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(54) Sample injector.

(57) A disposable sample tip (10) to provide a liquid sample of a predetermined volume and a plunger type injector (12) to introduce the sample into a spectrometer for analysis. The injector (12) is provided with an anti-suction means (104) so that the sample will not be withdrawn from the sample tip (10) in the event the sample tip (10) is filled before the injector (12) is made ready to introduce the sample into the spectrometer.

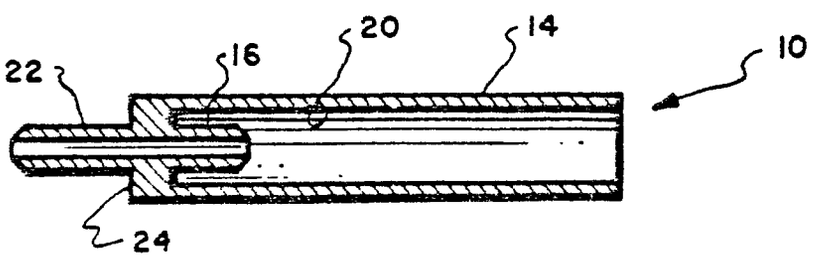

Fig. 1.

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SAMPLE INJECTOR

BACKGROUND OF THE INVENTION

This invention relates, in general, to liquid sample delivery and liquid chromatography and, in particular, to an apparatus for introducing liquid samples into an atomic absorption spectrometer.

It is common practice to use pipetting devices to predetermine the precise volume of a sample to be analyzed and to use gas pressure, sometimes air pressure, to dispense the sample from the pipetting device. The gas pressure may be from a separate tank-type source or may be provided by a plunger type device. Pipetting devices are shown in a number of U.S. Patents, for example, to Morrill, No. 3,200,650 and to Gerrarde, No. 3,040,494 and the textbook of Paul L. Kirk "Quantitative Ultra Micro Analysis", John Wiley and Sons, New York, 1950, pages 22-26, 73/864.02, teaches pipetting to determine sample volume. The patents also show a source of gas to dispense the liquid sample. Plunger type dispensing devices, in connection with pipettes, are shown, for example, in the U.S. Patents to Avakian, No. 3,732,734, to Norton, 3,754,687, and to Parsons, 4,257,267. The Avakian patent also shows a removable tip used with a pipette and the Parson patent shows a removable tip, which is called a pipette, but is not used to determine the volume of the liquid sample.

SUMMARY OF THE INVENTION

This invention comprises a disposable sample tip which is used to provide a liquid sample of a predetermined volume and a plunger type injector which is used to introduce the sample into a spectrometer with a precise amount of air pressure. The sample tip comprises an outer tube for mounting the sample tip on the injector and an inner tube (pipette) of a desired bore and length. The injector is provided with an anti-suction means so that the sample liquid will not be withdrawn from the inner tube by the injector in the event the inner tube is filled with the liquid sample before the injector is made ready to introduce the sample into the spectrometer.

It will be apparent to those skilled in the art that, while the recommended procedure is to make the injector ready for the step of introducing the sample into the spectrometer, either before or after the sample tip is mounted on the injector, and before the sample tip is inserted into the liquid to be sampled, it is possible that the sample tip will be mounted on the injector and the sample tip inserted into the liquid to be sampled before the injector is made ready for the introduction step. The anti-suction means compensates for this latter variation from the recommended procedure for if it were not operative, such a variation would cause all or a portion of the sample to be withdrawn from the inner tube.

It is also to be understood that this compensation is important since this invention may be used in non-laboratory environment with relatively unskilled personnel.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross-sectional view of the sample tip with an internal pipette,

Figure 2 is a plan view showing the sample tip on the injector,

Figures 3 and 4 show the introduction of the liquid into the sample tip and how the sample is introduced into the spectrometer,

Figure 5 is an elevational view, in cross section, showing the details of the injector with its piston in an upper or cocked position,

Figure 6 is a view, similar to figure 5, but showing the piston in its lower or uncocked position,

Figures 7 is an enlarged view of the area encircled in figure 5 showing the anti-suction feature of this invention by showing the flow of air through the piston as the piston is moved upwardly,

Figure 8 is an enlarged view of the area encircled in figure 6 showing the piston moving downwardly,

Figure 9 is an enlarged view of the area encircled in figure 5 showing the details of the latch mechanism in the latched position, and

Figure 10 is an enlarged view of the area encircled in figure 6 and showing the latch mechanism in the unlatched position.

DETAILED DESCRIPTION

The drawings show a sample tip 10 and a plunger type injector 12. Figure 1 shows the sample tip enlarged relative to the injector 12 but figure 2 shows the relative sizes of the two devices and also shows the sample tip 10 mounted on the injector 12.

The sample tip 10 comprises an outer hollow tube 14 and a shorter inner capillary tube (pipette) 16 spaced from the inner wall 20 of the outer tube 14. Although shown as one molded piece, effectively one end of the inner tube 16 extends beyond

the outer tube 14 to form an insertion tip 22 and a step 24 and the other end of the inner tube 16 terminates substantially midway of the outer tube 14. The length of the inner tube 16 and the size of its internal bore establishes the volume of the sample to be analyzed.

Figure 3 illustrates the step of filling the inner tube 16 with liquid by inserting the sample tip 10 into a body of liquid 26 and figure 4 shows the step of introducing the sample into the spectrometer by inserting sample tip 10 into a graphite tube 30 of a spectrometer (not shown) with the step 24 establishing the distance between the end of the sample tip 10 and the graphite tube inner surface 32.

Turning now to figures 5 through 9 which depict the injector 12, it can be seen that the injector 12 comprises a long tubular body 34 (handle) and a relatively thin walled hollow nozzle 36 which has a tubular portion 40 of the same outer diameter as the tubular body 34, a first taper 42 and, a second tubular portion 44 of a lesser diameter than tubular portion 40 which terminates in a slightly tapered narrow hollow point 46. The hollow point 46 holds the sample tip 10 as shown in figures 5 and 6 and the tubular portion 40 forms a piston chamber 48. The nozzle 36 is fitted over the end of the tubular body 34 and held thereon in any suitable manner as by internal and external complimentary threads 50.

The tubular body 34 has a central bore 52 in which a plunger 54 is slidably fit and which extends beyond the ends of the tubular body 34. The lower end of the plunger 54, as more clearly shown in figures 7 and 8, has a reduced portion 56 which is fitted with a retainer 60 which has a collar 62, a radially extended disc 64 and a downwardly extending short connecting rod 66. The retainer 60 is held on the plunger 54 by a lock pin 70 and lock washer 72 holds a hollow, relatively thin walled, downwardly opening piston 74 on the connecting rod 66. Both the piston 74 and the retainer 60 are enclosed in the piston chamber 48 where movement of the piston 74 downwardly will expell a measured amount of air under pressure from the nozzle point 46 and dispense the sample from the sample tip 10.

A counterbore 76 in the lower end of the tubular body 34 encloses a helical piston spring 78 which biases the piston 74 toward a downward or uncocked position. The upper end of the counterbore 76 is open to atmosphere by radial holes 80 (Figs 5 & 6). The spring 78 and the piston 74 are held in an upper, or cocked, position by a latching mechanism 82. (See the enlarged view of the latch mechanism 82 in figures 9 and 10). This latching mechanism 82 comprises a latch button 84 with an extension arm 86 of a lesser diameter and containing an opening 90 which allows the plunger 54 to pass therethrough. The extension arm 86 is disposed in sliding relationship within a sleeve 92 and a blind radial counterbore 94 in the tubular body 34. In one position, the cocked position, an edge 96 on the extension arm 86 near the opening 90 engages a shoulder 100 on the plunger 54 formed by a reduced radius 102 in the area of the latch mechanism 82 and, in another position, the uncocked position, allows the plunger 54 to move freely in response to the piston spring 78. The extension arm 86 is spring biased toward the cocked position by a helical spring 104. As shown in figures 2,5 and 6, a handle 106, attached to the upper end of the plunger 54, is provided for the purpose of pulling the plunger upwardly and is operable manually. Thus, the latching mechanism 82 will automatically latch the piston 54 in the cocked position when the handle 106 is pulled upwardly a sufficient distance. The plunger 54 and piston 74 are released by pressing the latch button 84 radially inwardly against the force of the spring 104 which will free the shoulder 100 of the edge 96 and allow the helical spring 78 to move the piston 74 downwardly to create a sufficient amount of air under pressure to be expelled from the nozzle 40 and to expel the sample from the sample tip 10 as shown schematically in figure 4. It is to be noted that, as shown in figures 5 and 6, the handle 106 extends into a blind bore 110 in the top of the tubular body 34 in sliding relationship and the bottom 112 of the handle 106 engages the bottom 114 of the blind bore 110 to limit the stroke of the piston 74.

The recommended procedure is to cock the injector 12 either before and after the sample tip 10 is mounted on the injector 12 but before the sample tip 10 is inserted into the liquid to be sampled.

However, it is possible that an operator will forget to cock the injector 12 before inserting the sample tip into the liquid and then, realizing his mistake, will then cock the injector 12 which normally would withdraw all or part of the sample into the injector 12.

To prevent this, the injector 12 is provided with an anti-suction means 120 which is a function of the retainer 60 and the piston 74 and which will now be described in detail. This is considered an important feature of this invention and figures 7 and 6 show its operation.

It can be seen that the top wall 122 of the piston 74 contains holes 124 (2 shown) of a relatively small size. These small holes 124 form passage means for air on one side of the piston 74 to flow to the other side of the piston 74 and the disc 64 forms a closure means for opening and closing these holes 124 during movement of the piston 74. With the pinning of the retainer 60 to the plunger 54 by lock pin 70, there is no relative movement between the disc 64 and the piston 74, but the

piston 74, being fixed on the connecting rod 66 by the lock washer 72 is free to move relative to the disc 64 and the distance is determined by the spacing between the lock washer 72 and the disc 64. With this arrangement, when the piston 74 is being pulled to its cocked position, the disc 64 is spaced from the top wall 122 allowing air from the upper part of the piston chamber 48 to flow through the holes 124 downwardly into the lower part of the piston chamber 48. On the other hand, when the plunger 54 is released by the latch mechanism 82, the disc 64 which moves the piston 74 downwardly and, at the same time, acts as a closure to prevent the flow of air through the holes 124. At this time, air is free to flow through radial holes 80 located at the top of the counterbore 76. Thus, it can be seen that this arrangement allows an equilibrium in the air pressure on both sides of the piston 74 during cocking and also prevents the sample in the sample tip 10 from being disturbed by the movement of the piston 74 toward the cocked position.

It is to be understood that wherever the words "upper" or "lower", "down" or "up", or "left" or "right" are used, they were used to facilitate the description of the invention with reference to the drawings. Also, while the words "bore" and "counterbore" are used, they were not meant to imply that these were necessarily formed by a machining process since the injector (and many of its parts) and the sample tip may be formed of a suitable commercially available plastic by a molding process. It is also to be understood that the liquid of the sample to be analyzed may be any liquid, but in this case, lubricating oil is the liquid for which this invention is particularly directed so that wear of movable metal parts, such as aircraft engine parts, may be determined by atomic absorption spectrometry.

Claims

1. An injector comprising,
a tubular body with a longitudinal axial bore, a hollow nozzle on said tubular body with a narrow hollow point,
a plunger slidably received in said axial bore, a piston at one end of said plunger and within said nozzle,
closure means on said plunger and within said nozzle,
said closure means and piston being spring biased toward a first position,
said nozzle forming a piston chamber in which said piston moves so that movement of said piston from a second position to said first position generates gas pressure to be emitted from said nozzle, and
a latching mechanism for cocking said piston in said second position against the bias of said spring and for releasing of said piston so that said spring bias will move the piston to said first position, and
anti-suction means to equilibrate the gas in said piston chamber when said piston is moved to said second position.

2. The injector as claimed in claim 1 wherein said closure means comprises disc means.

3. The injector as claimed in claim 2 wherein said disc means move said piston to said second position in response to said spring bias.

4. The injector as claimed in claim 3 wherein said anti-suction means includes passageways in said piston opening into said piston chamber for the free flow of gas from one part of said piston chamber to the other as said piston moves to said second position from said first position.

5. The injector as claimed in claim 4 wherein said closure means closes said passageways as said piston is being moved to said first position and closes said passageways as said piston is being moved to said second position.

6. The injector as claimed in claim 5 wherein said closure means has means connecting said disc means to said plunger and connecting said piston to said closure means such that there is relative movement between said disc means and said piston means.

7. The injector as claimed in claim 6 further including handle on said plunger for pulling said plunger against the bias of said spring.

8. The injector as claimed in claim 7 further including means for determining said first position.

9. The injector as claimed in claim 8 wherein said last mentioned means forms part of said handle.

10. The injector as claimed in claim 9 further including a sample tip including a pipette insertable on said nozzle so that gas pressure emitted from said point will eject a liquid sample in said pipette.

11. The injector as claimed in claim 10 wherein the function of said anti-suction means will not disturb any liquid sample in said pipette if said piston is moved to said first position while said sample is on said injector.

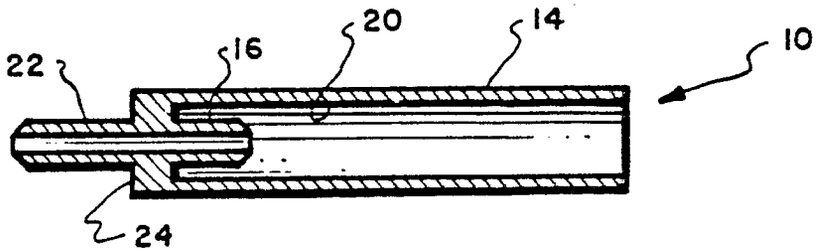


Fig. 1.

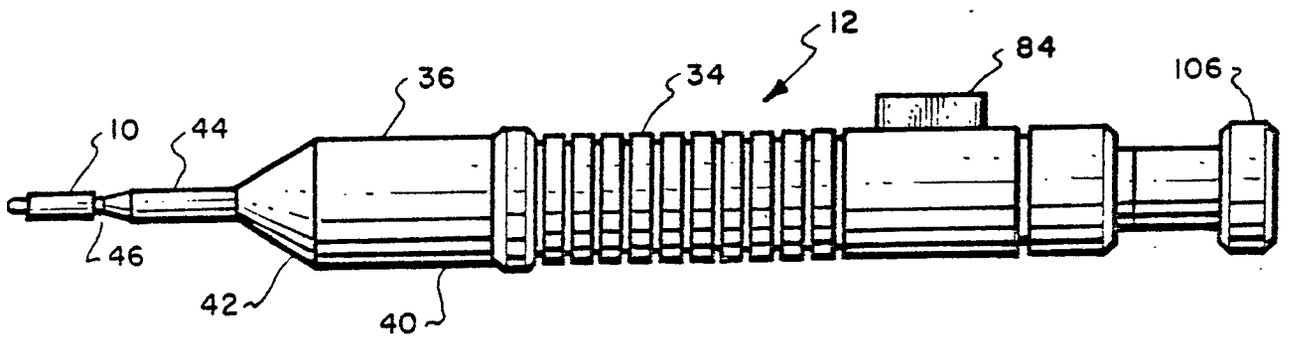
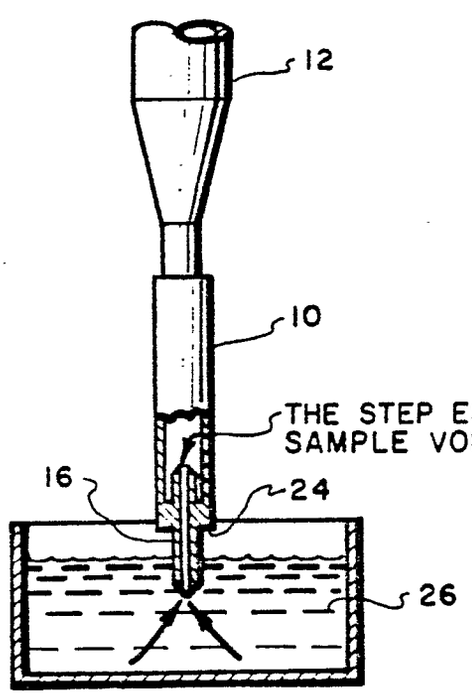


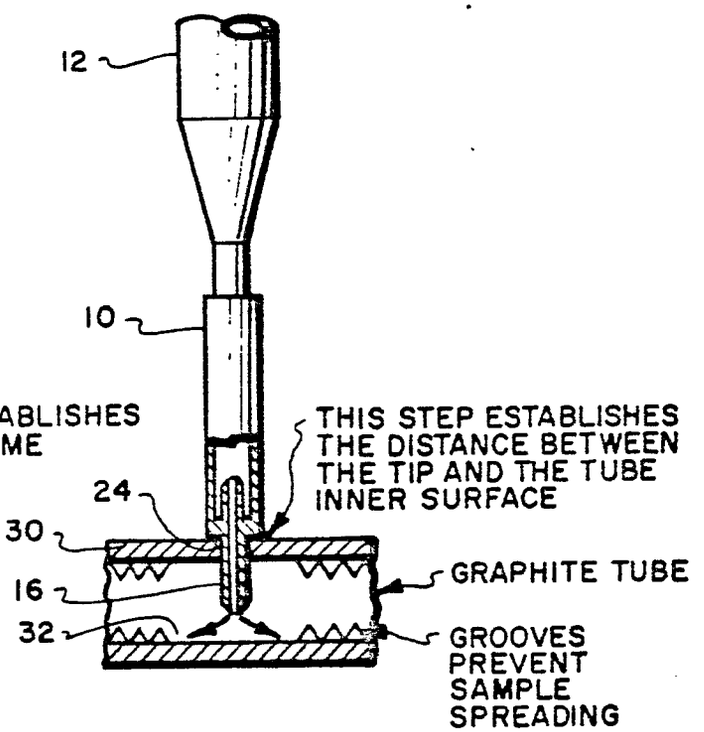
Fig. 2.



EXTRACTING SAMPLE

STEPPED SAMPLER ASSURES CONSISTENT SAMPLE SIZE

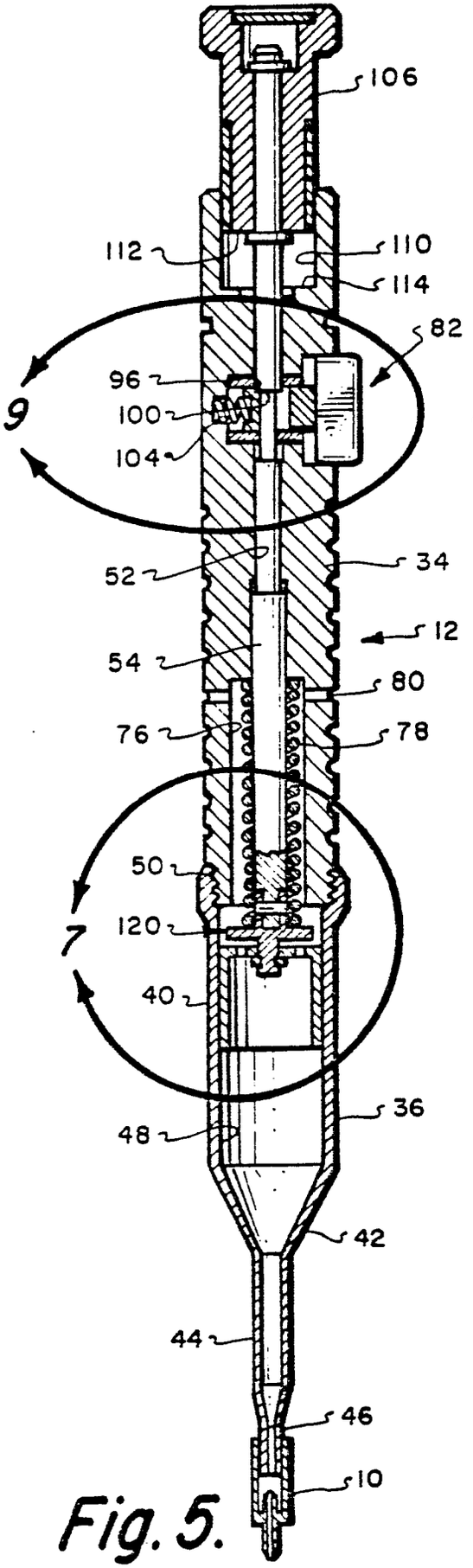
Fig. 3.



EXPELLING SAMPLE

POSITIVE PRESSURE ASSURES COMPLETE SAMPLE EXPULSION

Fig. 4.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10

Fig. 5.

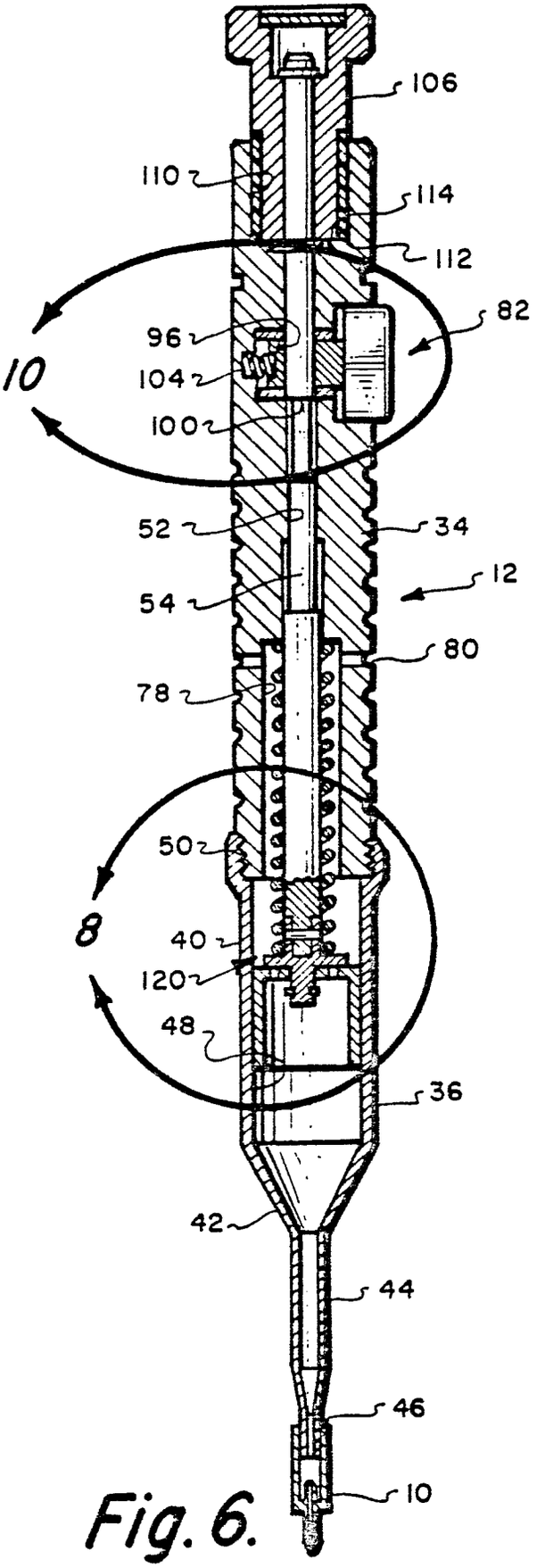
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Fig. 6.

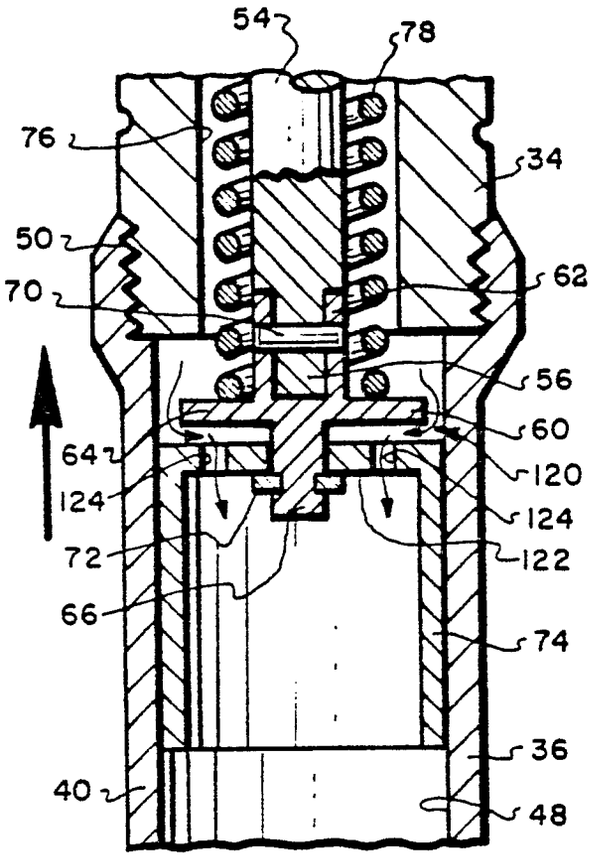

Fig. 7.

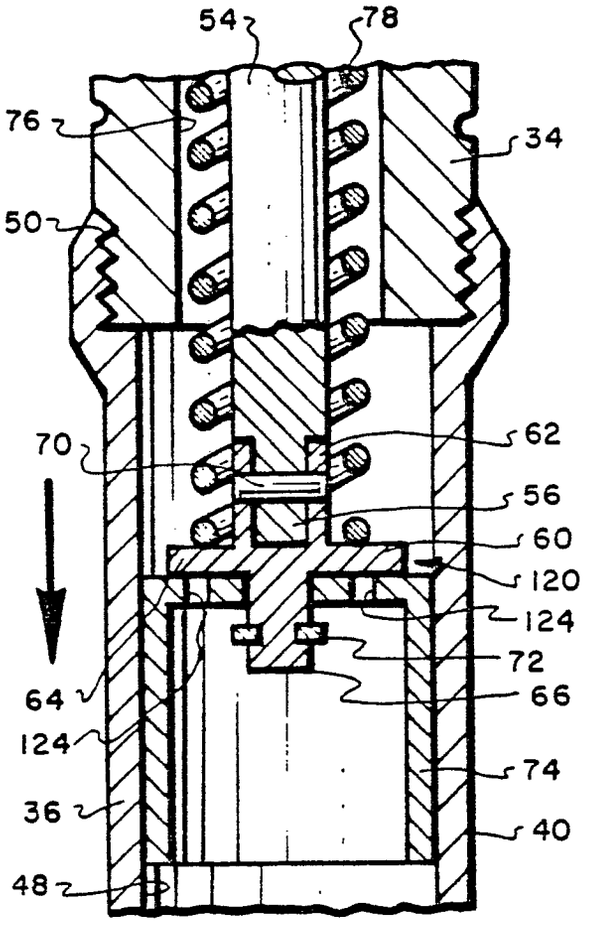

Fig. 8.

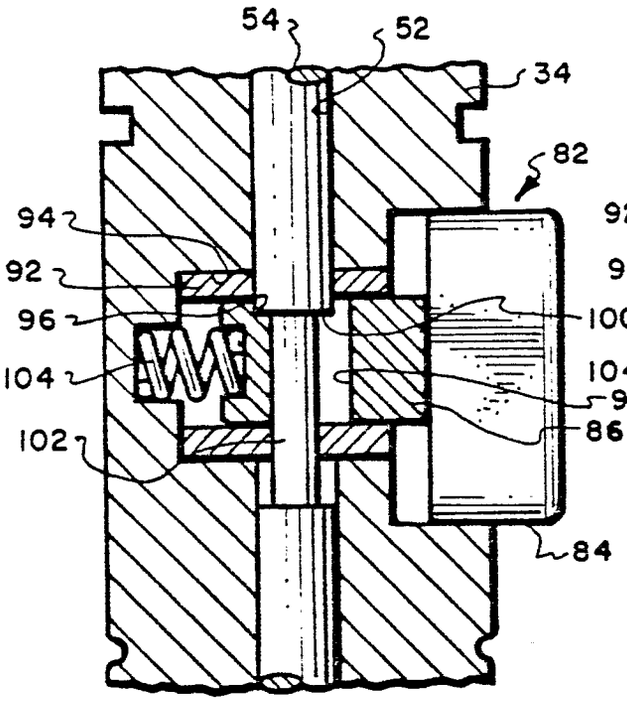

Fig. 9.

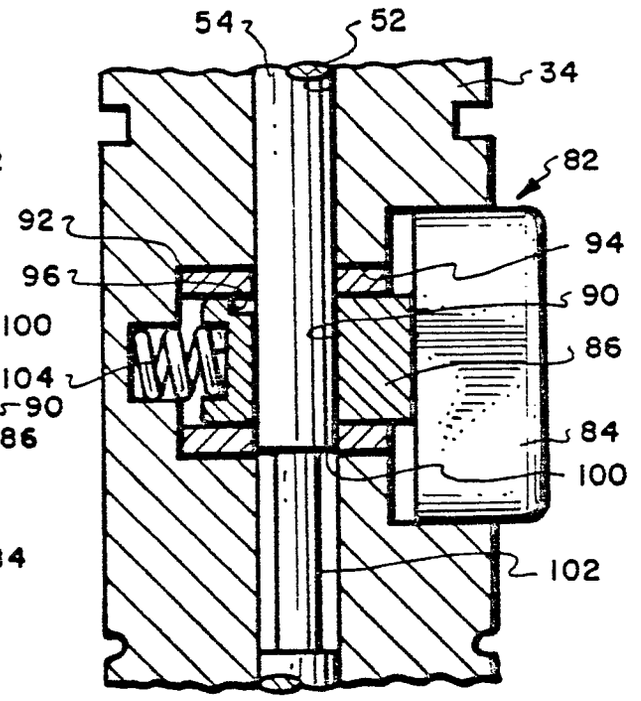

Fig. 10.