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[54] PRESSURIZATION SYSTEM

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[51] **Int. Cl.** **C06d 5/04**

[58] **Field of Search** 60/39.48, 37, 35; 137/209, 137/210, 211; 222/394; 23/281, 282

[56] **References Cited**

UNITED STATES PATENTS

2,958,193	11/1960	Prince	60/39.48
3,015,210	1/1962	Williamson	60/39.48
3,170,290	2/1965	Porter	60/39.48
3,456,440	7/1969	Keller	60/39.48

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[57] **ABSTRACT**

A pressurization system for supplying a constant pressure source including a liquid propellant source, a reaction chamber for disposing the liquid propellant into a gasified product, a storage tank for storing the gasified products and a feedback system for maintaining the output pressure from the storage tank.

3 Claims, 3 Drawing Figures

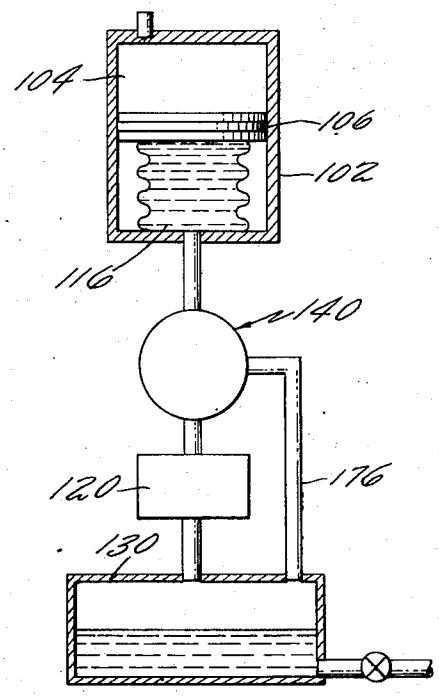


FIG. 1

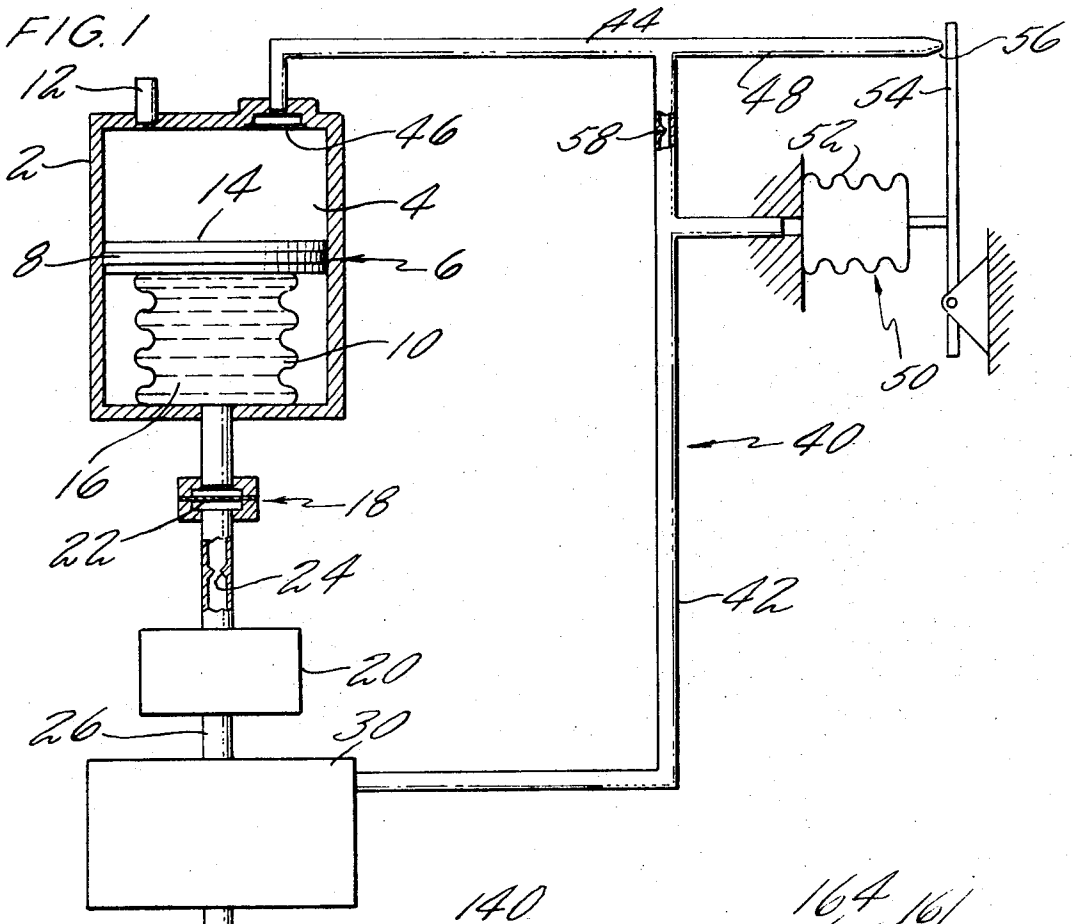
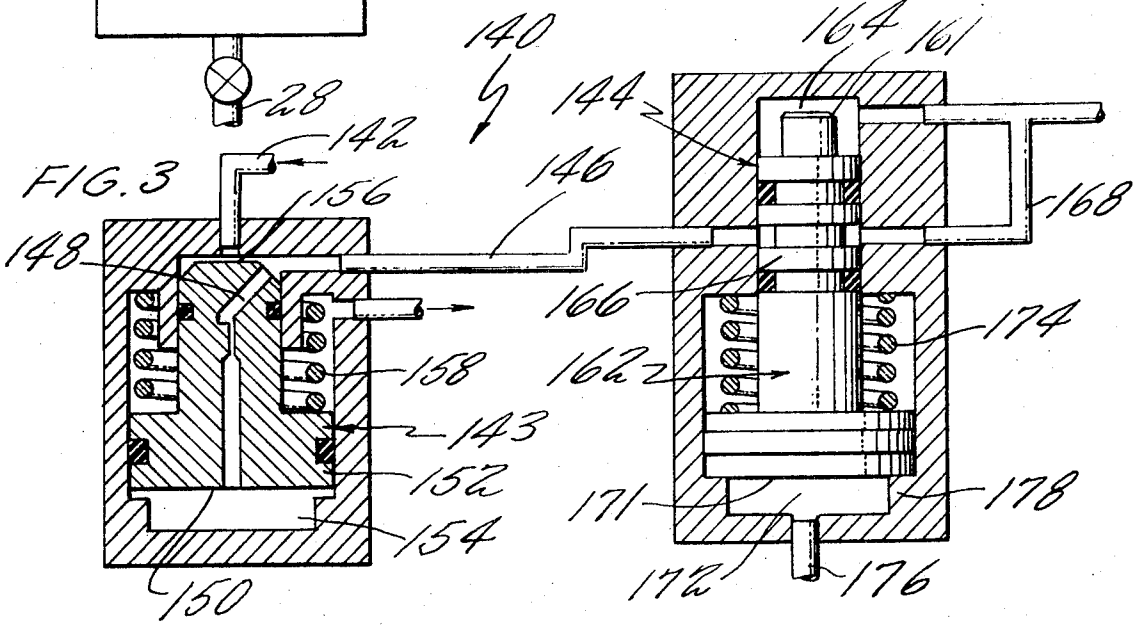


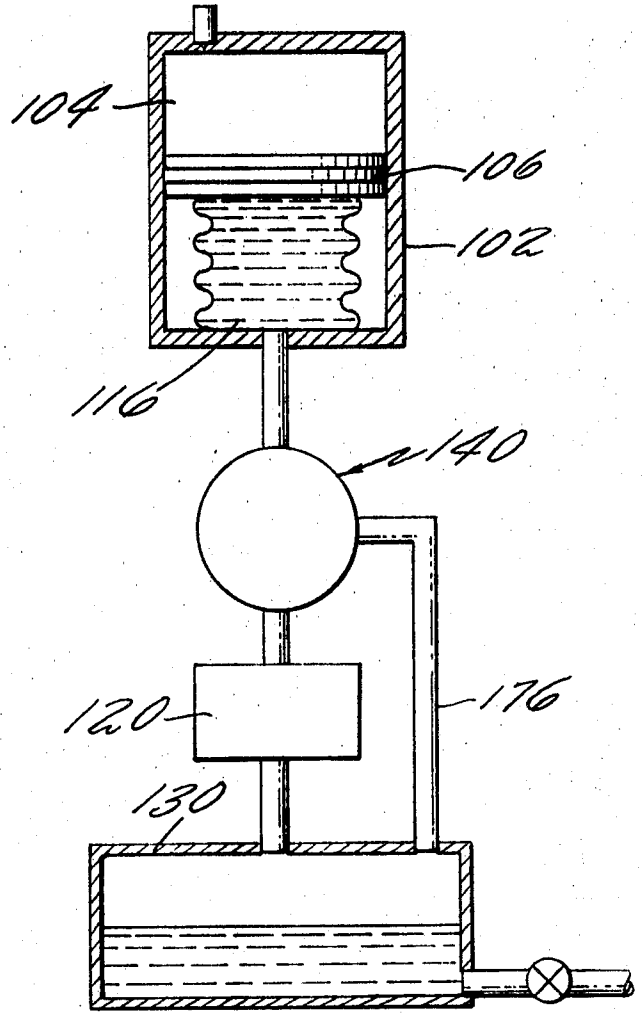
FIG. 3



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FIG. 2



PRESSURIZATION SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to a gas generator system and more specifically to a system which provides a predetermined volume of pressurized gas which may be utilized as a constant pressure source.

In the conventional prior art systems whenever gas or a constant pressure source is to be provided, a major difficulty encountered is the necessity of supplying gas under pressure to the propellant fluid storage tanks to furnish the necessary fluid supply pressure. An auxiliary gas supply is generally employed and this therefore requires the use of high pressure containers of considerable weight and bulk. This is quite disadvantageous particularly when spaced and weight are at a premium, such as in missile and space vehicles.

Another major disadvantage of these prior art systems is the relative complexity of the systems. For example, these systems employ separate supply storage tanks, piping and pressurant chambers as opposed to the present invention single pressurant chamber which contains the liquid propellant. Additionally, in the construction of the present invention, when the supply in the pressurant chamber is exhausted, it may be replenished by simply refilling the chamber or inserting a full chamber and discarding the old. Since the supply liquid does not have to be stored under pressure it can be of a relatively lightweight construction.

Another major problem with the prior art systems is that normally the systems are not self-regulated and in the ones that are, self-regulation is achieved in the rather unsatisfactory manner of controlling the supply pressure of the liquid propellant. These latter constructions therefore only control the output pressure indirectly. Self-regulation achieved through regulation of the supply pressure and hence indirectly controlling the output pressure is undesirable in that the supply pressure remains constant for a given load only and only if that load remains constant throughout the entire operating cycle. The present invention not only provides self-regulation, but maintains a constant pressure on some variable demand load. More specifically, it will maintain a constant degree of pressurization on the system load within a very tight tolerance band at an infinite variety of flow rates from the pressurized load from zero flow up to the maximum capacity of the system.

SUMMARY OF THE INVENTION

It is a primary object of this invention to provide a pressurization system which provides a constant source of pressure which is relatively lightweight and uncomplex, the system being a self-regulating one and providing this constant pressure even when there is a variable demand load.

The present invention accomplishes the foregoing object by utilizing a pressurant chamber which contains a liquid propellant. The chamber contains means for accepting an external signal which initiates the pressurization process. Once the external signal is applied the system becomes self-sustaining as this signal acts on pressure responsive means contained in the chamber. These pressure responsive means in turn act on the liquid propellant and cause the pressure thereof to rise. Downstream of the pressurant chamber is a sealing means which prevents the liquid propellant from exiting from the pressurant chamber until the pressure of the liquid propellant reaches a predetermined level.

Once the pressure of the liquid propellant has reached this predetermined level, it flows through the sealing means and then into a reaction chamber where the liquid propellant decomposes and produces a gasified product. Positioned downstream of the reaction chamber and in communication with the outlet of the reaction chamber is a storage tank. The gasified products from the reaction chamber flow into the storage tank and either the gasified products or some other source within the storage tank may be utilized as the constant pressure source.

To maintain this constant pressure source and to provide a self-regulating system, one embodiment of this invention employs a feedback system between the storage tank and the pressurant chamber. This feedback system includes pressure responsive means which permit the gasified products within the storage tank to pressurize and charge the pressurant chamber and its pressure responsive means. The feedback system also includes bleed means positioned between the storage tank and pressurant chamber so that when the pressure rises to a predetermined level, substantially all the flow is diverted from the pressurant chamber thereby causing the pressure to decrease and cause the pressure in the storage tank to return to the desired constant pressure level. This occurs irrespective of the demand load and without regard to whether this load is constant or varying.

In a second embodiment of this invention a control valve is positioned upstream of the reaction chamber. This regulator is simultaneously a pressure responsive and a flow-regulating device. More specifically, the regulator meters flow from the pressurant chamber to the reaction chamber as a function of the pressure within the storage tank, and is characterized by moving to the full open or full closed position upon initiating movement and at a particularly fast rate.

The embodiments of the invention described herein have a number of advantages, e.g., they provide a gas generating constant pressure source with zero pressure storage capability; they provide a gas generating means which is simple and which is capable of being relatively insensitive to varying load or operating demand characteristics.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic showing of a gas generating means incorporating the device of the invention.

FIG. **2** is a schematic showing of a second gas generating system incorporating the device of the invention.

FIG. **3** is a fragmentary sectional view of the control valve.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In order to understand clearly the nature of the invention and the best means of carrying it out, reference will now be made to the drawings. The gas generating system illustrated in FIG. **1** includes a housing **2** which incloses pressurant chamber **4**. Positioned therein are pressure responsive means **6** herein illustrated as piston **8** and propellant bellows **10**.

The gas generator system is activated by applying an external signal. In the present embodiment a pyrotechnic squib **12** is employed, squib **12** pressurizing chamber **4** with pressurized gas. The resulting pressure force acting on upper surface **14** of piston **8** causes bellows **10** to compress against a charge of liquid propellant **16**. An acceptable liquid propellant has been found to be hydrazine and when the hydrazine propellant **16** reaches a predetermined pressure, sealing means **18**, which is responsive to pressure, permits the hydrazine to flow into reaction chamber **20**. A pressure responsive sealing means may be employed, a burst-disc **22** and injector **24** having been found to be an acceptable configuration.

Liquid hydrazine **16** entering reaction chamber **20** then undergoes catalytic or thermal decomposition to produce gasified products. The gaseous output from the reaction chamber **20** then enters storage tank **30** through a reaction chamber outlet **26** where it is pressurized, stored and available on demand through outlet **28**. It is to be understood that the constant pressure source may be either the gasified products or a liquid supply on which the gasified products act or exert a pressure.

Positioned between the storage tank **30** and pressurant chamber **4** and providing communication therebetween is a feedback system, indicated generally by the reference character **40**. Feedback system **40** includes conduit **42** and conduit **44** through which the pressure in storage tank **30** is transmitted to pressurant chamber **4**. Positioned between storage tank **30** and pressurant chamber **4** is a pressure

responsive means **46** herein illustrated as a burst disc. Therefore, before the pressure in storage tank **30** can be transmitted to pressurant chamber **4**, the pressure has to rise to a predetermined level and rupture burst disc **46**. Once the disc has been ruptured the pressure in tank **30** is transmitted to pressurant chamber **4** and sustains the pressure therein.

Also included in feedback system **40** is duct **48** and upstream therefrom pressure responsive means **50**. Pressure responsive means as herein illustrated is bellows **52** which when it expands or contracts, acts on pivotally mounted flapper valve **54**. Flapper valve **54** in turn acts as an opening and closing means for nozzle **56**. Nozzle **56** is a bleed means and is positioned in duct or conduit **48**. To illustrate the operation of this particular portion of feedback system **40**, it should be noted that during the preliminary charging function of storage tank **30**, gaseous products flow through duct **48** because bellows **52** hold flapper valve **54** tight against nozzle **56**. However, when the pressure in storage tank **30** increases to a predetermined level, bellows **52** cause flapper valve **54** to pivot and open nozzle **56**, thus initiating the pressure regulating function of the gas generating system. Further, when the pressure is maintained at a predetermined value, the entire flow of gas through conduit **42** and restriction **58** therein enters duct **48** and is vented to atmosphere through nozzle **56**.

If the pressure in storage tank **30** was to rise above the set predetermined value, bellows **52** would immediately increase the flow area of nozzle **56** through movement of flapper valve **54**, and cause a pressure drop in conduits **44** and **48**. The pressure drop in duct **44** would initiate a flow out of pressurant chamber **4** which would reduce the pressure in chamber **4** and decrease the propellant supply flow entering reaction chamber **20**. This causes the activity within the reaction chamber to fall to a predetermined minimal level while the pressure in storage tank **30** slowly bleeds down to the set predetermined level. The small gaseous discharge flowing through duct **42** and restriction **56** remains almost constant regardless of pressure excursions above the minimal set value in storage tank **30** because the percentage change in pressure drop across restriction **56** remains small.

If the pressure in storage tank **30** were to fall below the minimal set value, bellows **52** would immediately close the flow area of nozzle **56**. This would permit the entire gaseous discharge to enter pressurant chamber **4**, thus increasing the pressure force of piston **8**. Accordingly, this increases the activity within the reaction chamber in an endeavor to augment the pressure in storage tank **30** to normal levels.

FIG. **2** is a second embodiment of the present invention and depicts a schematic for a system that controls the output pressure of a liquid propellant gas generator by metering the flow of propellant. FIG. **3** illustrates a control valve which permits performing this function.

The system in FIG. **2** is basically the same system described in FIG. **1**. More specifically, the system in FIG. **2** includes a pressurant chamber **104**, housing **102**, pressure responsive means **106** and liquid propellant **116**. Positioned downstream of chamber **104** is reaction chamber **120** and downstream therefrom is storage tank **130**. Both the reaction chamber **120** and storage tank **130** are of similar constructions as chamber **20** and tank **30** of FIG. **1** and perform the same functions.

In the system illustrated in FIG. **2**, a control valve **140** is positioned downstream of pressurant chamber **104** and upstream of reaction chamber **120**. This control valve is more clearly described in FIG. **3** and comprises a two-stage valve, a pressure regulator and a flow regulator. As shown, the input to the propellant control valve **140** is pressurized propellant entering port **142**. Intermediate port **146** distributes propellant at a regulated pressure from pressure regulator **143** into flow regulator portion **144**. Port **148** permits the output regulated pressure to act against larger surface **150** of piston **152** by pressurizing the chamber **154**. The force exerted on surface **150** will cause piston **152** to move towards inlet port **142**. This movement affects the regulating function by restricting the flow area of metering described by the diameter of inlet portion **142** and the clearance between the outlet of this port and the metering face **156** of spool **152**. A steady-state regulated pressure is maintained by spring **158** which provides the biasing effect and the proportional characteristics of the regulated output pressures.

Flow regulating valve **144** assumes a stable position only at the extremes of its stroke. Flow regulating valve **144** includes valve spool **162** and as illustrated in FIG. **3**, one end **161** of valve spool **162** is positioned within chamber **164**. As shown, valve spool **162** is in its open position so that metered propellant flow from duct or port **146** is permitted to flow past metering edge **166** and into duct **168** unimpeded. Duct **168** is actually the outlet of the control valve and any flow issuing therefrom would flow into reaction chamber **120**, and, additionally is in communication with chamber **164**.

Valve spool **162** also includes a large piston-like surface **171** positioned in chamber **172** which is the distal end from end **161**. Piston surface **171** is acted on on one side by spring **174**, the spring tending to exert an opening force on valve spool **162**. Acting on the opposite side of piston surface **171** is the pressure storage tank **130**. This occurs since chamber **172** is in communication with storage tank **130** by means of duct **176**. It should be noted that the pressure in storage tank **130** is substantially the output pressure from reaction chamber **120**. Chamber **172** also includes stop means **178** which physically limits the stroke of valve spool **162** in the opening direction. It is pointed out that the pressure in chamber **164** and spring **174** are substantially the basic forces tending to move the valve spool in an opening direction and that the pressure in chamber **172** is the sole force tending to cause valve spool **162** to move in a closing direction. More specifically, when the pressure in storage tank **130** increases to a predetermined value, this pressure is transmitted to chamber **172** and sets valve spool **162** into motion. As mentioned hereinbefore, movement of valve spool **162** is resisted by two forces, the pressure force in chamber **164** and the force of the spring **174**. However, it is the relative change in these forces which affects the primary motion of the valve spool **162**. The force exerted by spring **174** increases because of the compressive effort of the motion of valve spool **162**. The motion of the valve spool **162** also decreases the pressure force in chamber **164** because of the flow of liquid propellant, restricting effects of the metering edge **166** which has now partially closed off the exit of duct **146**. However, the pressure force in chamber **164** decreases inordinately compared to the force increase from spring **174**, thus forcing the valve spool **162** to complete the closing stroke very rapidly. In the stroked position, metering edge **166** completely covers duct **146** preventing all propellant from entering. The lack of propellant causes the reaction chamber process to recede, thus allowing the pressure force in storage tank **130** to remain constant or decrease according to the system demand flow.

It should be clear that the flow regulating portion of the control valve **140** is such that the only position in which it is stable is at either extreme of its stroke, more specifically, the full open or full closed position and that the opposing forces are so arranged that when the spool valve begins to move, it completes its stroke very rapidly. Additionally, it should be clear that the single variable pressure force that causes the spool valve to change its position is the storage tank pressure which is transmitted to chamber **172**. When this pressure rises to a predetermined level, it causes the valve to cut off flow and when the pressure in chamber **172** decreases to a predetermined level, the spool valve is open to permit flow of liquid propellant.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described but may be used in other ways without departure from its spirit as defined by the following claims.

We claim:

1. A pressurization system for supplying a constant source of pressure comprising:

a pressurant chamber including an outlet therefrom, the chamber including means for receiving an external actuation signal, the chamber having means responsive to the external actuation signal and containing a liquid propellant charge, these means pressurizing the liquid propellant and causing the liquid propellant to flow out of the pressurant chamber,

a reaction chamber downstream of the pressurant chamber containing means of decomposing the liquid propellant and producing a gasified product,

a storage tank downstream of the reaction chamber for receiving the gasified products from the reaction chamber,

a control valve positioned between the pressurant chamber and the reaction chamber, the control valve being in a closed position when the pressure level remains at a constant predetermined level,

said control valve being a two-stage regulator, the first of said stages receiving an input pressure signal from the propellant leaving the pressurant chamber, the second of said stages receiving pressurized liquid propellant from the first stage for regulating the flow to the reaction chamber, said second stage having means to permit the liquid propellant to flow therefrom in response to a pressure signal received from the storage tank.

2. A pressurization system as in claim **1** wherein:

the flow regulating device includes a valve spool, the valve spool having means for opening and closing its inlet and outlet, a first chamber downstream of the outlet, the chamber being in communication with the outlet means and one end of the valve spool, the pressure within this chamber being substantially regulated pressure from the first stage, a second chamber within which a piston means is positioned, the piston means being connected to the valve spool, a biasing means positioned on one side of the piston, the biasing means tending to exert an opening force on the piston and hence open the valve spool inlet, and the chamber side opposite thereto containing stop means and being in communication with the storage tank, the pressure therewithin exerting a closing force on the piston means.

3. A pressurization system as in claim **2** wherein:

the valve spool is in a stable position at the extremes of its stroke only, the first chamber pressure force and biasing force being such as to cause the spool valve to move from one end of its stroke to another when the storage tank pressure decays, and the pressure within the second chamber being such as to cause the spool valve to travel to its other extreme stroke position when the storage tank pressure increases to a predetermined level.

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