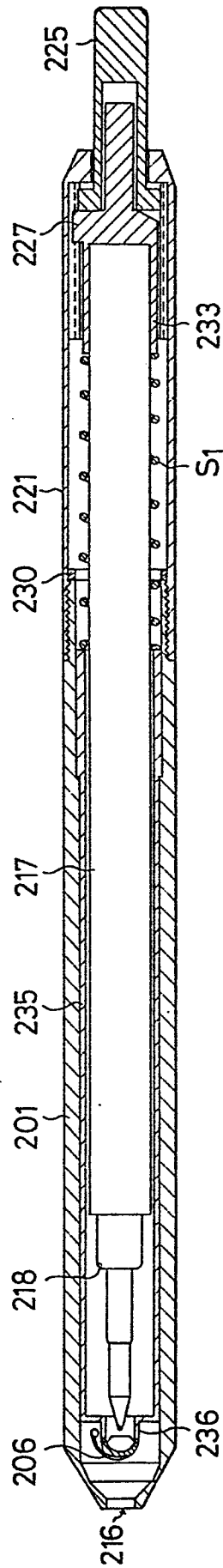


FIG. 54

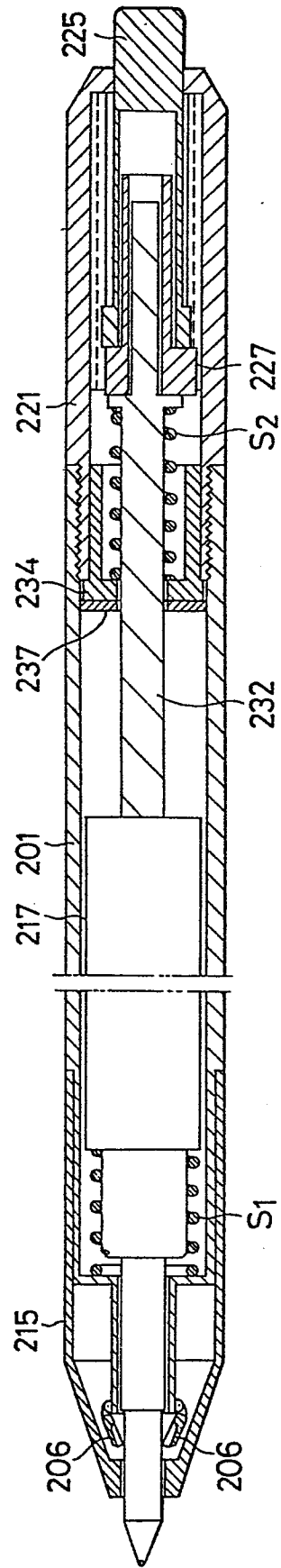


FIG. 55

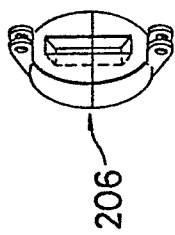


FIG. 56

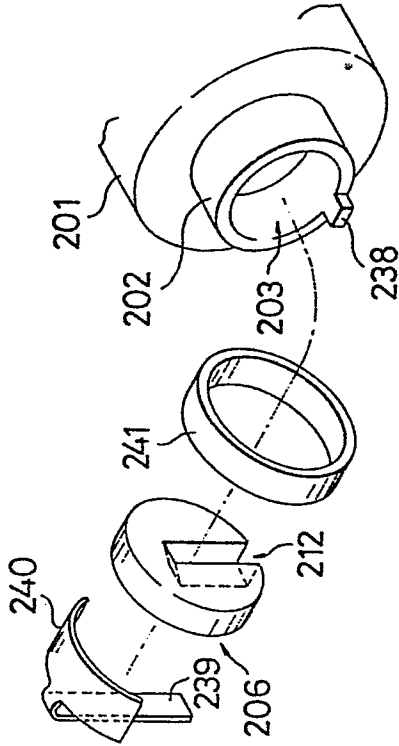


FIG. 57

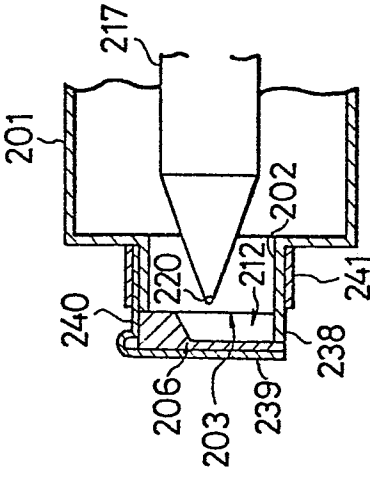


FIG. 61A

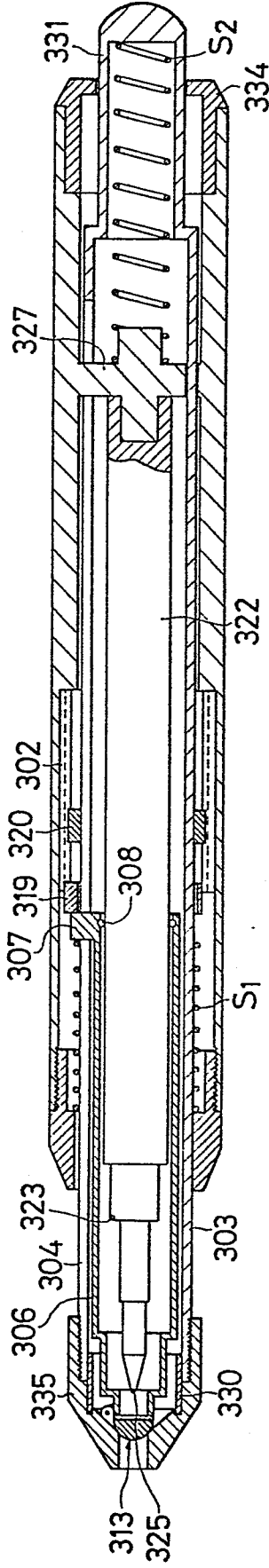


FIG. 62

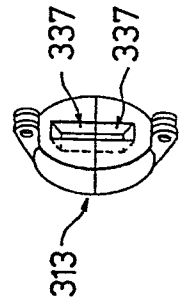
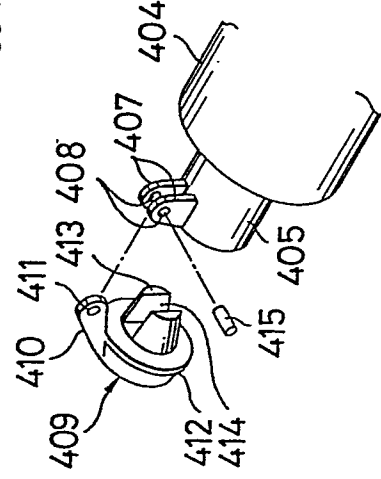


FIG. 64



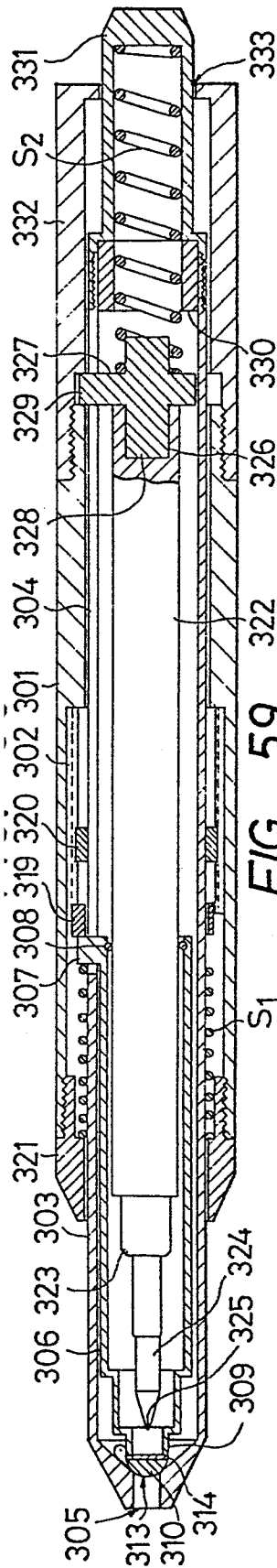


FIG. 59

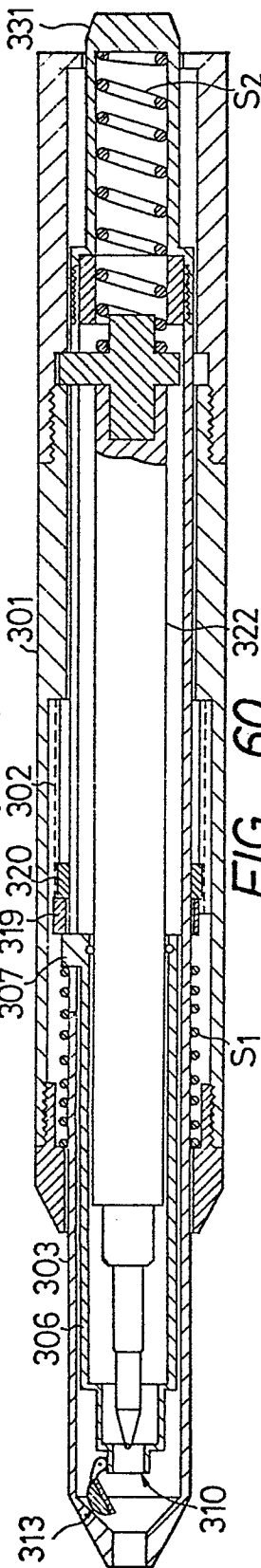


FIG. 60

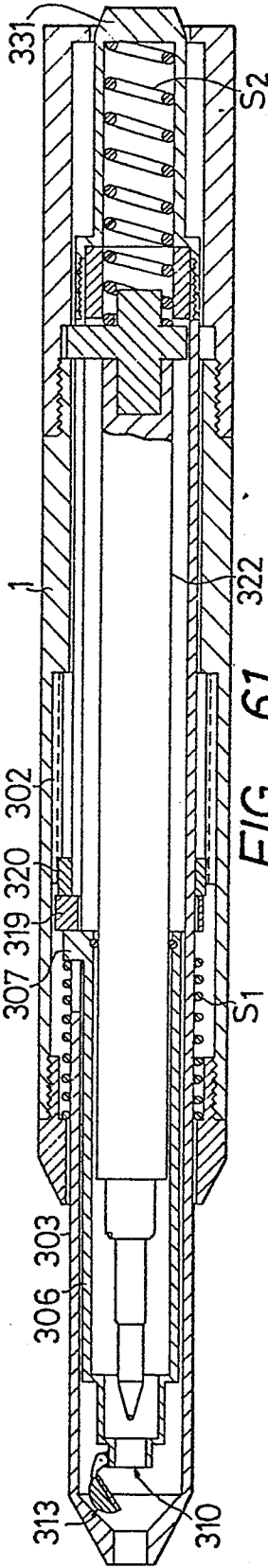


FIG. 61

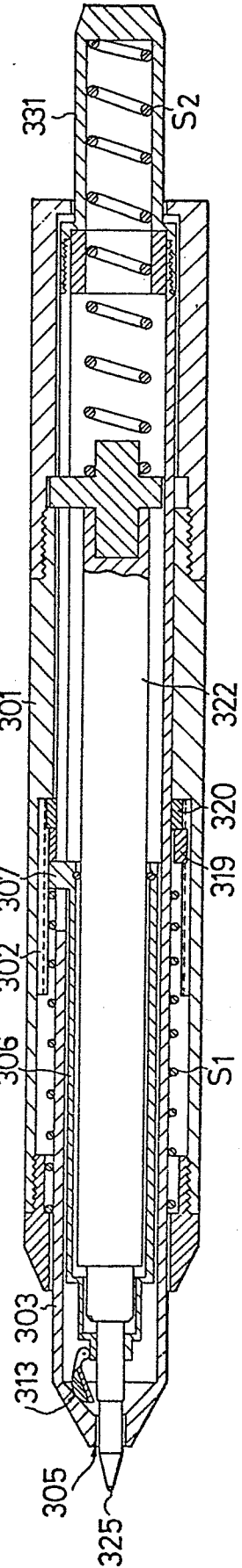


FIG. 63

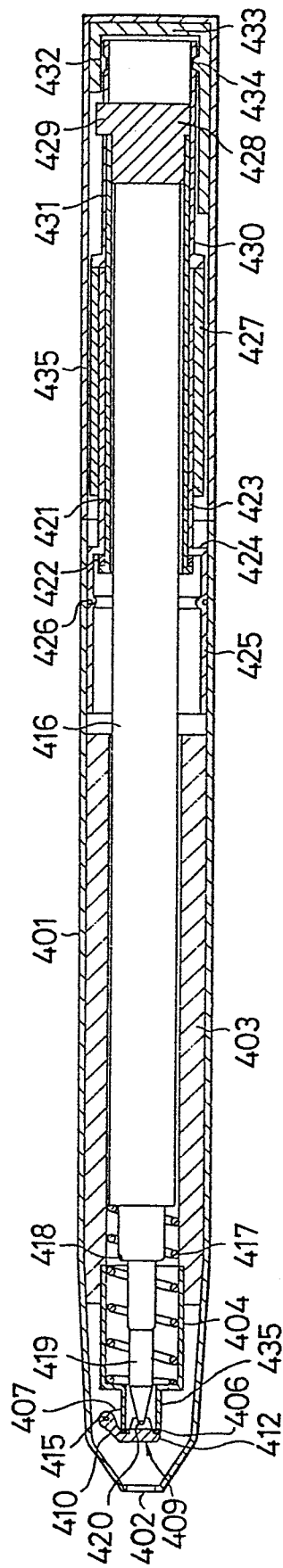


FIG. 65

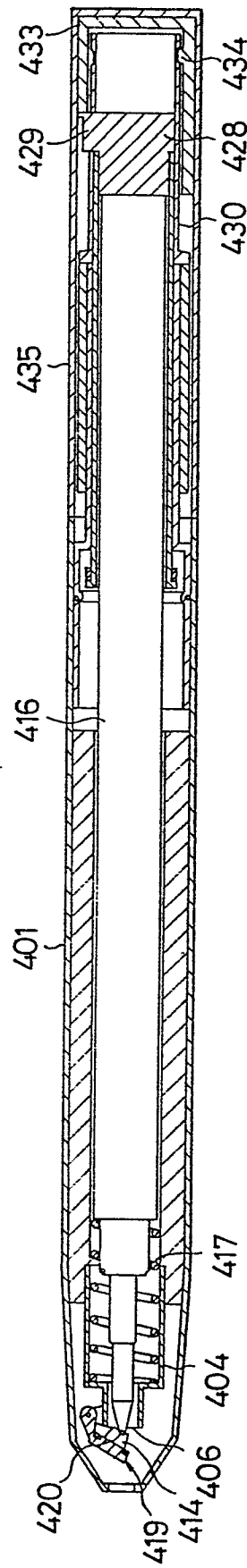


FIG. 66

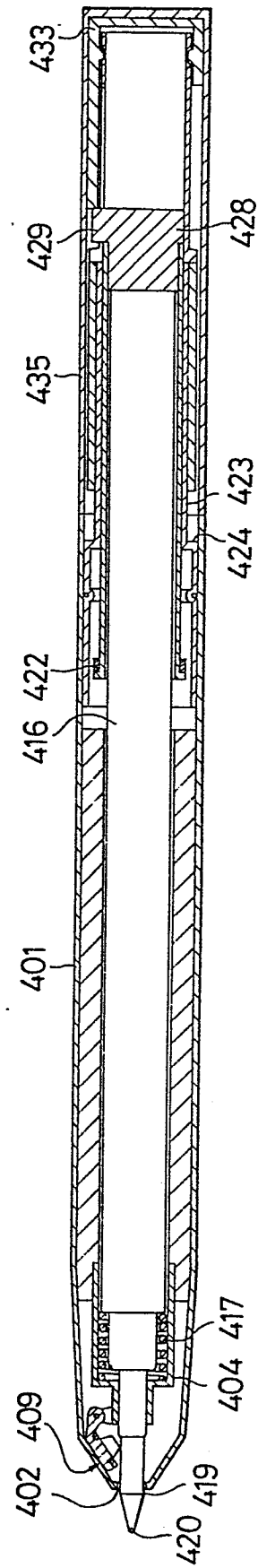


FIG. 67

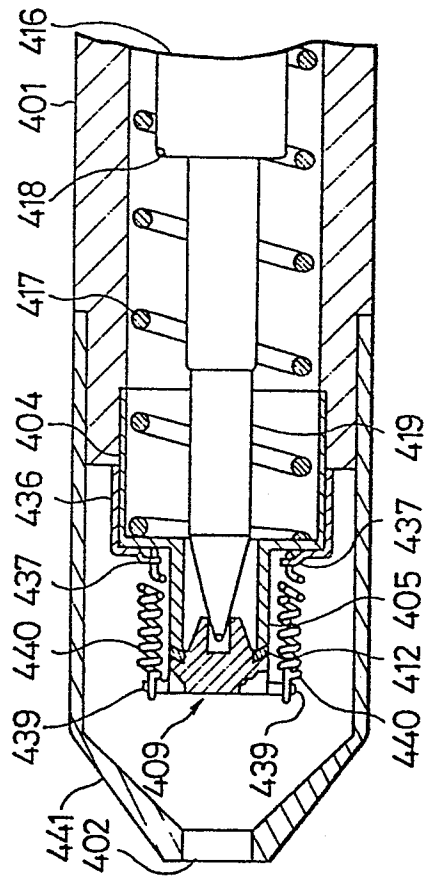


FIG. 68

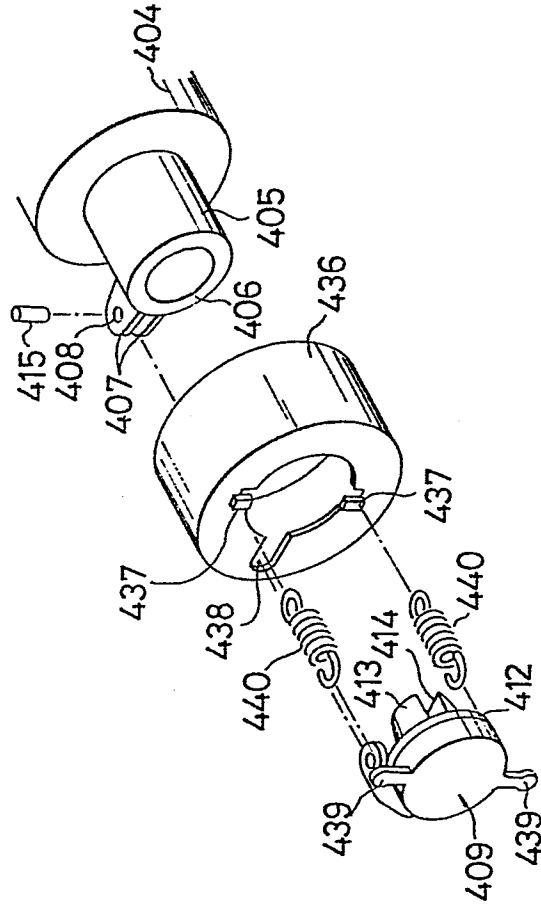


FIG. 69

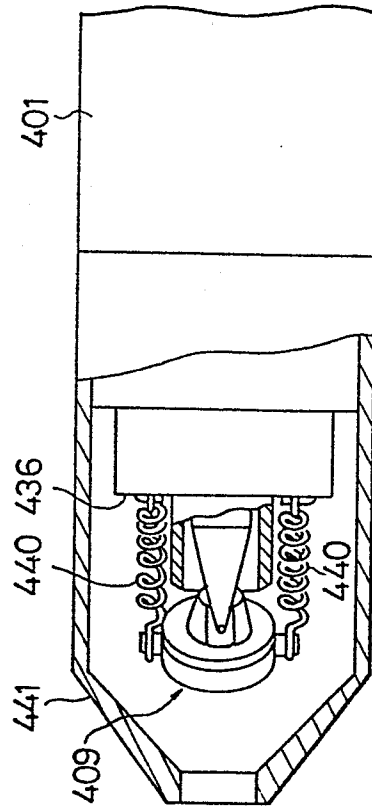


FIG. 70

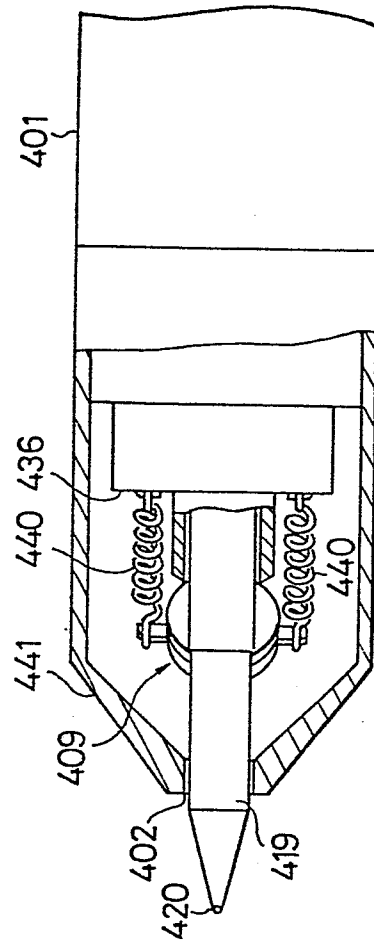


FIG. 71

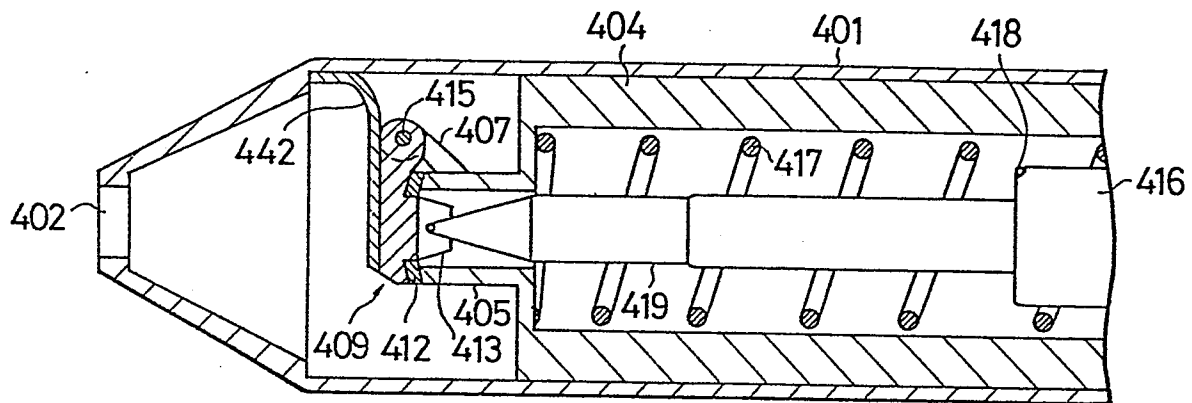


FIG. 72

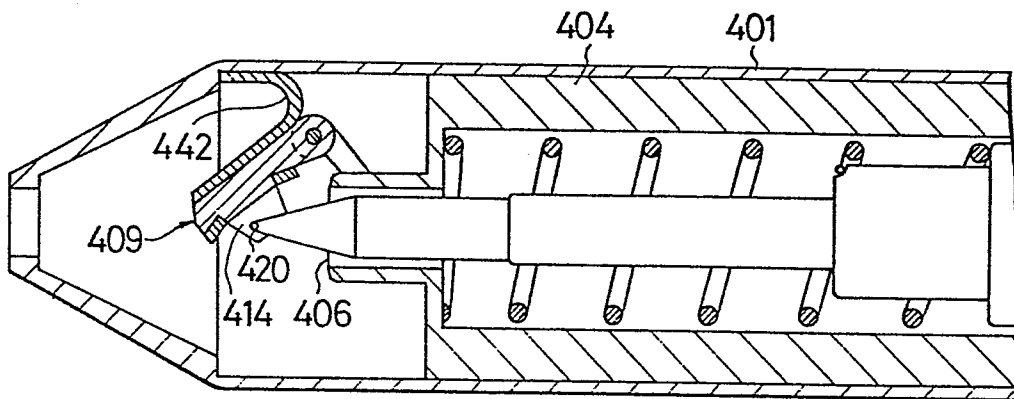


FIG. 73

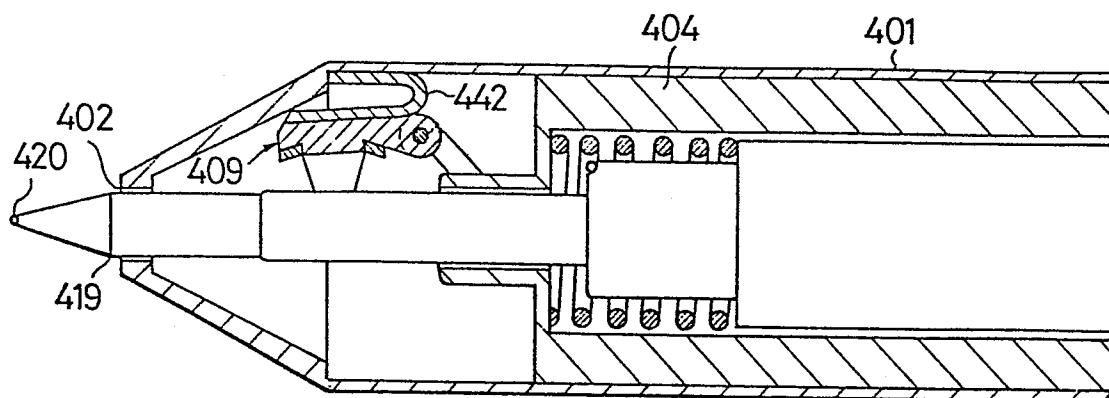


FIG. 74

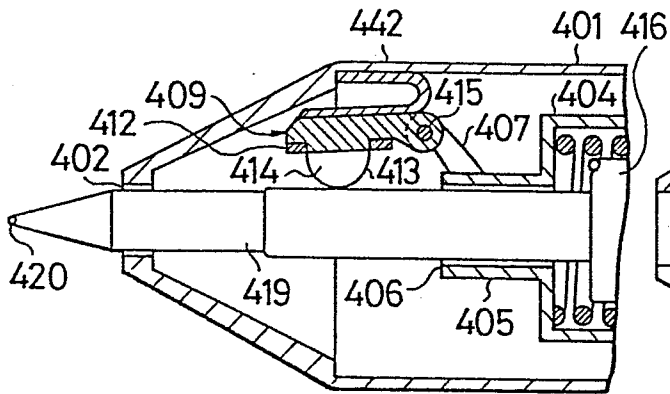


FIG. 75

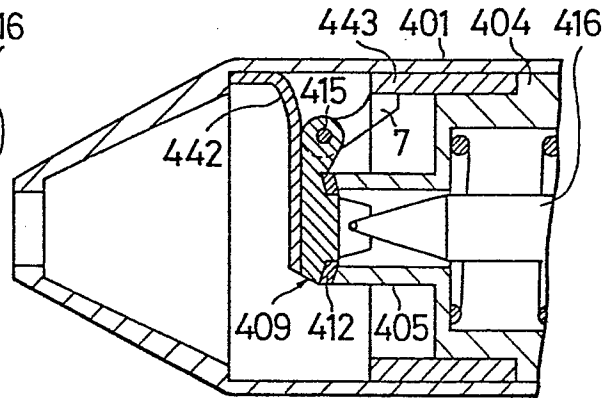


FIG. 76

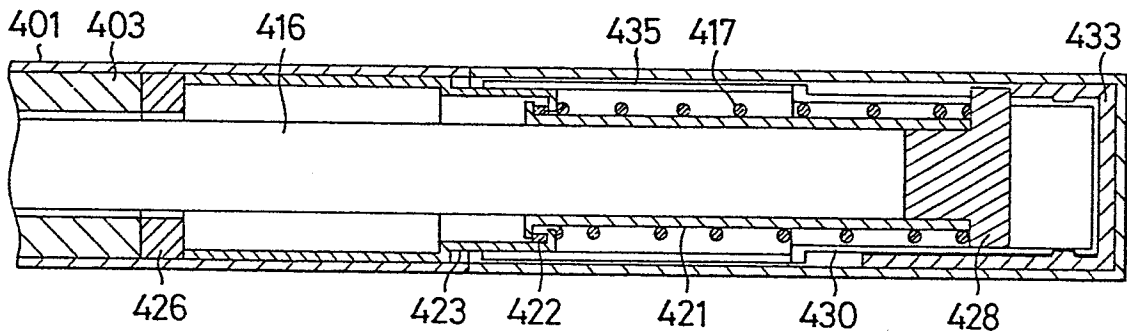


FIG. 77

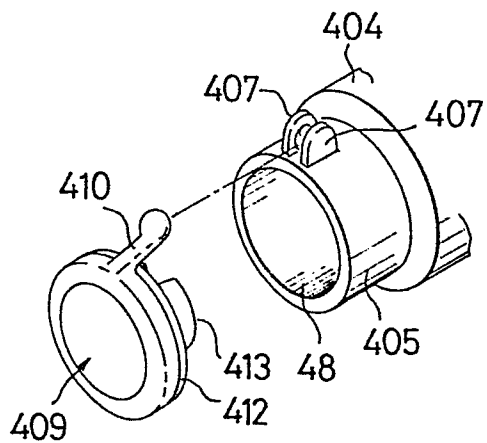


FIG. 78

