US 20110030817A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2011/0030817 A1**

(43) **Pub. Date: Feb. 10, 2011**

Arnott

(54) **GAS PRESURE REGULATOR WITH A VALVE AND PISTON ASSEMBLY**

(76) Inventor: **Glen M. Arnott**, New Braunfels, TX (US)

Correspondence Address:
Jackson Walker LLP
112 E. Pecan, Suite 2400
San Antonio, TX 78205 (US)

(21) Appl. No.: **12/908,105**

(22) Filed: **Oct. 20, 2010**

Related U.S. Application Data

(62) Division of application No. 11/804,455, filed on May 18, 2007, now Pat. No. 7,836,911.

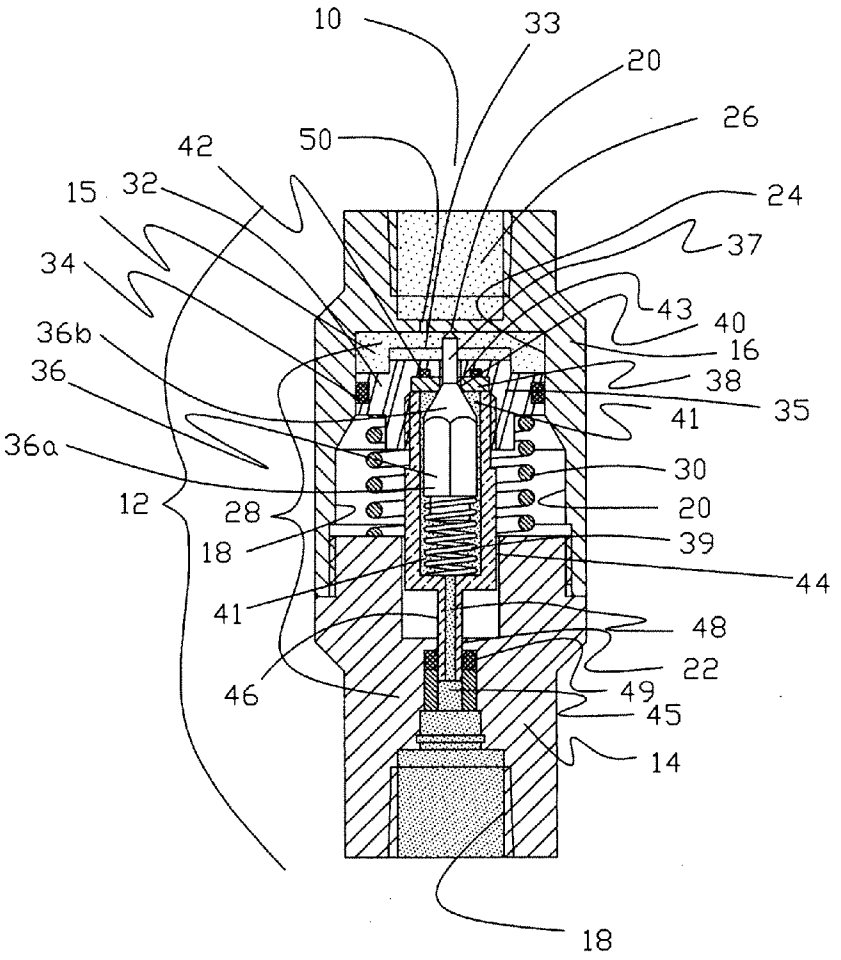
Publication Classification

(51) **Int. Cl.**
F16K 31/12 (2006.01)

(52) **U.S. Cl.** **137/505.25**

(57) **ABSTRACT**

A pressure regulator which includes a body. The body has inner walls defining an inlet port. Slidably moving within the inlet port is a hollow stem of a valve and piston assembly. The hollow stem is in slidable gas sealing contact with the inlet port. The valve and piston assembly includes a piston having a piston head with a valved opening therethrough. In the opening in the piston head is the arm of a plug. A body of the plug lies within the sliding piston held in place by a keeper spring, the keeper spring for maintaining a removed end of the plug arm against inner walls of the body. With such a structure, movement of the piston and valve assembly will be capable of unseating the plug from the valved opening in the piston allowing gas to flow from the hollow stem at the inlet port through an inner volume of the piston, through the valved opening of the piston head and into a regulated gas chamber defined in part by the inner walls of the body and an outer surface of the piston head.



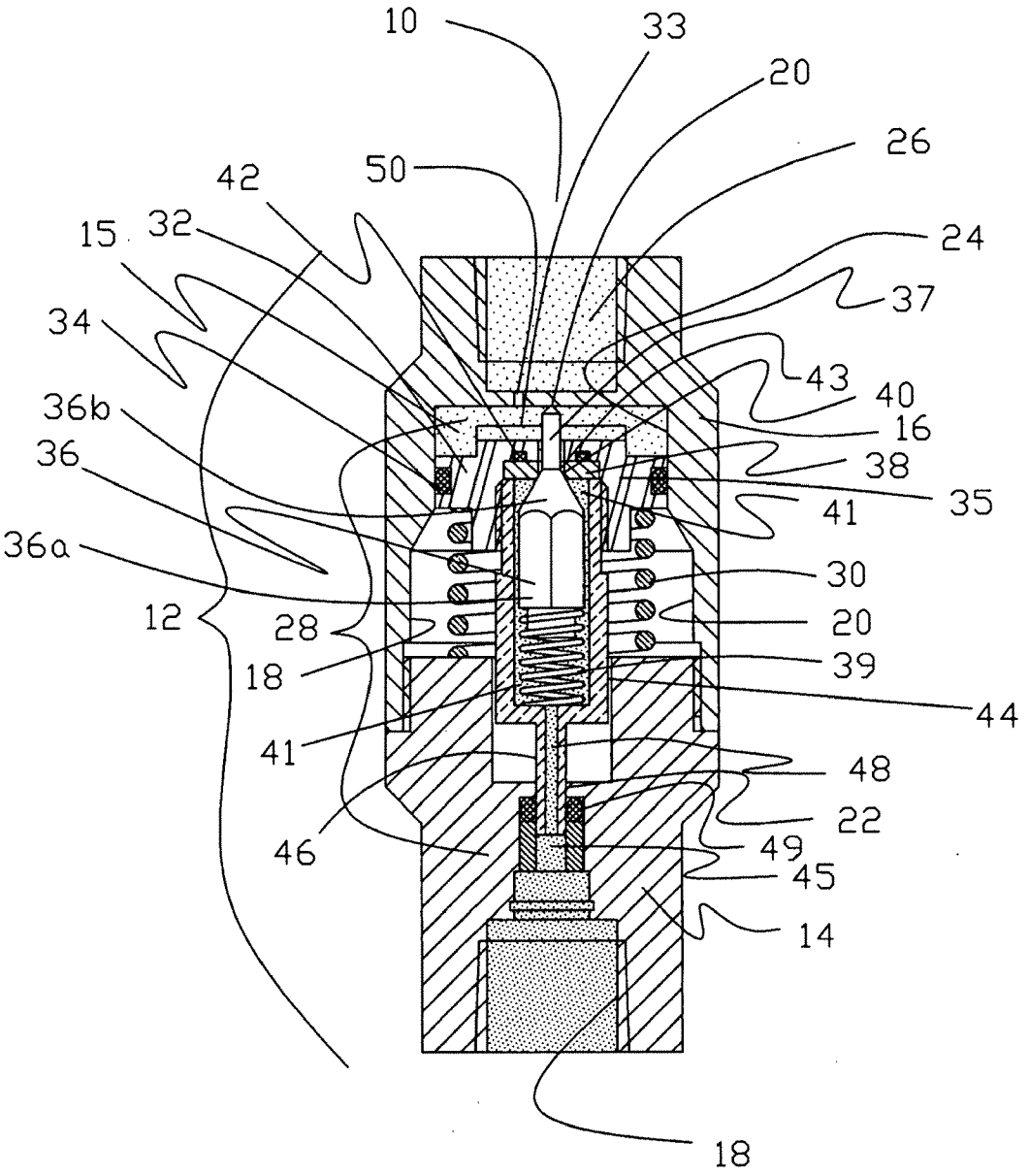

10
33
20
26
50
42
24
15
32
37
34
43
40
36b
16
38
36
35
41
36a
30
12
28
20
18
39
44
41
48
22
46
49
45
14
18

Fig 1

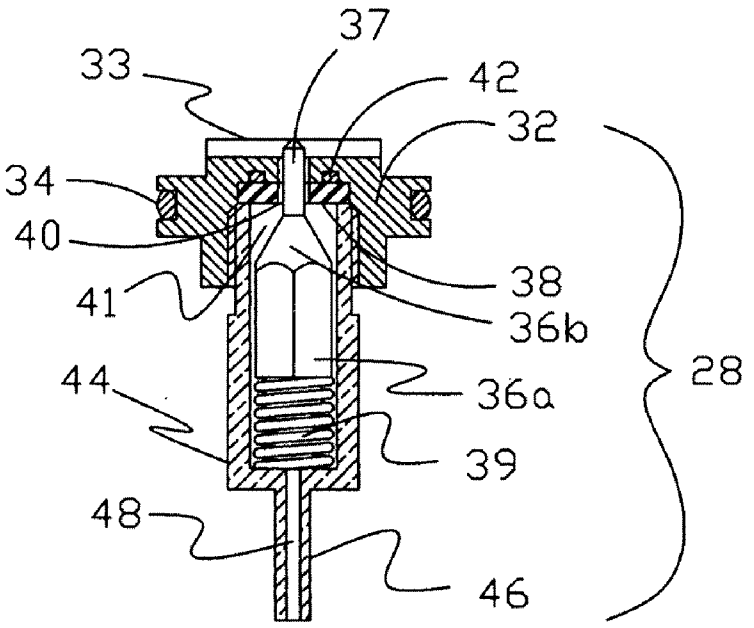


Fig. 1a

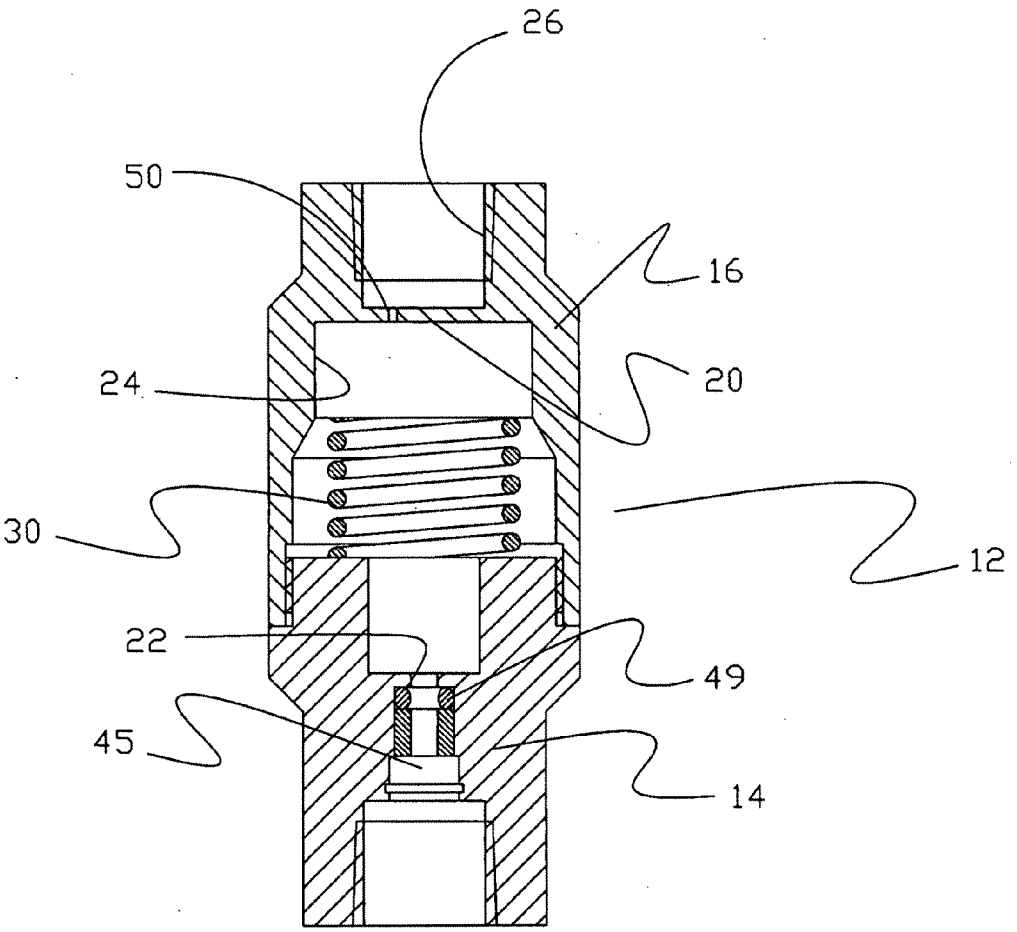


Fig. 1b

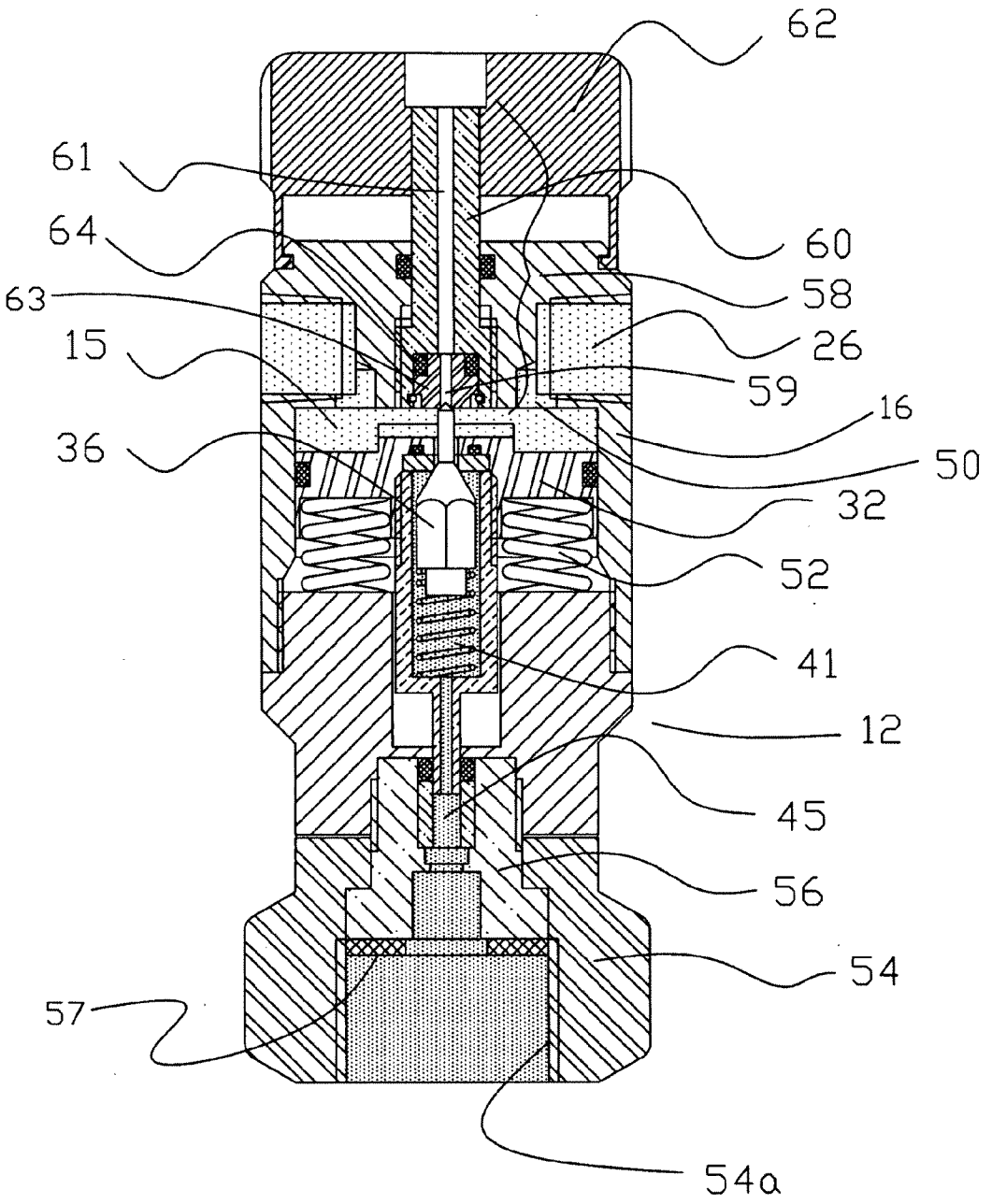


Fig. 2a

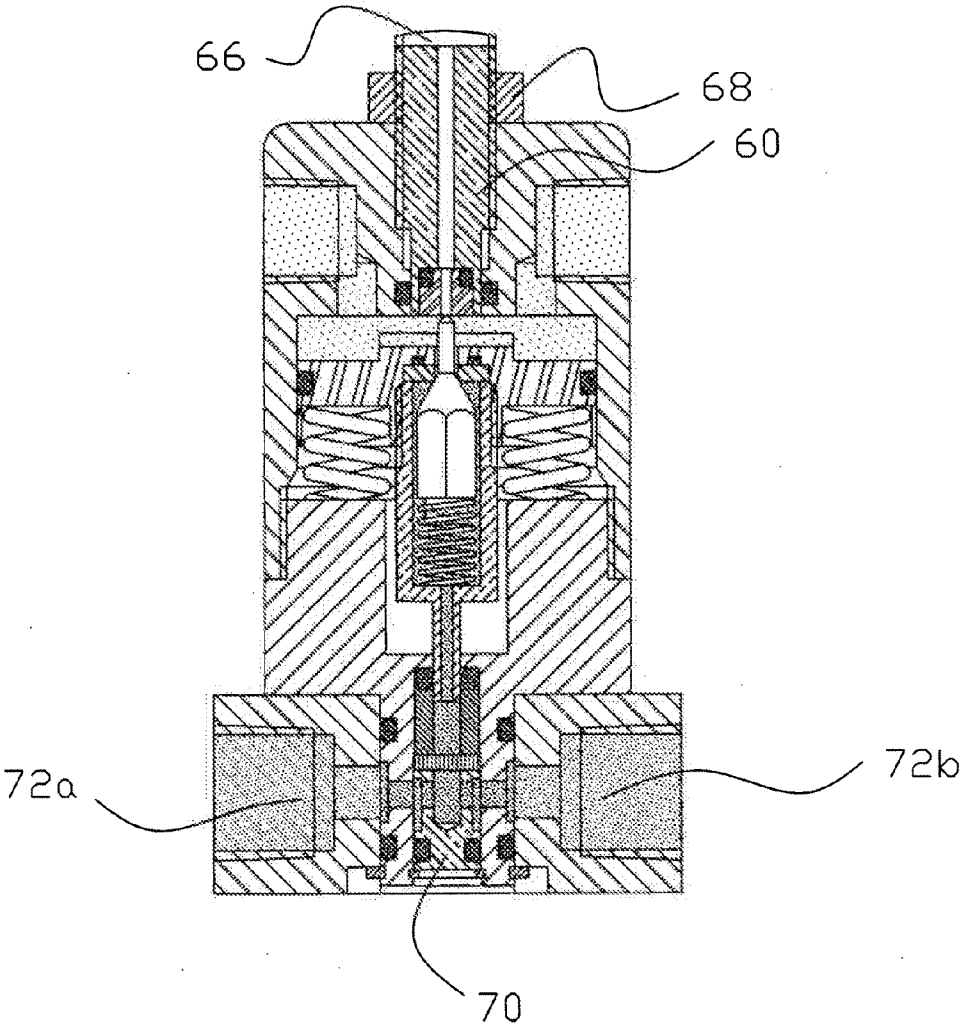


Fig. 2b

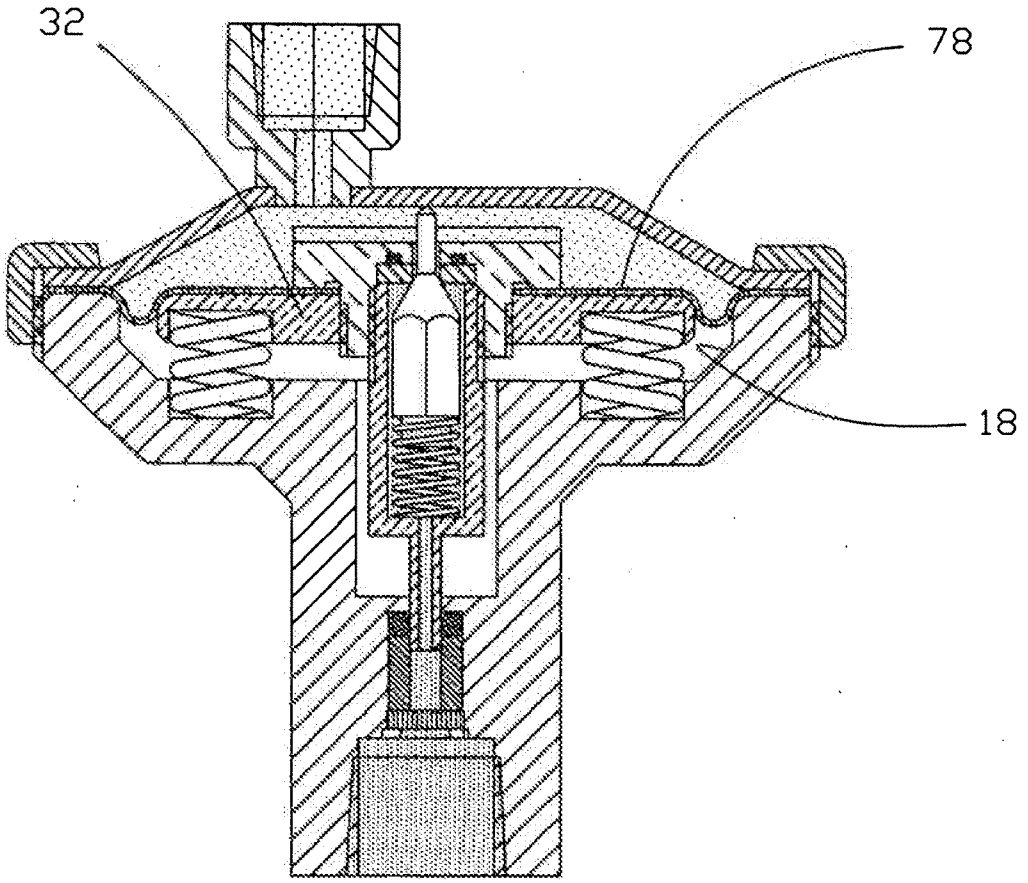


Fig. 2c

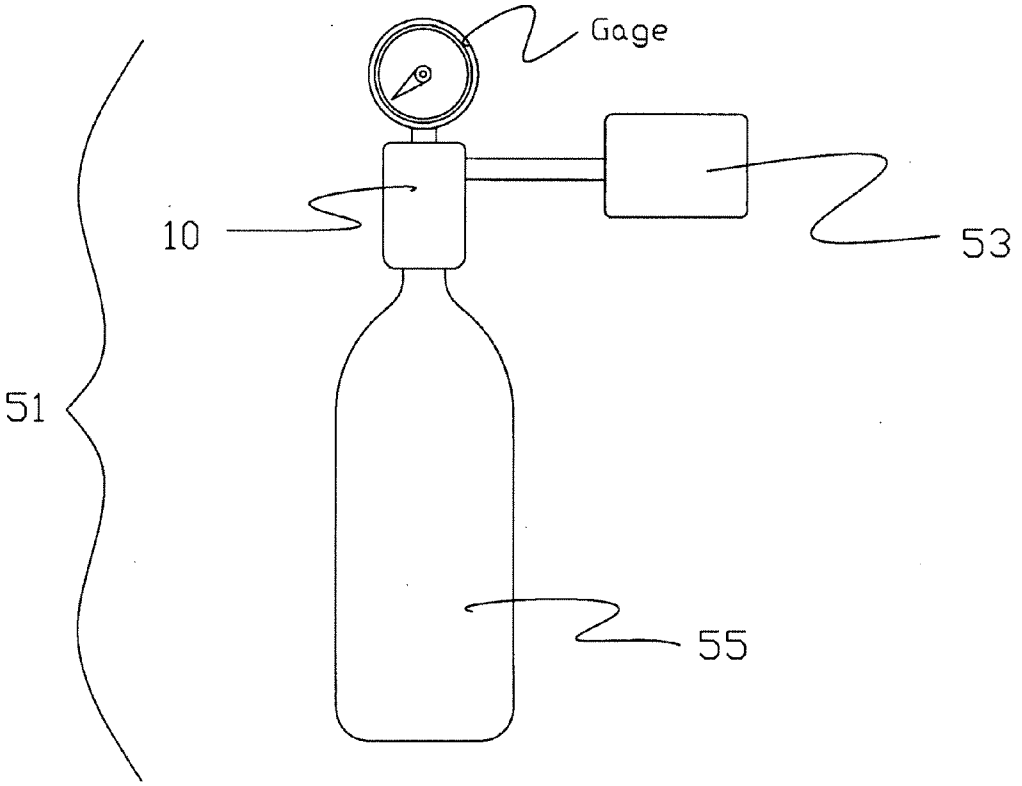


Fig 3

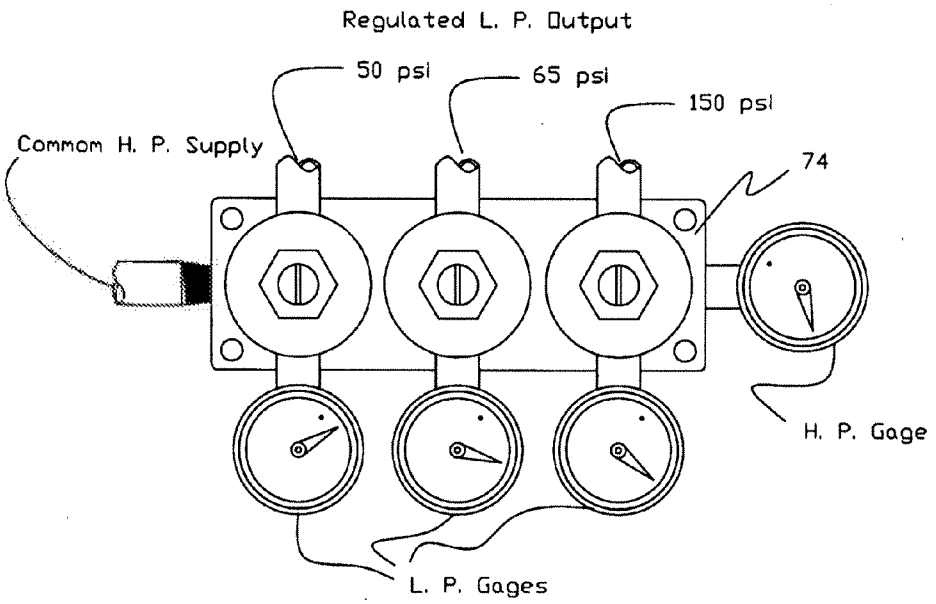

Regulated L. P. Output
50 psi
65 psi
150 psi
Commom H. P. Supply
74
H. P. Gage
L. P. Gages

Fig 4a

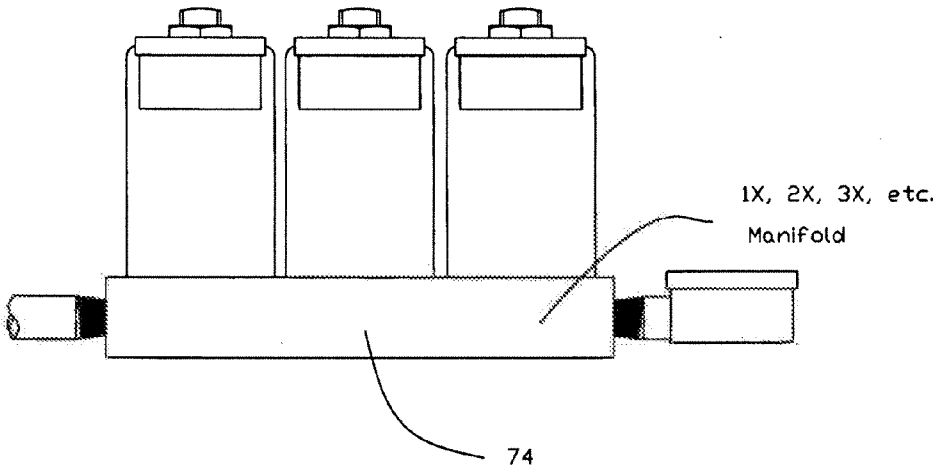

1X, 2X, 3X, etc.
Manifold
74

Fig 4b

GAS PRESURE REGULATOR WITH A VALVE AND PISTON ASSEMBLY

[0001] This is a divisional of U.S. patent application Ser. No. 11/804,455, filed May 18, 2007, and claims priority therefrom and incorporates that application herein.

FIELD OF THE INVENTION

[0002] Gas pressure regulators, namely, a piston-type gas pressure regulator with a valve in piston assembly for maintaining a set outlet pressure when the high pressure source drops.

BACKGROUND OF THE INVENTION

[0003] Gas pressure regulators have a number of uses. One such use of a gas pressure regulator includes providing a fixed output pressure from a variable high pressure inlet source. For example, a high pressure tank of breathing gas at 3000 psi may provide an output gas at 20 psi to a downstream device. However, one of the shortcomings of the prior art gas pressure regulators is that, as the high pressure source is depleted, the low pressure, even when set at a fixed value, may rise above that value before the regulated valve shuts off the source. For example, as a high, variable pressure source gas initially at 3000 psi drops, through use, say to 800 psi, the initial set pressure for closure at the transition or regulated valve can rise from its initial set pressure of, for example, 20 psi, to a higher pressure of, for example, 38 psi.

[0004] While in some applications this may not be a problem, other applications are sensitive to over pressurization from an initial set pressure. Therefore, there is a need for a gas pressure regulator in which the set pressure at the outlet port or in a regulated gas chamber does not change materially with the drop in pressure of the high pressure gas.

OBJECTS OF THE INVENTION

[0005] It is one of several objects of the present invention to provide for a pressure regulator which is capable of maintaining a set downstream regulated pressure when engaged to a high pressure source whose high pressure may diminish in value through use.

SUMMARY OF THE INVENTION

[0006] One embodiment of Applicant's device includes a gas pressure regulator which includes a body. The body has inner walls defining an inlet port. Slidably moving within the inlet port is a valve and piston assembly. The valve and piston assembly includes a hollow stem in slidable, gas sealing contact with the inlet port. The valve and piston assembly includes a piston having a piston head with a valved opening therethrough. Engaged with the opening in the piston head is a plug having an arm, the arm extending through the valved opening. A body of the plug lies within the sliding piston held in place by a keeper spring, the keeper spring for maintaining a removed end of the plug arm against the inner walls of the body.

[0007] With such a structure, movement of the piston and valve assembly will be capable of unseating the plug from the opening in the piston head allowing gas to flow from the hollow stem at the inlet port through an inner volume of the piston, through the valved opening of the piston head and into a regulated gas chamber defined in part by the inner walls of the body and an outer surface or crown of the piston head.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a cutaway view of one embodiment of Applicant's novel gas pressure regulator.

[0009] FIG. **1***a* is a view of the valve and piston assembly of an embodiment of the pressure regulator.

[0010] FIG. **1***b* is a view of the pressure regulator with the valve and piston assembly removed therefrom.

[0011] FIG. **2***a* is a cutaway view of another embodiment of Applicant's novel gas pressure regulator.

[0012] FIG. **2***b* is a cutaway view of another embodiment of Applicant's novel gas pressure regulator.

[0013] FIG. **2***c* is another embodiment of the pressure regulator.

[0014] FIG. **3** is an equipment drawing of a system showing a high pressure gas source and a low pressure gas receiving device, using Applicant's novel gas pressure regulator.

[0015] FIGS. **4***a* and **4***b* are top and side elevational views respectively of a system using a high pressure source in a multiplicity of Applicant's novel gas pressure regulators.

ELEMENT NUMERICAL DESIGNATIONS

[0016] **10** Gas regulator
[0017] **12** Body
[0018] **14** First portion of body
[0019] **15** Regulated chamber
[0020] **16** Second portion of body
[0021] **18** Inner walls
[0022] **20** Engagement walls
[0023] **22** Stem guide walls
[0024] **24** Piston chamber walls
[0025] **26** Low pressure outlet walls of second portion **16**
[0026] **28** Valve and piston assembly
[0027] **30** Main spring
[0028] **32** Piston head
[0029] **33** Crown of piston head
[0030] **34** O-ring (of piston head)
[0031] **35** Piston
[0032] **36** Plug
[0033] **37** Plug arm
[0034] **38** Seal
[0035] **39** Plug keeper spring
[0036] **40** Piston head opening
[0037] **41** Inner volume of piston
[0038] **42** O-ring
[0039] **43** Transition or regulator valve (equals **36**, **38**, **40**, and **42**)
[0040] **44** Piston body
[0041] **45** Piston stem port
[0042] **46** Piston stem
[0043] **48** Channel
[0044] **50** Transfer port
[0045] **51** System
[0046] **52** Spring set
[0047] **53** Receiving device
[0048] **54** Coupler
[0049] **55** High pressure source
[0050] **56** Body (nipple portion)
[0051] **57** Seat
[0052] **58** Outlet pressure adjustment mechanism
[0053] **60** Adjustment stem

[0054] **62** Adjustment stem knob

[0055] **70** Plug seal

[0056] **72** Manifold

[0057] **72***a* High pressure source opening

[0058] **72***b* High pressure source opening

[0059] **78** Membrane

[0060] FIG. **1** is a cross-sectional area of gas pressure regulator **10** comprising body **12**. Body **12** may include, in one embodiment of the invention, first portion **14** and second portion **16**, the portions engaged, for example, by threads.

[0061] Body **12** may have inner walls **18**, including stem guide walls **22** defining, in part, piston stem port **45**. Inner walls **18** may also include piston chamber walls **24**, and low pressure source walls **26**.

[0062] A valve and piston assembly **28** is provided, which valve and piston assembly is acted upon by a main spring **30**, which main spring engages inner walls **18** of body **12**. A piston **35** includes a piston body **44** having a piston stem **46** and a piston head **32** having a crown **33**. The piston body has a piston stem **46** for engagement with stem guide walls **22**. Piston body **44** may be threadably engaged to piston head **32**. O-ring **34** of piston head **32** is provided for a gas sealing engagement of piston head **32** with piston chamber walls **24**. Piston head **32** includes a valved piston head opening **40**. Valved piston head opening **40** may also include, in part, a seal **38**, typically cylindrical such as a Delrin seal that surrounds opening **40**. Seal **38** may be elastomeric and act as a seat for receiving a plug **36** as set forth in more detail below. Piston stem **46** is hollow, having a channel **48**, which channel is in fluid communication with walls defining an interior volume **41** of piston **35**.

[0063] Valve and piston assembly **28** also includes the plug **36**, the plug having a plug arm **37**, the plug arm **37** extending through valved piston head opening **40**. The plug **36** may have a plug body **36***a* including a conical section **36***b*, which conical section **36***b* may terminate at a plug arm **37**. Plug keeper spring **39** acts against inner walls of piston **35** and plug **36** so as to bias plug arm **37** towards seal **38** and against inner walls of body **12** at engagement walls **20** as seen in FIG. **1**. That is, plug keeper spring **39** will assert a force against plug **36** so as to urge plug arm **37** against inner walls of body **12**, while piston **35** may move longitudinally along piston chamber walls to move valved piston head opening **40** longitudinally back and forth in the piston chamber responsive to pressure at piston stem port **45** and in regulated chamber **15** to seat and unseat plug **36**.

[0064] A number of O-rings are provided, including O-ring **42**, between seal **38** and walls of piston head **32**, O-ring **49** sealing walls of piston stem **46** against walls of body **12**, namely stem guide walls **22** and O-ring **34** between the sliding piston head and body walls.

[0065] In operation, high pressure is provided at piston stem port **45**, which acts through channel **48**, and inner volume **41** on valved opening **40** in piston head **32**. If the force asserted on the piston stem port and by spring **30** as seen in FIG. **1** (pushing the piston upward) is greater than the force pushing the piston downward, the piston will move up and, if the plug is seated against seal **38**, will unseat and uncover piston head opening **40** to allow gas to enter a regulated chamber **15** defined by the piston head crown **33** and some of the inner walls of piston body **12** seen in FIG. **1**. As the regulated chamber fills, pressure will be asserted on the piston crown to urge the piston in a downward direction as seen in FIG. **1** until it seats seal **38** against plug **36** closing valved opening **40**. Here the forces will be substantially in balance.

[0066] To move the piston up as seen in FIG. **1**, the force at piston stem **46** must overcome the force applied by gas in the regulated chamber acting against the piston crown, as well as the slight force of plug spring **39**.

[0067] Looking at the forces on the seal plug, Applicant's note the balanced forces

[0068] a. A_s=sealed area

[0069] b. B_s=supply fluid pressure

[0070] c. F_s=seal force on plug ($F_s=A_s \times B_s$)

[0071] d. $F_s=F_p$

[0072] e. A_c=area compression tube

[0073] f. F_c=force on compression tube

[0074] g. $F_c=B_s \times A_c$

[0075] h. F_c varies with input pressure, ΔP_s

[0076] i. $F_x+F_c=F_{rg}+F_p$, where F_{rg} is force of regulated pressure, and F_p is force of stem. F_s is a constant (load spring).

[0077] Therefore, $F_s \approx F_p$, which $\approx F_c$; therefore, when there is a drop at $F_s(\Delta F_s)$, F_p drops as does F_c. The valve is sensitive and responsive, due in part, to the cross-sectional area of the piston stem being about equal to valved opening **40**.

[0078] FIGS. **2***a* and **2***b* illustrate two variations of Applicant's novel valve and piston gas pressure regulator.

[0079] FIG. **2***a* illustrates that, in place of a single main spring, as shown in FIG. **1**, a spring set **52** may be used. Two springs of the spring set **52** are illustrated in the view shown in FIG. **2***a*, but a multiplicity, here six, would be provided in the full instrument. Sets may include two or more springs. Each spring of spring set **52** is ideally materially identical and the springs of the spring set are typically arranged circumferentially around a longitudinal axis of the piston between outside walls of the piston and inner walls of the body. The use of a multiplicity of springs instead of a single spring is believed to achieve the benefits of better balance, sensitivity and accuracy, especially at low pressure; as well as the ability to provide a more compact design.

[0080] FIG. **2***a* also illustrates the use of a high pressure source coupling knob or coupler **54**, which includes a threaded portion **54***a*, and which coupler **54** is engaged with valve body **12**, so it may freely rotate with respect to the valve body. Further, a nipple portion **56** of valve body **12** (engaged, for example, by threads) may be dimensioned to slideably receive the valve stem and define piston stem port **45**. The use of coupler **54** allows one to hold the valve body **12** in a fixed position as the coupler **54** rotatably engaged or disengaged with the threaded portion of a high pressure source, the threads for being engaged and bringing the high pressure source into gas sealing relation with seat **57**. In other words, coupler **54** avoids the necessity of rotating the entire body **12** of the gas pressure regulator onto the high pressure source, such as is required in the embodiment set forth in FIG. **1**.

[0081] FIG. **1** illustrates a set pressure regulator. The value of the cutoff pressure may be set by taking into account the length of the plug arm and the main spring length, as well as the main spring compression factor. For given plug arm length and main spring, movement of engagement walls towards the piston crown will increase the cutoff pressure, requiring greater spring compression before the seat meets the plug to cut off flow through the valved opening.

[0082] FIG. **2***a* also illustrates the use of an outlet pressure adjustment mechanism **58**, which may include an over pressurization relief port **59** located in seat **63**. Outlet pressure

adjustment mechanism **58** includes an adjustment stem **60**, adjustment stem knob **62**, and adjustment stem seal **64**, defining relief port **59**. Stem knob **62** is in slotted engagement with adjustment stem **60**. Rotating knob **62** will slide stem **60** longitudinally.

[0083] As can be seen in FIG. **2***a*, plug arm **37** engages relief port **59**. Further, it is seen that adjustment stem knob **62** is rotationally engaged to the first portion of the valve body so as to rotate about the valve body. Moreover, a near end of adjustment stem **60** has a seat **63**. A near end of adjusting stem **60** is threadably engaged with first portion **16** of valve body **12**. Thus, when stem knob **62** (which is fixedly attached to adjusting stem **60**) is rotated, it will cause adjusting stem **60** to rotate, which being threadably engaged to first portion **16** of valve body **12** will move the seat **63** with relief port **59** longitudinally. Such movement will change the distance between the piston head and relief port **59**. As discussed above, for a given plug arm dimension, changing the distance from the engagement walls, here defining relief port **59**, and the valved opening **40** will change the setting of the outlet pressure valve. Thus, FIG. **2***a* illustrates a manner in which the outlet pressure may be selectively set. Further, FIG. **2***a* illustrates the use of engagement walls **20** defining a relief port **59**, which relief port allows for the relief of gas in an overpressurization system that may occur downstream of regulated chamber **15** by allowing gas to escape through relief port **59** and out relief port vent channel **61**.

[0084] FIG. **2***b* illustrates the use of Applicant's valve and piston assembly with an adjusting stem **60** that has, instead of an adjusting knob, a screwdriver slot **66** which, when engaged to a screwdriver allows the adjustable stem **60** to be rotated as in the embodiment set forth in FIG. **2***a*, but includes a locknut **68** which, when the desired cutoff pressure is selected by positioning adjustable stem **60** with respect to the valve body, locknut **68** can be rotated down tight onto the valve body to prevent rotation of adjustable stem **60** and subsequent loss of proper set value.

[0085] FIG. **2***b* also illustrates plug seal **70** that may be used to seal high pressure source port opening as it is positioned longitudinally in the other embodiments and provide, for example, two high pressure source openings **72***a* and **72***b* laterally with respect to a longitudinal axis of the body, as seen in FIG. **2***b*.

[0086] FIG. **2***c* illustrates another preferred embodiment of Applicant's novel gas regulator **10**. In this embodiment, a difference is the use of a flexible fluid sealing membrane **78**, which seals a gap between piston head **32** and inner walls **18** of body **12**. It is noted in the embodiment illustrated in FIG. **2***c*, that the frictional forces found in the earlier embodiments where the piston head and O-ring slide along the inner walls **18** are avoided—yet there is in fact an effective seal generated by fluid sealing membrane **78**. Thus, it is believed that even further sensitivity may be achieved with this embodiment. Note that this embodiment may be used with one or more of the features illustrated in other embodiments. Fluid sealing membrane **78** may be made from a number of suitable materials, such as, for example, steel mesh reinforced rubber or fabric reinforced rubber or the like. Indeed a thin steel sheet may be used. Membrane **78** acts as a "bellows" in this embodiment. Thus, the embodiment illustrated in FIG. **2***c* may utilize a diaphragm action for cutoff.

[0087] The O-ring between the piston head **32** and inner walls **18** of the body **12** or the flexible membrane **78** or other means known in the art may define a fluid sealing means between the piston head and the inner walls of the body. A sealing means (hydraulic or pneumatic) will function to seal off a regulated chamber which is in fluid communication with the high pressure source through the valved opening and also a low pressure device downstream.

[0088] The use of any of the embodiments disclosed herein provide for low pressure accuracy, sensitivity and repeatability, for example, down to 5 to 7 lbs. on a ⅛ inch diameter piston, that in the prior art would typically require a larger piston diameter. The use of a flexible sealing member provides the ability to get greater area on the piston face, removes friction of the O-rings, and may provide better performance and increased accuracy at low pressure.

[0089] FIG. **3** illustrates a system **51**, which system **51** provides for a regulated transfer of gas from a high pressure source **55** to a regulated gas receiving device **53** through Applicant's novel gas pressure regulator **10** which has a valve in piston structure to compensate for a drop in pressure at high pressure source **55** as receiving device **53** uses the high pressure source gas, which structure allows the receiving device to continue to receive gas from the high pressure source at the preset pressure value. The high pressure sources may include: oxygen, a breathable gas, an inert gas, CO_2, N_2, argon, nitrous oxide or any other gas or fluid Receiving devices may include: a wine bottle, tool or any other device. The receiving device may also include a helmet for use by an astronaut, race car driver or underwater diver wherein the high pressure source is a tank containing a breathable gas.

[0090] FIGS. **4***a* and **4***b* illustrate two views of the system in which a multiplicity of Applicant's novel regulator **10** (see FIG. **2***b*) are used with a manifold **74** and a high pressure supply. In this manner, one or more single high pressure supplies can provide low pressure gas to two or more low pressure receiving devices with the use of manifold **74**, which manifold would have inner channels that will supply fluid from the high pressure supply line, which is engaged to the walls of the manifold to the low pressure users through Applicant's novel gas regulators **10**. In the system illustrated, the first gas pressure regulator is set at a first cutoff pressure, here 50 lbs., at a second pressure, here 65 lbs., and the third at a third pressure, here 150 lbs.

[0091] Although the invention has been described in connection with the preferred embodiment, it is not intended to limit the invention's particular form set forth, but on the contrary, it is intended to cover such alterations, modifications, and equivalences that may be included in the spirit and scope of the invention as defined by the appended claims. For example, gas is considered to be a fluid, the device may operate with either a liquid or a gas.

1. A system for the regulated transfer of gas, the system comprising:

at least one upstream high pressure gas source;

at least one downstream gas receiving device for receiving gas at a pressure lower than that of the high pressure gas source; and

at least one regulator engaging the upstream source and downstream device including a valve and piston assembly adapted to compensate for drop in the high pressure gas source while providing receiving device at a set pre-selected pressure.

2. The system of claim **1**, wherein the gas pressure regulator includes:

a body and a valve in piston assembly, the body having a longitudinal axis and inner walls, the inner walls defin-

ing at least engagement walls, piston chamber walls, piston stem guide walls, and a piston stem port;

a spring; and

a valve and piston assembly, including a piston having a body and piston head, the piston body having a piston stem, the piston stem having a compensating tube therein, the piston head having a valved opening, the piston body also having an inner volume in fluid communication with the compensating tube and the valved opening, the piston and valve assembly further including a plug, the plug having a plug body dimensioned for receipt substantially within the inner volume of the piston body and a plug arm, the plug arm extending through the valved opening past the piston head for engagement with the engagement walls of the body, the valve and piston assembly further including a keeper spring for acting between the piston body and the plug to urge the plug against the engagement walls of the body;

wherein the piston is biased towards engagement walls by the spring;

wherein the piston stem is in sliding engagement with the piston stem guide walls, such that a change in pressure at the piston stem port may move the piston with respect to the body, thus moving the valved opening in relation to the plug and allowing a gas to move between the inlet port through the stem, through the inner volume of the piston through the valved opening into the regulated chamber.

3. The system of claim **1**, further including at least two regulators and a manifold, the manifold for engaging the upstream high pressure gas source and two or more regulators and at least two downstream gas receiving devices.

4. The system of claim **1**, wherein the upstream gas source is a high pressured tank containing at least one of the following: CO_2, N_2, argon, and nitrous oxide.

5. The system of claim **1**, wherein the downstream gas receiving device includes one of the following: wine bottle, pneumatic tool, and helmet.

6. The system of claim **3**, wherein the gas pressure regulator includes:

a body and a valve in piston assembly, the body having a longitudinal axis and inner walls, the inner walls defining at least engagement walls, piston chamber walls, piston stem guide walls, and a piston stem port;

a spring; and

a valve and piston assembly, including a piston having a body and piston head, the piston body having a piston stem, the piston stem having a compensating tube therein, the piston head having a valved opening, the piston body also having an inner volume in fluid communication with the compensating tube and the valved opening, the piston and valve assembly further including a plug, the plug having a plug body dimensioned for receipt substantially within the inner volume of the piston body and a plug arm, the plug arm extending through the valved opening past the piston head for engagement with the engagement walls of the body, the valve and piston assembly further including a keeper spring for acting between the piston body and the plug to urge the plug against the engagement walls of the body;

wherein the piston is biased towards engagement walls by the spring;

wherein the piston stem is in sliding engagement with the piston stem guide walls, such that a change in pressure at the piston stem port may move the piston with respect to the body, thus moving the valved opening in relation to the plug and allowing a gas to move between the inlet port through the stem, through the inner volume of the piston through the valved opening into the regulated chamber.

7. The system of claim **4**, wherein the gas pressure regulator includes:

a body and a valve in piston assembly, the body having a longitudinal axis and inner walls, the inner walls defining at least engagement walls, piston chamber walls, piston stem guide walls, and a piston stem port;

a spring; and

a valve and piston assembly, including a piston having a body and piston head, the piston body having a piston stem, the piston stem having a compensating tube therein, the piston head having a valved opening, the piston body also having an inner volume in fluid communication with the compensating tube and the valved opening, the piston and valve assembly further including a plug, the plug having a plug body dimensioned for receipt substantially within the inner volume of the piston body and a plug arm, the plug arm extending through the valved opening past the piston head for engagement with the engagement walls of the body, the valve and piston assembly further including a keeper spring for acting between the piston body and the plug to urge the plug against the engagement walls of the body;

wherein the piston is biased towards engagement walls by the spring;

wherein the piston stem is in sliding engagement with the piston stem guide walls, such that a change in pressure at the piston stem port may move the piston with respect to the body, thus moving the valved opening in relation to the plug and allowing a gas to move between the inlet port through the stem, through the inner volume of the piston through the valved opening into the regulated chamber.

8. The system of claim **1**, wherein the gas pressure regulator includes:

a body and a valve in piston assembly, the body having a longitudinal axis and inner walls, the inner walls defining at least engagement walls, piston chamber walls, piston stem guide walls, and a piston stem port;

a spring; and

a valve and piston assembly, including a piston having a body and piston head, the piston body having a piston stem, the piston stem having a compensating tube therein, the piston head having a valved opening, the piston body also having an inner volume in fluid communication with the compensating tube and the valved opening, the piston and valve assembly further including a plug, the plug having a plug body dimensioned for receipt substantially within the inner volume of the piston body and a plug arm, the plug arm extending through the valved opening past the piston head for engagement with the engagement walls of the body, the valve and piston assembly further including a keeper spring for acting between the piston body and the plug to urge the plug against the engagement walls of the body;

wherein the piston is biased towards engagement walls by the spring;

wherein the piston stem is in sliding engagement with the piston stem guide walls, such that a change in pressure at the piston stem port may move the piston with respect to the body, thus moving the valved opening in relation to

the plug and allowing a gas to move between the inlet port through the stem, through the inner volume of the piston through the valved opening into the regulated chamber;

further including at least two regulators and a manifold, the manifold for engaging the upstream high pressure gas source and two or more regulators and at least two downstream gas receiving devices;

wherein the upstream gas source is a high pressured tank containing at least one of the following: CO_2, N_2, argon, and nitrous oxide.

9. The system of claim **8**, wherein the downstream gas receiving device includes one of the following: wine bottle, pneumatic tool, and helmet.

* * * * *