United States Patent [19]

Riccio

[11] **3,733,010**

[45] **May 15, 1973**

[54] **AIR PRESSURE OPERATED DISPENSER**

[75] Inventor: **Pasquale R. Riccio,** Suffern, N.Y.

[73] Assignee: **Ciba-Geigy Corporation,** Ardsley, N.Y.

[22] Filed: **Apr. 30, 1971**

[21] Appl. No.: **139,027**

[52] **U.S. Cl.** **222/193,** 222/387, 239/357

[51] **Int. Cl.** **B67d 5/54**

[58] **Field of Search** 222/193, 387; 215/3; 239/355, 357; 128/278

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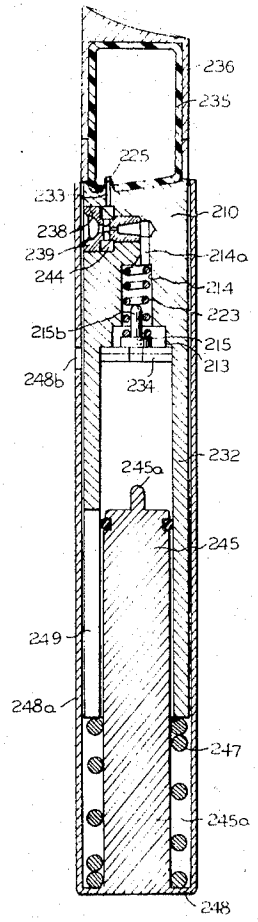
Primary Examiner—Robert B. Reeves
Assistant Examiner—Thomas E. Kocovsky
Attorney—Wenderoth, Lind & Ponack

[57] **ABSTRACT**

A dispensing device in which the product to be dispensed is aspirated and sprayed by the discharge of pressurized air. A valve assembly has a product flow path therethrough and a compressed air flow path therethrough. The valve stem of the assembly is actuated to open the compressed air flow path, and a flap valve is actuated to open the product flow path. Aspirating means is provided at the upper end of said stem for bringing one end of each of said flow paths together. A piston-cylinder assembly is provided on the device having a cylinder with one end around the end of the compressed air flow path, a piston slidable in the cylinder, and a piston rod on said piston and rod on said piston and extending out of the other end of said cylinder. A product container means is connected around the end of the product flow path remote from the aspirating means. The end of the valve stem extends into the cylinder and is engaged by the piston rod for moving the valve stem relative to the valve body for opening the compressed air flow path when the piston is moved to the inner end of the cylinder adjacent the valve assembly to provide a predetermined amount of compressed air. The action of the aspirating means opens the flap valve to draw the product to be dispensed from the product container and dispense it.

12 Claims, 26 Drawing Figures



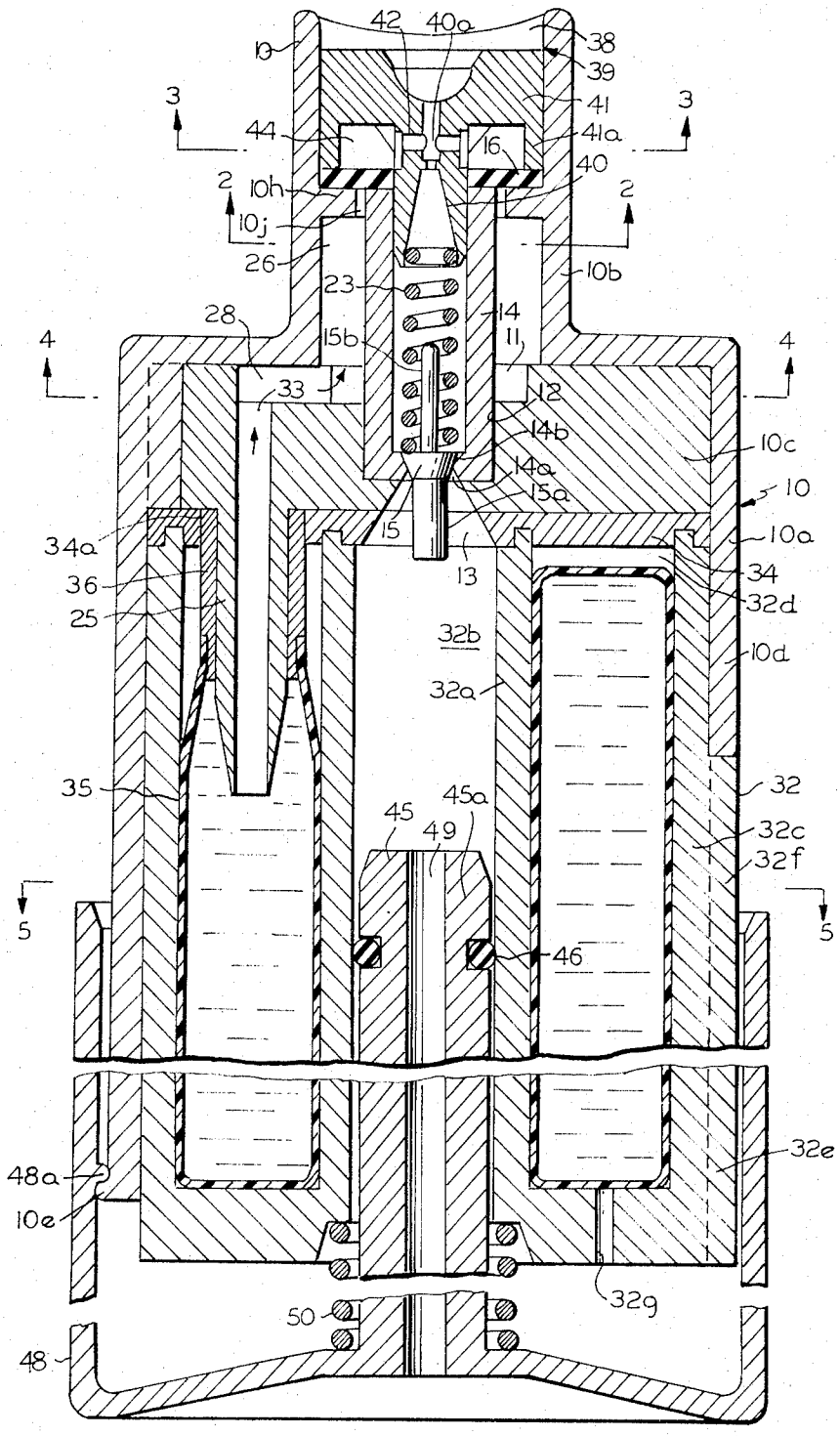


FIG.1

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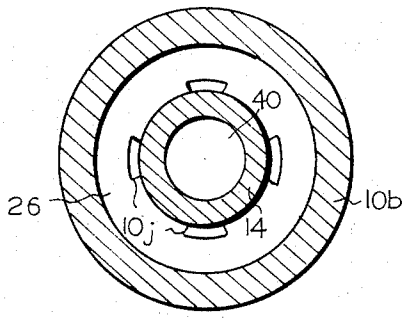

FIG. 2

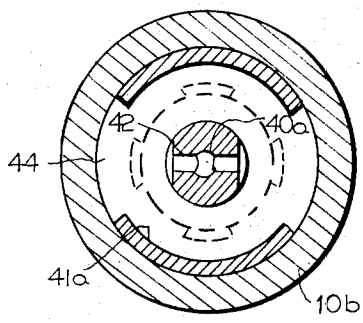

FIG. 3

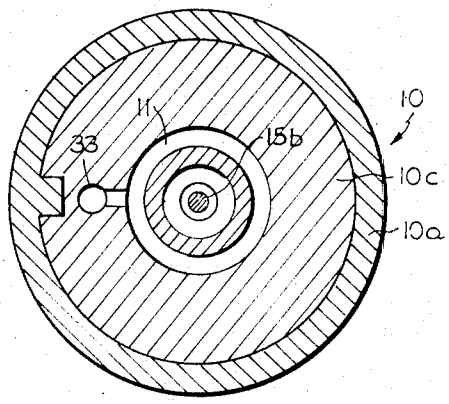

FIG. 4

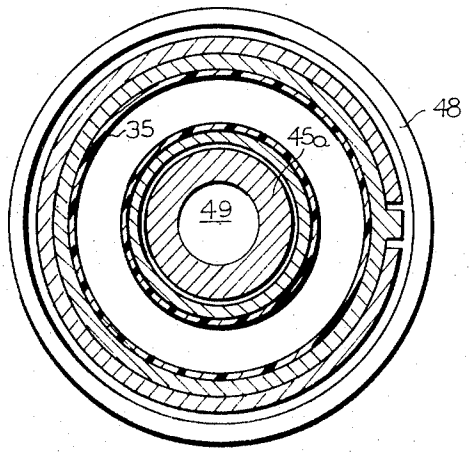

FIG. 5

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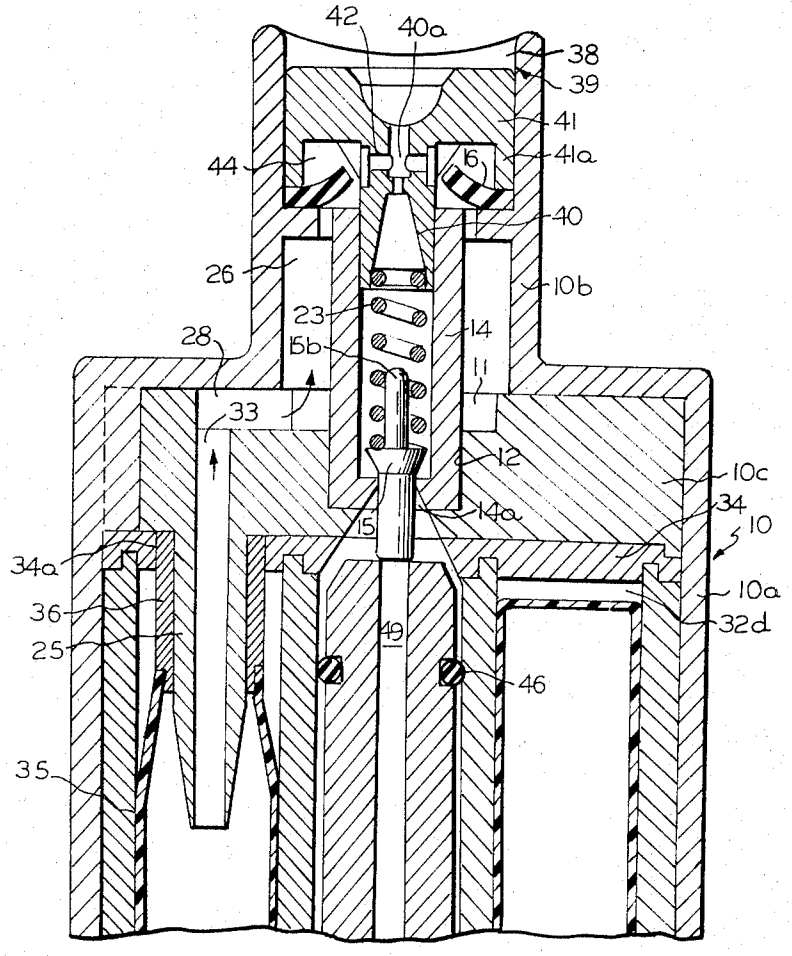

FIG. 6

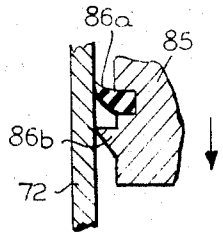

FIG. 8a

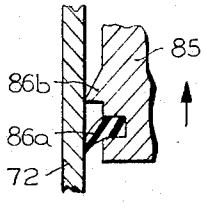

FIG. 8b

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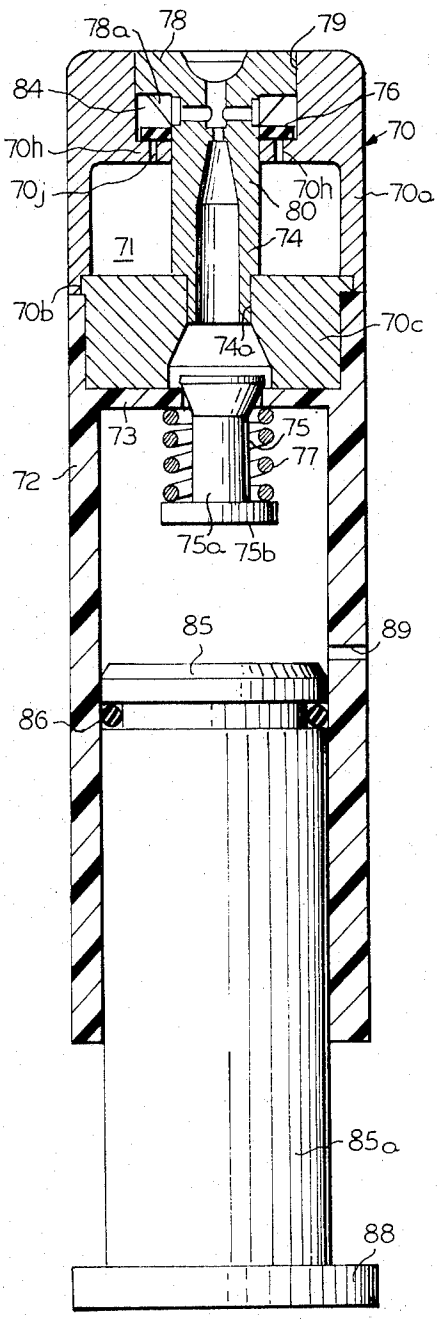

FIG.7

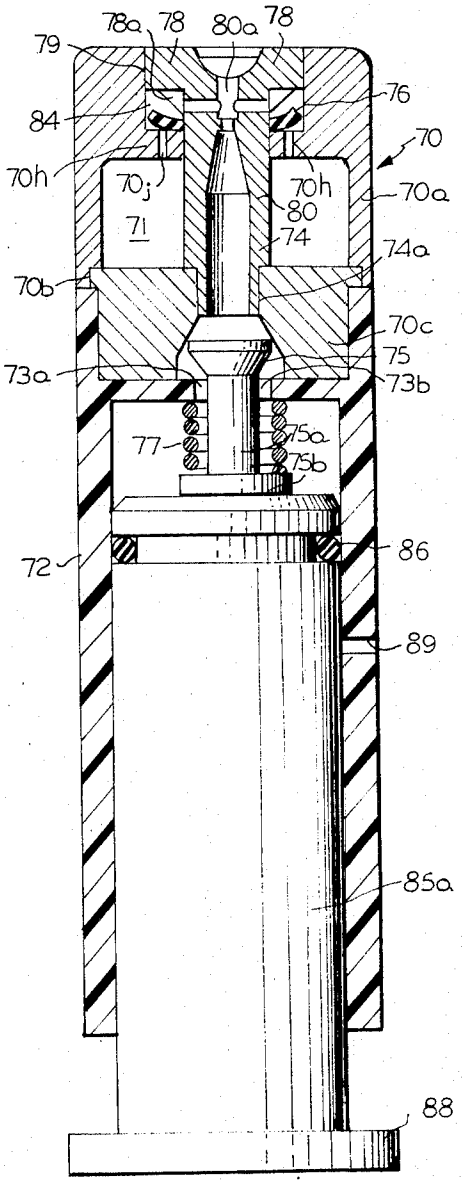

FIG.8

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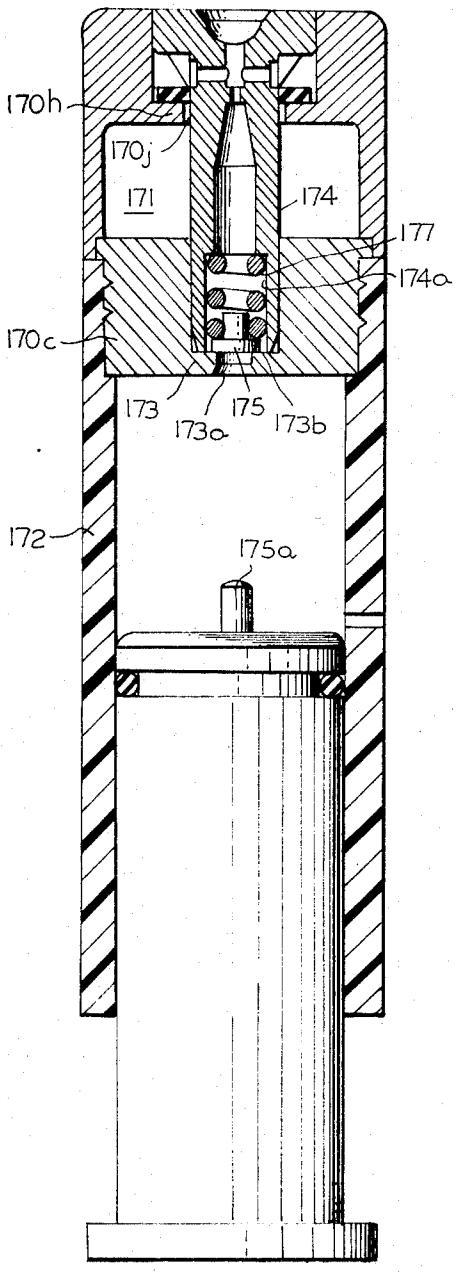

FIG.10

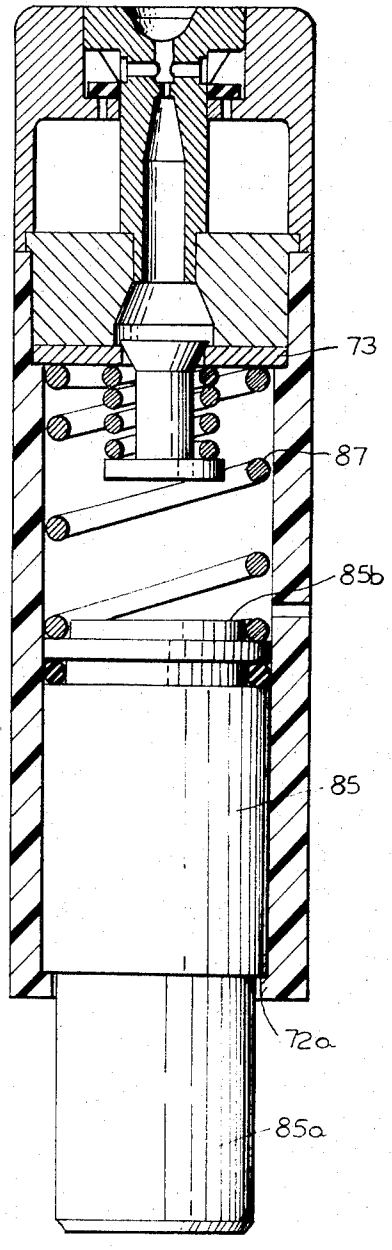

FIG.9

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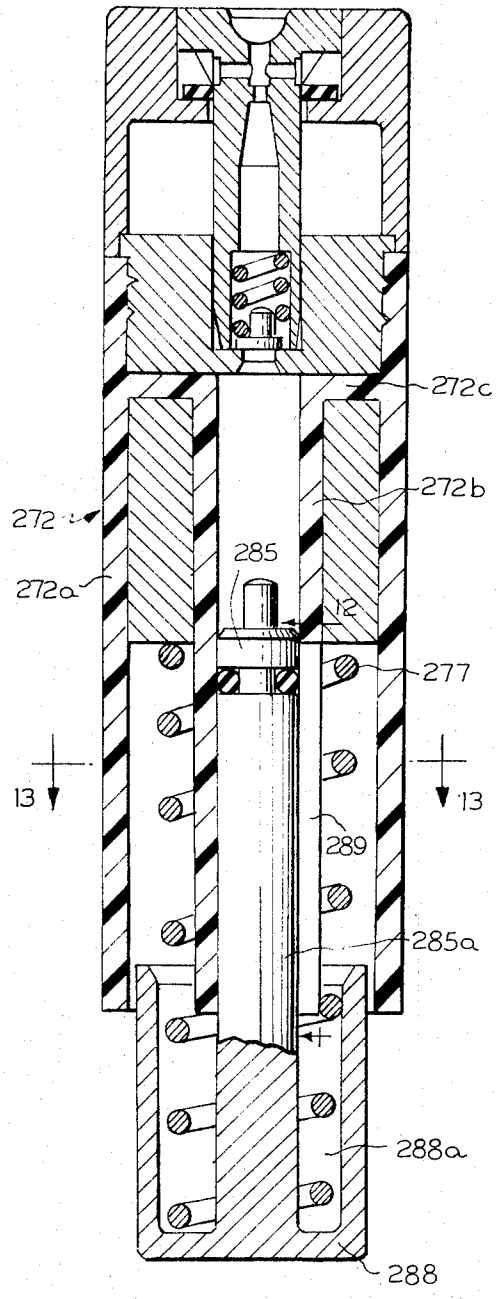

FIG.11

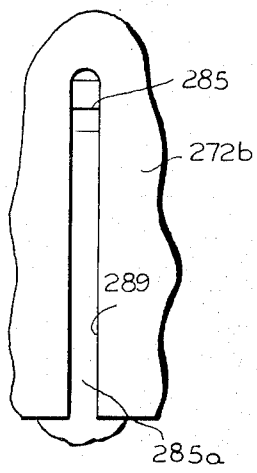

FIG.12

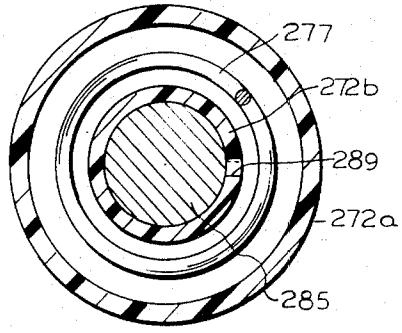

FIG.13

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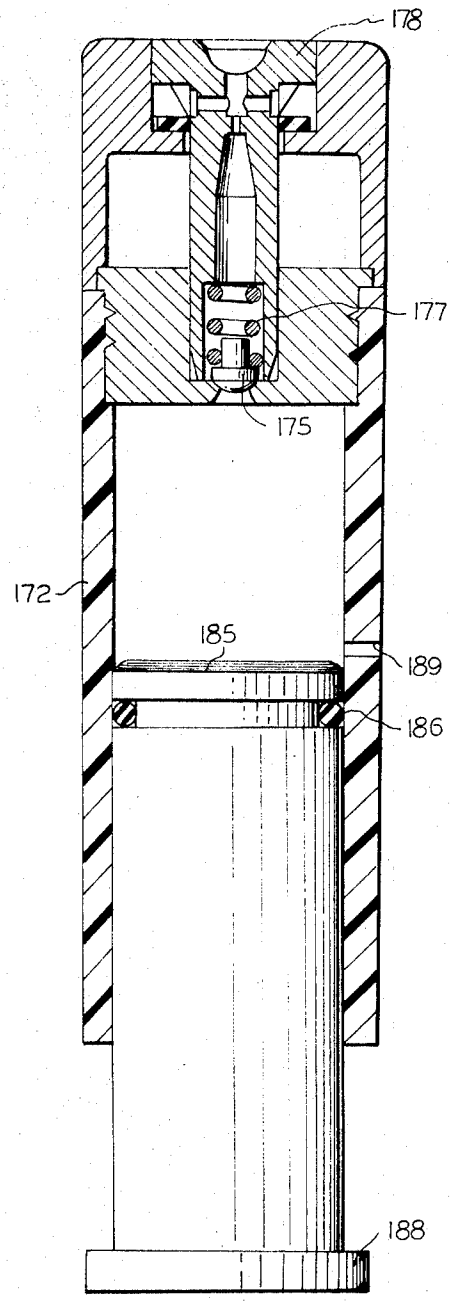

FIG.14

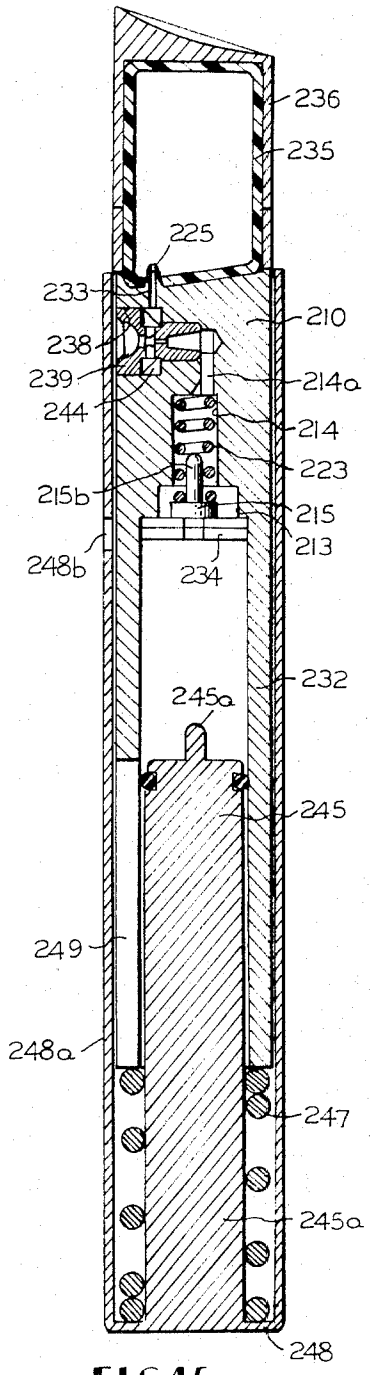

FIG.15

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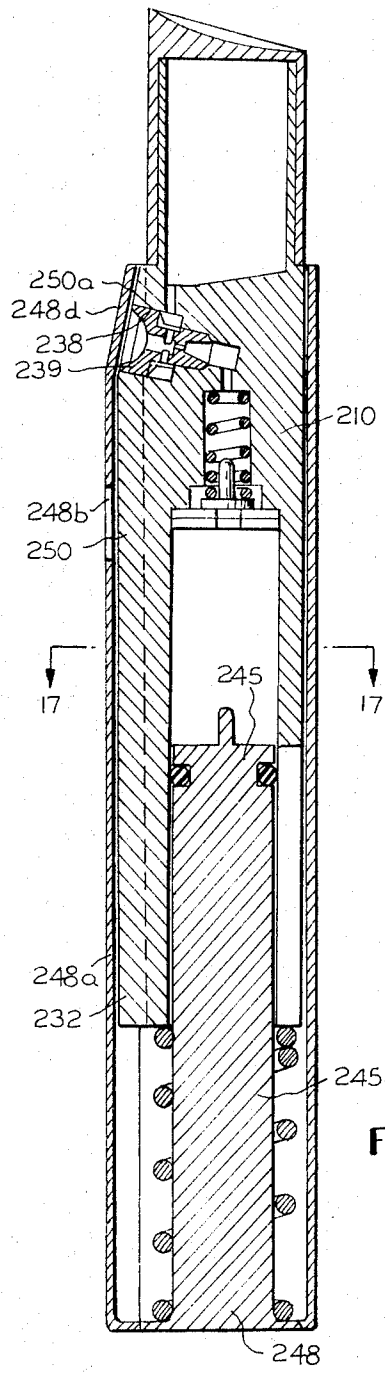

FIG.16

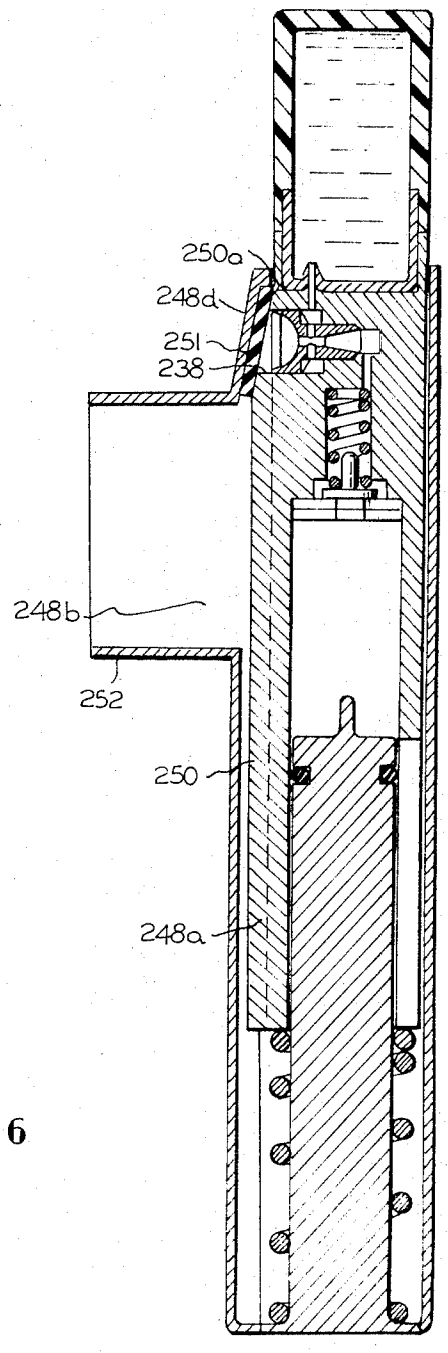

FIG.18

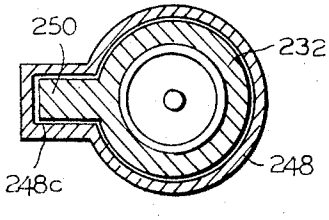

FIG.17

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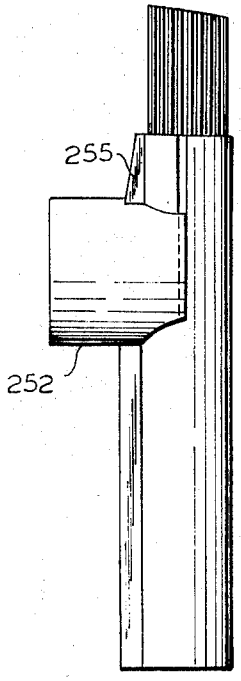

FIG. 19

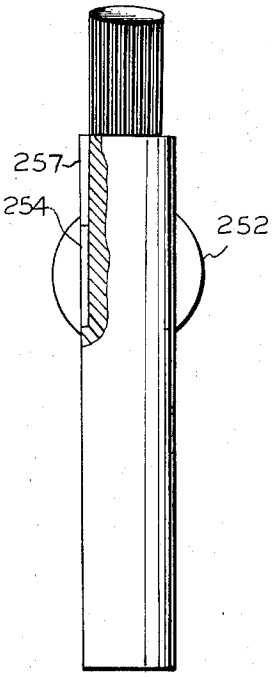

FIG. 20

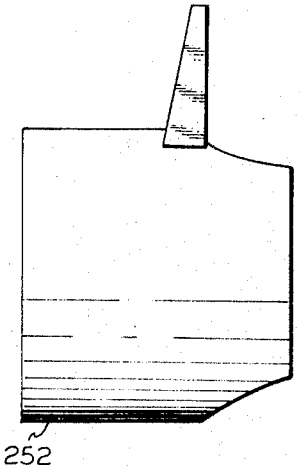

FIG. 21

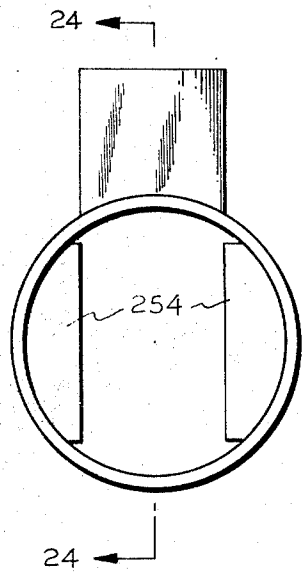

FIG. 22

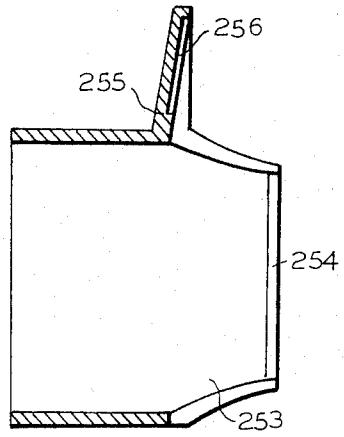

FIG. 24

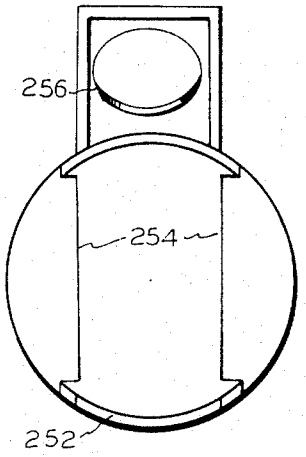

FIG. 23

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AIR PRESSURE OPERATED DISPENSER

BACKGROUND OF THE INVENTION

This invention relates to a dispenser for fluids, and more particularly to a device for aspirating a fluid and dis-pensing it as a spray by means of compressed air.

PRIOR ART

The art of dispensing fluid material is very highly developed. More recently there have been great advances in the art of dispensing fluid materials by means of a compressed propellant while keeping the fluid and propellent separate prior to dispensing. These recently developed so-called double aerosol type dispensers are quite satisfactory, but nevertheless have some disadvantages, particularly where they must be made in small sizes. Many of these disadvantages are also common to the single phase dispenser, where the propellant and the material to be dispensed are stored in the mixed condition in the dispenser prior to dispensing.

A most serious disadvantage arises from the fact that so-called aerosol propellants are used to dispense the material. When medicaments are dispensed from inhaler type devices, these propellants are inhaled by the user along with the medicament. It has recently been reported that fluorocarbon propellants, e.g. Freon which is a commonly used propellant, may be highly toxic, and the same situation may be found to hold true for other propellants. Pharmaceutical marketers would thus prefer to have the product dispensed by air instead of a chemical vapor conventionally used as a propellant.

A further disadvantage of the prior art aerosol dispensing devices is leakage of propellant from the propellant cartridge during storage, which reduces the shelf life of the dispenser. Additionally, the problem of exactly matching the amount of propellant with the amount of material to be dispensed is often difficult because of this leakage problem. Also because of differences between the various materials being dispensed a proper amount of propellant for one material will not suffice or will be in excess of that necessary for dispensing all of another material. In the first instance, part of the product is wasted, and in the second instance part of the propellant is wasted.

In addition, if it is desired to dispense only a measured quantity of material, special valving means must be developed. Otherwise, the amount of material dispensed is proportional to the time of actuation of the device, and there is no way accurately to insure that the user will properly time the actuation to dispense the desired measured quantity.

A further disadvantage is that with compressed gas type propellants when the propellant is running low, the dispensing of the last of the material to be dispensed can be carried out only at a very slow rate, as compared to when the dispenser is initially filled with propellant, when dispensing takes place rapidly.

Many of these disadvantages could be overcome if, instead of using compressed conventional propellant gases, air was used as a propellant and was compressed each time the dispensing operation was to be carried out. Conventional squeeze bulb and piston-cylinder atomizers operate somewhat in this fashion, but have the serious drawback that the compression is carried out gradually, and the aspiration is thus gradual, the amount of material being dispensed being dependent

on how fast and with what force the squeeze bulb or the piston-cylinder means is operated. They very often include a check valve at the delivery end of the cylinder, but this valve does not provide any significant resistance to flow of compressed gas once the piston starts to move into the cylinder.

It is desirable that a compressed air type dispenser, particularly one for dispensing medicaments which are to be inhaled or otherwise ingested, have the capability of dispensing measured amounts of a medicament and yet dispense no more than such amount regardless of how it is operated.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the present invention to provide a simple and compact dispensing device which utilizes compressed air for aspiration in a manner so as to overcome all of the recited disadvantages of the aerosol type dispensers.

It is a further object of the present invention to provide a simple and compact dispensing device which utilizes compressed air that is compressed each time dispensing takes place, but which releases the compressed air suddenly only after the pressure has been built to the maximum.

It is a still further object of the present invention to provide a simple and compact dispensing device which utilizes compressed air for dispensing, which dispenses a measured amount of material at each actuation of the device, is extremely safe to use, and which cannot dispense more than the measured amount of material.

It is a still further object of the present invention to provide a simple and compact dispensing device which can be stored without loss of a propellant and which therefore has a shelf life limited only by the life of the material to be dispensed, which can also be stored without fear of an explosion of a compressed propellant, and which can be shipped in interstate commerce as a non-pressurized item, thereby eliminating the need for special packaging and labeling.

It is still further object of the invention to provide a simple and compact dispensing device which has a singly positively operated valve in the compressed air flow path between the piston and aspirating means thereof, and a fluid pressure operated flap valve for sealing the product flow path when product is not being aspirated

These objects are achieved by providing a dispensing device which has a valve assembly with a valve body having a valve seat in a compressed air flow path through said valve assembly. A valve member seats on said valve seat. The valve assembly further has a product flow therethrough preferably with a resilient flap valve obturating it. Aspirating means are provided in the assembly to bring the flow paths together. The flow paths open out of the valve body remote from the aspirating means. A piston cylinder assembly has a cylinder around the end of the compressed air flow path having a piston slidable therein, and connected to the end of the product flow path is a product container. A piston rod is connected to the piston for moving the piston into the cylinder. When the piston reaches the inner end of the cylinder rod the valve member is caused to be lifted from the valve seat to open the compressed air flow paths, thus releasing the compressed air from the cylinder. The action of the aspirating means opens the flap valve obturating the flow path of the product for aspirating the product and dispensing it in a spray.

BRIEF DESCRIPTION OF THE DRAWINGS

Other and further features of the invention will be described in the following specification and claims, taken with the accompanying drawings, in which:

FIG. 1 is a sectional elevation view of the dispensing device according to the present invention, with the parts in positions ready for the start of the dispensing operation;

FIGS. 2–5 are sections taken on lines 2—2, 3—3, 4—4, and 5—5 respectively of the device shown in FIG. 1;

FIG. 6 is a view of the upper part of the device of FIG. 1 in which the parts are shown in their positions during a dispensing operation;

FIG. 7 is a sectional elevation view of a second embodiment of the dispensing device according to the present invention, with the parts in positions ready for the start of a dispensing operation;

FIG. 8 is a view of the upper part of the device of FIG. 7 in which the parts are shown in their positions during a dispensing operation;

FIG. 8*a* and 8*b* are details of an alternative form of gasket which can be used in this embodiment.

FIGS. 9–11 are sectional elevation views of third, fourth and fifth embodiments of the dispensing device according to the present invention, with the parts in positions ready for the start of a dispensing operation;

FIG. 12 is a partial elevation view taken along line 12—12 of FIG. 11;

FIG. 13 is a transverse section taken along line 13—13 of FIG. 11;

FIGS. 14 and 15 are sectional elevation views of sixth and seventh embodiments of the dispensing device according to the present invention, with the parts in positions ready for the start of a dispensing operation;

FIGS. 16 and 17 are sectional elevation and a cross section of a modified embodiment similar to that shown in FIG. 15;

FIG. 18 is a sectional elevation view of an embodiment similar to that of FIGS. 16 and 17 which has been further modified;

FIGS. 19 and 20 are elevation views, FIG. 20 being partly in section, of an embodiment similar to that of FIG. 18;

FIGS. 21–23 are a side elevation, front and rear elevation views, respectively, of a part of the embodiment of FIGS. 19 and 20; and

FIG. 24 is a section taken on line 24—24 of FIG. 22.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIGS. 1–6 there is shown a dispensing device according to the invention which is constituted by a valve assembly, a piston-cylinder assembly, and a product containing means. The valve assembly has a valve body generally indicated at 10 having two parts, an outer housing part 10*a* which is here shown as being cylindrical and having a tubular projection 10*b* thereon, and an inner part 10*c*, which is generally annular and which has a cylindrical recess 11*a* in the top. A bore 12 extends downwardly from the cylindrical recess 11 and opens into a downwardly open recess 13 in the bottom of the inner part 10*c*. Positioned in the bore is a hollow cylindrical sleeve 14 having an opening 14*a* in the bottom thereof with a valve 14*b* therearound.

A valve member 15 is positioned in the bottom of sleeve 14 and has an extension 15*a* which extends through the opening 14*a* and through downwardly open recess 13. A pin 15*b* on the top of valve member 15 serves to hold the lower end of a return spring 23. In the rest position of the valve member 15 as shown in FIG. 1, in which the valve member 15 is in the lowered position relative to the valve body 10, the valve member 15 seats on the seat 14*b* and closes off or obturates the opening 14*a*.

Extending radially outwardly from the cylindrical recess 11 toward one side of the valve body 10 is a product passage 28 and from the outer end thereof extends a downwardly extending product passage 33. Passage 33 extends through a fitting 25 projecting downwardly from the inner part 10*c* into a further downwardly open recess defined within the downwardly extending outer wall 10*d* of the housing part 10*a*.

The tubular projection 10*b* has a transverse partition 10*b* which has the upper end of sleeve 14 integral therewith. The interior of sleeve 14 opens through partition 10*h*. A plurality of aperatures 10*i* are provided in partition 10*h*. The interior of the tubular projection 10*b* above partition 10*h* defines an upwardly opening recess 38. In this upwardly opening recess is fitted aspirating means in the form of a nozzle insert generally indicated at 39. The nozzle insert has a Venturi portion 40 which has the lower portion fitted into the interior of the sleeve 14. The Venturi portion 40 extends beyond the outer end of the sleeve 14. The nozzle insert has a portion 41 on the upper end thereof having a depending annular flange 41*a*, the outer diameter of the portion 41 and flange 41*a* fitting tightly within the upwardly opening recess 38. The Venturi portion 40, the portion 41, and the flange 41*a* define an annular product supply chamber 44 into which apertures 10*j* open. The Venturi nozzle insert 39 has a Venturi nozzle 40*a* therein, with radial product passages 42 opening into it through the Venturi portion 40 from the product supply chamber 44.

Within tubular projection 10*b* below the partition 10*h* is an annular passage 26 into which recess 11 opens. The passage 33, radial passage 28, recess 11, annular passage 26, apertures 10*j* and product supply chamber 44 define a product flow path through the valve assembly 10, while the recess 13, opening 14*a* and the hollow interior of sleeve 14 define a compressed air flow path though the valve assembly. A flap valve in the form of a flexible resilient annular gasket 16 is positioned on the upper surface of the partition 10*h* over aperatures 10*j*. The outer perpheral edge of the gasket 16 is held against partition 10*h* by the depending flange 41*a*, while the inner edge is free to flex upwardly into product supply chamber 41.

The cylinder assembly 32 has an inner cylinder 32*a* defining a cylindrical space 32*b*, and an outer cylinder 32*c* defining with the inner cylinder 32*a* an annular space 32*d*. The inner and outer cylinders are joined by a bottom wall 32*e*. The top end of the annular space 32*d* is closed by annular cover member 34, which in the embodiment shown is attached securely to the inner and outer cylinders 32*a* and 32*c* by the engagement of the top ends of the inner and outer cylinders in annular grooves in the under side of the cover member. The cover member 34 has an aperture 34*a* therein which aligned with the fitting 25 and through which the fitting 25 extends. The outer diameter of the outer cylinder

32c is such that it fits securely within the downwardly extending outer wall 10d of the housing part 10a. A rib 32f is provided on the outside of the outer cylinder 32c which fits in a corresponding slot in the outer wall 10d to properly align the aperture 34a with the fitting 25. It will be seen that the upper end of the cylindrical space 32b is closed by the cover 34, inner part 10c and the valve member 15. A piston 45 is slidable in the cylindrical space 32b and a piston ring 46 which is the form of an O-ring is positioned in a groove around the piston. The piston 45 includes a rod 45a which extends out through the open end of the cylindrical space 32b and a cover member 48 is mounted on the end of the rod part 45a and extends upwardly over the lower end of the wall 10d, and an internal rib 48a engages an external projection 10e on the lower end of wall 10d. A return spring 50 is positioned around the piston 45 between wall 32c and cover member 48. A vent bore 49 extends through the rod part and the piston. In the annular space 32d is positioned an annular flexible collapsible product containing sac 35. The product containing sac 35 has a discharge outlet 36 on the upper end thereof which extends upwardly and into sealing engagement around the fitting 25 and tightly into aperature 34a. A venting opening 32g extends through bottom wall 32e into space 32d.

In operation, starting with the parts in the position shown in FIG. 1 the valve body 10 is held and a finger is placed over the end of the bore 49 through the piston 45 and piston rod 45a. A force is then exerted on cover member 48 to force the piston 45 into the cylinder assembly 32. This causes the air pressure in the cylinder to build up, the cylinder being closed at one end of the valve assembly and at the other end by the finger over the vent bore 49. This movement is continued until the piston nears the inner end of the cylindrical space 32b. At this point, the pressure within the cylindrical space 32b has been built up to a maximum. Further movement of the cover member 48 moves the piston against the valve member extension 15, thus moving the valve member 15 relative to the rest of the valve assembly.

Up to this point, the interior of the cylindrical sleeve 14 has been sealed off from the interior of the cylindrical space 32b by the valve member 15 which completely seals off the opening 14a due to the resistance of spring 23. In addition, the part of the product flow path from the aperatures 10j to the passage 33 is sealed off from the product supply chamber 44 by the gasket 16 and its sealing engagement with the top surface of the partition 10h.

As shown in FIG. 6, movement of the valve member 15 opens the compressed air flow path from the interior of cylindrical space 32b through the opening 14a to the Venturi portion 40 of nozzle insert 39.

Flow of compressed air through Venturi portion 40 causes reduced pressure in the Venturi nozzle 40a which is communicated to the product supply chamber 44 through the radial product passages 42. This causes an upward flexing of the inner edge of annular gasket 16 to a point where the bottom surface moves away from the upper surface of the partition 10h. This uncovers aperatures 10j and opens the product flow path into the product supply chamber 44. The product to be dispensed is thereby aspirated from the product containing sac 35. Aspiration will continue until the compressed air in the cylinder 32 assembly is exhausted.

As the product is aspirated from the product containing sac, the sac will collapse under the effect of the pressure of the atmosphere around the dispensing device, which acts on the sac 35 through the vent opening 32g in the bottom wall 32e.

After completion of aspiration, release of the force on the cover member 48 enables the return spring 23 to urge the valve member 15 to the rest position of FIG. 1, thereby closing opening 14a. The finger is then removed from the end of the vent bore 49 and the piston 45 is urged out of the cylinder assembly 32 to the FIG. 1 position by the return spring 50.

It will be understood that the movement of the valve member 15 upwardly is limited by the engagement of piston 45 with the walls defining downwardly open recess 13.

The product to be dispensed can be replenished simply by pulling the cover member 48 off the housing part 10a, forcing the rib 48a over the projection 10e and withdrawing the piston 45 from the space 32b. Then the cylinder assembly is pulled out of the depending wall 10d of the valve body, pulling the projection 34a off the fitting 25, thus withdrawing the fitting 25 from within the sac 35. A new cylinder assembly 32 with a full sac 35 is inserted into the valve body 10 and the piston 45 and cover member 48 is replaced.

Many variations are possible in the specific structure of the dispenser according to the invention, some of which are shown in the remaining figures.

The embodiment shown in FIGS. 7 and 8 is basically the same as that shown in FIGS. 1–6, but has been somewhat simplified as far as the parts thereof are concerned, and the product containing means has been moved and the overall shape of the device made almost completely cylindrical. The valve assembly has a valve body 70 having an outer housing 70a which extends upwardly and has the recess 79 in the upper end thereof. The valve body has an inner part 70c which is fitted into an annular groove 70b around the bottom edge of the downwardly depending wall 70d so as to define a hollow product containing space 71 within the wall 70d. A partition 70h is positioned across the top of the space 71 between the space 71 and the recess 79, and has aperatures 70j therethrough. Nozzle insert 78 is provided which has a larger diameter portion which fits tightly within the recess 79, and which has a Venturi portion 80 depending from the larger diameter portion. The bottom surface of the larger diameter portion, the Venturi portion 80, the wall of the recess 79, and the top of the partition 70h define product supply chamber 84. Positioned on top of the partition 70h covering aperatures 70j is annular gasket 76 which has the inner edge thereof held down by the bottom ends of flanges 78a spaced at intervals around the outer periphery of the Venturi portion 80, and which has the outer edge free. A sleeve 74 depends from the Venturi portion 80 and fits into an opening 74a in the inner part 70c in the housing. The outer surface of the sleeve 74 defines the inner wall of the product containing space 71.

Secured to the outer periphery of the inner part 70c is a cylinder assembly having cylinder 72 and closing the upper end thereof is a wall 73 in which is an aperature 73a the wall defining which constitutes a valve seat 73b. Opening 74a diverges outwardly and is aligned with the aperture 73a. A valve member 75 is positioned in the aperture 73a and has a downward extension 75a thereon with a flange 75b on the end thereof. A return

spring 77 is positioned between the flange 75*b* and the bottom surface of the wall 73 and urges the valve member 75 downwardly into the closed position seated against the valve seat 73*b*.

Piston 85 is positioned in the cylinder 72 and an O-ring gasket 86 is positioned around the piston to act to seal the piston in the cylinder. The portion 85*a* of the piston 85 which extends out of the cylinder functions as a piston rod, and a pressure exerting member 88 is provided on the end of the piston rod portion 85*a*. A vent aperture 89 is provided in the cylinder 72 just above the position of the piston 85 at the lowermost position of the piston in the cylinder.

The operation of the device is substantially the same as that of the embodiment of FIGS. 1–6. The device is held by the valve assembly 70 and pressure is exerted on the pressure exerting member 88 on the end of the piston rod 85*a*. Once the inner end of the piston 85 moves past the vent aperture 89, the air in the space within the cylinder 72 is compressed until the piston reaches the flange 75*b* on the lower end of the extension 75*a* of the valve member 75. At this point the air is compressed to a maximum pressure. Further movement of the piston 85 into the cylinder lifts the valve member 75 from the valve seat 73*b*, thus opening the flow path for the compressed air through the opening 73*a*, along the sleeve 74 and through the Venturi passage 80*a* in the Venturi portion 80 of the nozzle insert. The reduced pressure in the Venturi passage 80*a* is communicated to the product supply chamber 84 and causes the outer edge of the annular gasket 76 to be raised, as shown in FIG. 8, to uncover the apertures 70*j*, thus opening a product flow path from the product containing space 71 to the Venturi passage 80*a*. Product to be dispensed is thus aspirated from the space 71 and dispensed in a spray through the nozzle insert 78.

Aspiration will continue until the compressed air is exhausted. At this point, the flexible gasket 76 again lies against the top of the partition 70*h* to cover the apertures 70*j*. The pressure on the pressure exerting member 88 is then released, and the return spring 77 closes the valve member 75 down against the valve seat 73*b*. The piston 85 is then manually withdrawn from the cylinder 72 until the inner end thereof is below the vent aperture 89.

Normally the parts will be made of inexpensive materials such as plastic, and the fits are sufficient only to produce sufficient pressure to aspirate the desired amount of product, not so close as to prevent all possible leakage past the O-ring gasket 86, and therefore the piston can be manually withdrawn from the cylinder. Alternatively a gasket arrangement such as is shown in FIGS. 8*a* and 8*b* can be used, the gasket 86*a* sealing against projection 86*b* during the inward stroke, and flexing to allow passage of air during the outward stroke. Other equivalent arrangements can also be used.

This embodiment is designed to be used only until the product in the product space 71 is exhausted. The device cannot be refilled with product. Moreover, it is extremely compact, having the shape of a fountain pen or similar article meant to be carried in the pocket or purse. Because of the relatively few parts, it is inexpensive to manufacture, so that it can be used for a wide variety of products.

The embodiment of FIG. 9 is substantially the same as that of FIGS. 7 and 8. However, to avoid the necessity of manually with drawing the piston 85 from the cylinder 72 after completion of an aspirating stroke, a piston return spring 87 is provided within the cylinder 72. The spring extends between the top or inner surface of the piston 85, being centered thereon by a projection 85*b*, and the wall 73. The wall 73 closing the upper end of the cylinder is separate from the cylinder 72 rather than being integral therewith, as in FIGS. 7 and 8, so that the piston 85 can be inserted into the cylinder through the top end. The bottom end of the cylinder has a retaining flange 72*a* therearound against which the outer or bottom end of the piston 85 abuts when the piston is in the lowermost or outermost position. The pressure exerting member 88 has been omitted, pressure being exerted on the free end of the piston rod 85*a*.

The operation of this embodiment is the same as that of the embodiment of FIGS. 7 and 8, except that at the end of the aspiration stroke, the piston rod 85*a* is simply released, and the parts of the device return to their initial positions automatically.

The embodiment of FIG. 10 is also similar to that of FIGS. 7 and 8, but has been simplified even more. Instead of a cylinder with a top wall, the cylinder is a simple cylindrical member 172 which is screw threaded to the exterior of the inner part 170*c*. The inner part 170*c* has an inwardly projecting partition 173 at the lower end of the aperture 174*a* which has the opening 173*a* and valve seat 173*b*. The sleeve 174 extends into the aperture 174*a* and has an internal shoulder therein against which a return spring 177 for a valve member 175 rests, the return spring urging the valve member 175 downwardly against the valve seat 173*b*. An actuating pin 175*a* is mounted on the upper or inner end of piston 185 in alignment with the aperture 173*a*. The apertures between the product containing space 171 and the product supply chamber 174 have been replaced with an annular space 170*j* between the inner edge of the partition 170*h* and the outer periphery of the sleeve 174.

When the piston is forced into the cylinder, the pin 175*a* lifts the valve member 175 thus opening the compressed air path through the sleeve 174 to the Venturi nozzle. Otherwise the embodiment operates the same as that of FIGS. 7 and 8.

The embodiment of FIGS. 11–13 is similar to that of FIG. 10 insofar as the structure of the valve assembly and the product containing space. The piston and cylinder assembly have been changed to simplify the manufacture and to provide a return spring. The cylinder 272 has an outer wall 272*a* and an inner wall 272*b* attached thereto by a web member 272*c*. The piston 285 and the piston rod 285*a* slide within the inner wall 272*b*. The piston rod 285*a* has a pressure exerting and spring retaining member 288 on the outer end thereof with a recess 288*a* therein. A piston return spring 287 is positioned in the space between the inner and outer walls 272*a* and 272*b* and in the recess 288*a*, and the outer periphery of the spring retaining member 288 fits slidably within the outer wall 272*a*. A slot 289 is provided in the inner wall 272*b* extending from a position just above or inwardly of the end of the piston 285 in its normal rest position to the lower or outer end of the cylinder 272.

In operation, with the parts as shown in FIGS. 11–13, the interior of the inner wall 272*b* is vented to the atmosphere through the slot 289. Once the end of the piston 285 is moved past the end of the slot, the air ahead of the piston will be compressed, as in the other embodiments. The remainder of the operation is the same as the embodiment of FIG. 9.

The provision of the slot 289 instead of a vent hole such as 89 of the embodiment of FIGS. 7 and 8 makes it possible to mold the cylinder 272 in a single operation, instead of having to first mold it and then bore a vent hole in it.

The embodiment of FIG. 14 is the same as that of FIG. 10, except that the pin 175a has been omitted. As a result, it is possible to make the manner in which the device operates to aspirate the product and spray it through the nozzle slightly different than in the previously described embodiments. In the previous embodiments, the valve member has been positively actuated when the piston reaches the end of its compression stroke. The compressed air is automatically released at the end of the compression stroke, and aspiration and spraying of the product takes place automatically. In the embodiment of FIG. 14, by providing a return spring 177 of the proper strength and designing the size of the piston and cylinder and the stroke of the piston properly, the valve member 175 can be made to remain closed, even after the air has been compressed in the cylinder, until the pressure across the valve member is made equal to the resistance of the spring 177, for example by producing a suction on the outer end of the nozzle insert 178. This is done by designing the piston and cylinder to produce a certain pressure just slightly less than the desired pressure to produce the necessary aspiration, and then providing a return spring which will yield only when the desired aspiration pressure is exerted on it. Then a user can place the device in his mouth, depress the piston rod to produce the compression stroke of the piston, and then inhale. At the end of the compression stroke of the piston, but before the inhalation, the compressed air will be present in the inner end of the cylinder, but the valve member 175 will not move, since this pressure is just slightly less than is necessary to overcome the force of the spring 177. Upon inhalation, the pressure downstream of the valve member 175 becomes subatmospheric, so that the pressure across the valve member will exceed the force exerted by the spring 177. The valve member 175 will then open, and aspiration and spraying will occur. This arrangement is particularly useful for the types of sprayers which serve as inhalers.

Many different combinations of the parts as disclosed in the various embodiments are possible. For example, return springs and stop flanges could be provided in the embodiments of FIGS. 7, 8, 10 and 14. The specific product supply means of FIGS. 1–6 could be provided in any of the remaining embodiments. The product supply means could be relocated to some other position in the device. The nozzle insert could be rearranged so that it is directed laterally of the device instead of in the axial direction.

In the embodiment of FIG. 15, the position of the product supply means has been relocated, and the nozzle insert has been redirected in order to provide a device which can be used in a position more like that of an ordinary aerosol type dispenser.

As seen in the Figure, the valve assembly has a valve body 10 which has a longitudinally extending recess 214 therein which opens out of the bottom of the valve body in an enlarged recess 213. A passage 214*a* extends from the upper end of the recess 214 and is intersected by a lateral opening 238 having a larger diameter portion. A venturi nozzle insert 239 is positioned in the recess 238 so as to define a product supply chamber 244 around the nozzle insert, in somewhat the same manner as in the embodiments of FIGS. 1–6 and FIGS. 7 and 8. The recesses 213 and 214 and the passage 214*a* forms a compressed air flow path through the valve body to the nozzle insert 239. A passage 233 extends upwardly from the product supply chamber 244 through the valve body 210 through a fitting 225.

Depending from the valve body 210 and integral therewith is a cylinder 232. Against the bottom of the valve body over the recess 213 at the inner end of the cylinder 232 is an apertured gasket member 234, and above the gasket member is a valve member 215 which is urged toward the gasket member 234 by a return spring 223 positioned in the recess 214. A piston is slidably fitted into the cylinder and has an actuating pin 245*a* thereon which, when the piston reaches the inner end of the cylinder 232 extends through the aperture in the gasket member 234 and lifts the valve member 215 from the gasket member, thereby opening the compressed air flow path. A slot 249 is provided in the wall of the cylinder which extends to a point just above the level of the piston 245 when the piston is in the rest position. A piston rod portion 245*a* extends from the piston 245 out through the bottom of the cylinder 232 and has a pressure exerting member 248 on the end thereof. A return spring 247 is positioned between the end of the cylinder 232 and the pressure exerting member. A sleeve 248*a* extends upwardly from the pressure exerting member around the outside of the cylinder 232 and the valve body 210, and has an aperture 248*b* therein which is aligned with the recess 238 when the piston 245 is at its uppermost position at the end of a compression stroke.

A housing 236 is provided which is detachably connected to the upper end of the valve body 210 around the fitting 225, and the housing contains a product containing sac 235 which fits tightly over the fitting 225.

The operation of this embodiment is generally the same as that of the previously described embodiments. The device is held between the thumb and a finger, the thumb preferably being against the bottom of the pressure exerting member 248, and the device is squeezed between the thumb and finger. The piston 245 is moved into the cylinder 232 and when the pressure is at a maximum near the end of the stroke, the actuating pin 245*a* lifts the valve member 215, thus allowing the air compressed in the cylinder to flow through the nozzle insert 239 and aspirate product through the fitting 225, passage 233 and product supply chamber 244 and to spray it out of the nozzle insert through the aperture 248*b*, which is aligned with the recess 238. At the end of the compressed air flow, return spring 223 will seat valve member 215. Release of the finger pressure at the end of the spraying action allows the return spring 247 to return the piston 245 to its initial position.

Redirecting the nozzle insert 239 makes the device easier to use the products which are to be sprayed into the mouth, such as breath fresheners or medicaments which are to be inhaled. Relocation of the product con-

taining sac **235** makes it easier to replace it by removing the housing member **236.** Although no valve means is shown in the product flow path, one could easily be provided in the same manner in which it has been provided in the previously described embodiments. Alternatively, the passage **233** can be made a capillary passage, and the product will not flow by gravity into the product supply chamber **244,** but will flow only when aspirated by compressed air flowing through the nozzle insert **239.**

The embodiment of FIGS. **16** and **17** is substantially the same as that of FIG. **15,** but with the added feature of a keying and orientation means. The valve body **210** and the cylinder **232** have an orientation key **250** extending along one side thereof, and the sleeve **248***a* has a corresponding portion **24***c* shaped to fit around the key **250.** In addition to providing an indication of how the device is oriented with respect to the position of the nozzle insert **239,** the key provides a means to insure that the sleeve **248***a* maintains its relative position with respect to the cylinder **232** and the valve body **210.** The aperture **248***b* will thus always be properly aligned with the recess **238** and the nozzle insert **239** at the end of the compression stroke of the piston **245.**

The embodiment of FIGS. **16** and **17** also provides a stop means to prevent the sleeve **248***a*, the pressure exerting member **248,** the piston rod **245***a* and the piston **245** from coming off the cylinder **232** and valve body **210.** The upper end of the key **250** is beveled inwardly at **250***a* toward the valve body **210,** and the upper end of the portion **248***c* is correspondingly beveled at **248***d.* At the rest position of the piston **245,** the portion **248***c* rests against the bevel **250***a* preventing further movement of the sleeve **248***a* in the downward direction.

The embodiment of FIG. **18** is substantially the same as that of FIGS. **16** and **17,** except that there has been added sealing means for sealing the nozzle insert recess **238,** and a tubular extension has been provided around the aperture **248***b.* On the inside of the bevel portion **248***d* is a recess with a seal **251** therein which, when the sleeve **248***a* is in the rest position as shown, rests against the bevel **250***a* and seals the recess **238** which opens out of the bevel **250***a.* When the sleeve **248***a* is moved upwardly during the compression stroke of the piston, the seal **251** is lifted off the bevel **250***a* to open the recess **238.**

A tubular extension **252** is mounted on the sleeve **248***a* around the opening **248***b.* This permits the device to be used as an inhaler, the user holding the tubular extension in his mouth as he actuates the device.

In order to make it easier to assemble the embodiment as shown in FIG. **18,** the tubular extension and bevel portion can be made in a separate piece as shown in FIGS. **19–24,** and can be attached to the device after the other parts are assembled. As seen in FIGS. **21–24** the separate piece has a tubular extension **252** which has the rear, with respect to the open mouth thereof, sides **253** extending to about the periphery of the sleeve **248***a.* The top and bottom edges of the sides **253** are contoured along the surface of the sleeve **248***a*, and at the rear end of each side is an inwardly extending flange **254.** Extending upwardly from the top of the tubular extension **252** is a bevel member **255,** which corresponds in shape to the bevel portion **248***d* of FIG. **18.** On the inside surface thereof is a recess **256** for holding the seal **251.** The edges of the bevel member **255** are contoured to fit the surface of the sleeve **248***a* around the top of the device.

The sleeve **248***a* has a pair of diametrically opposite slots **257** in the upper end thereof into which the flanges **254** are fitted so that the separate piece with the tubular extension can be attached to the sleeve **248***a* after the remainder of the device is assembled.

The various embodiments of the device have many advantages. While the compression of the air is carried out gradually, the release of the compressed air occurs suddenly and only after compression has reached a maximum. Thus the maximum aspiration effect is produced rather than a gradual aspiration, such as is produced with conventional squeeze bulb or piston-cylinder type atomizers. Moreover, the device is extremely compact, and the use of the cylinder and piston enables the provision of the product containing means in a number of places in the device. The provision of the nozzle insert **39** within the upper end of the hollow stem makes this part compact and especially useful for dispensing a product in a direction substantially axially of the device. The use of the piston-cylinder arrangement eliminates the need for a compressed or liquefied propellant and a separate container therefor, which in turn eliminates any problem of compatability of the propellant with the product being dispensed. In addition, it eliminates problems of shelf life of the device due to leakage of any such propellant container, and always assures that there will be a supply of air under pressure to aspirate the product.

Because the amount of compressed air available for aspiration is inherently limited by the size of the device, it inherently dispenses a measured dose. By properly designing the piston-cylinder assembly and properly dimensioning the various orifices and flow paths within the valve assembly, it is possible to control the amount of the product dispensed. The amount of product dispensed depends mainly on the size of the cylindrical piston space. This results in the delivery of a specific amount of air, which in turn aspirates a specific quantity of product. The pressure created in the space depends mainly on the length of the piston stroke, and this pressure will effect the characteristics of the spray pattern of product delivered. If the structure is changed so that the size of the pressure chamber, i.e. the cylindrical space, remains constant, but the stroke of piston is longer or shorter, the pressure created will be different, but the quantity of air delivered will remain about the same. Thus, the spray characteristics will change, but the quantity of product delivered will remain basically the same. Conversely, if the size of the pressure chamber is changed (increased or decreased in size) and the length of the piston stroke is kept the same, the characteristic of the spray pattern will remain generally the same, but the quantity of product delivered will either increase or decrease. Varying the size of the various orifices will also affect the spray pattern and delivery rates, and any desired spray pattern and amount of dispensed material can be obtained by proper design of the device.

Because of the fact that the device provides only a predetermined, i.e. by the design of the device, amount of compressed air for aspirating, the device can never dispense more than a given amount during any one actuation cycle. The device is therefore inherently extremely safe for use in dispensing medicaments, for example. Oral inhalation of medicaments is made safer

since only air and medicament, rather than potentially toxic propellents and medicament, are taken into the lungs.

Many variations in the construction of the device will be apparent. Instead of having a simple vent bore blocked by the finger of the user, the piston could be provided with a one way valve permitting flow of air only into the cylindrical space when the piston is being drawn out of the cylinder assembly.

It will be appreciated that although the terms upper, lower, top and bottom have been used in describing the device according to the invention, these terms have been used for convenience in referring to the device in the position in which it is shown in the drawings, and are not intended to be any limitation on the position in which the device can be used.

The terms "cylinder" and "cylindrical", as used throughout the specification are not intended to be limited to right circular cylinders, but are intended to include any desired shape generated by a straight line moving parallel to an axis, so that the cross-section of the such cylinder can be circular, square, triangular, or any other such geometrical shape. Likewise, the term "annular" is intended to include any shape which can fit around any such cylinder.

It will also be appreciated that while the seals between various pistons and cylinders have been shown as gaskets sliding along the walls thereof, these gaskets can be omitted in many instances and replaced by friction fits between the parts.

What is claimed is:

1. A dispensing device comprising: an integral cylinder and valve body having a compressed air flow path therethrough; aspirating means in said valve body at one end of said compressed air flow path, the other end of the compressed air flow path opening into said cylinder; a valve member movable in said valve body adjacent said cylinder and obturating said compressed air flow path; spring means engaging said valve member and normally holding said valve member in the obturating position; a product containing means in said device and mounted on said valve body, said valve body having a product flow path therethrough from said product containing means to said aspirating means; a piston means comprising a piston member slidable in said cylinder, said piston means extending out of the other end of said cylinder; and extension means on one of said members and engageable with the other member when the piston member is at the end of said cylinder adjacent said valve member for moving said valve member relative to said valve body for opening said compressed air flow path only after said piston member is moved to the end of said cylinder adjacent said valve member, said spring means being sufficiently strong to hold said valve member closed against the force of the air being compressed in said cylinder until moved when said piston member is at the end of said cylinder adjacent said valve member and yet be overcome by the force on said piston sufficient to move said piston to the end of said cylinder.

2. A dispensing device as claimed in claim **1** in which said extension means is on said valve member and extends into said cylinder and is engaged by said member at the end of the compression stroke.

3. A dispensing device as claimed in claim **1** in which said extension means is on said piston member and extends into said compressed air flow path and engages said valve member at the end of the compression stroke.

4. A dispensing device as claimed in claim **1** in which said valve assembly has a valve seat in said flow path which is engaged by said valve member, said spring means being a valve member return spring engaged with said valve member urging said valve member against the valve seat.

5. A dispensing device as claimed in claim **1** further comprising a piston return spring engaged with said piston means urging said piston means toward said other end of said cylinder.

6. A dispensing device as claimed in claim **1** in which said cylinder has an aperture therein opening into said cylinder at a point just above the position of said piston member at the start of the compression stroke.

7. A dispensing device as claimed in claim **6** in which said aperture is a slot along the length of said cylinder from said point to said other end of said cylinder.

8. A dispensing device as claimed in claim **1** in which said cylinder assembly is on one end of said device and said product containing means comprises a hollow housing member detachably connected to the other end of said device and having a space therein constituting said product containing means, said valve body and aspirating means being between said cylinder assembly and said product containing means and being directed laterally of the device.

9. A dispensing device as claimed in claim **8** in which said piston rod has a pressure exerting member thereon and said pressure exerting member has a sleeve depending therefrom and extending along the outside of said cylinder assembly and covering said cylinder assembly and said valve body and aspirating means, said valve body having a recess therein in which said aspirating means is positioned, said sleeve having an aperture therein which when the piston member is at the end of the compression stroke is aligned with said recess in which said aspirating means is positioned so that the spray of material to be dispensed can be sprayed through said aperture.

10. A dispensing device as claimed in claim **9** in which said cylinder assembly and said valve body have an orientation key therealong and said sleeve has a correspondingly shaped portion fitting around said key, whereby the sleeve is guided in its sliding movement along the cylinder and valve body.

11. A dispensing device as claimed in claim **10** in which the end of said key remote from said pressure exerting member is beveled and the end of said correspondingly shaped portion of said sleeve is correspondingly beveled, said beveled end of said correspondingly shaped portion engaging said beveled end of said key to act as to stop to prevent further movement of said piston out of said cylinder under the action of said piston member return spring.

12. A dispensing device as claimed in claim **11** in which said recess with said aspirating means therein opens out through said beveled end of said key, and the beveled end of said correspondingly shaped portion has a seal on the inside surface thereof which seals said recess when said beveled ends are engaged with each other.

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