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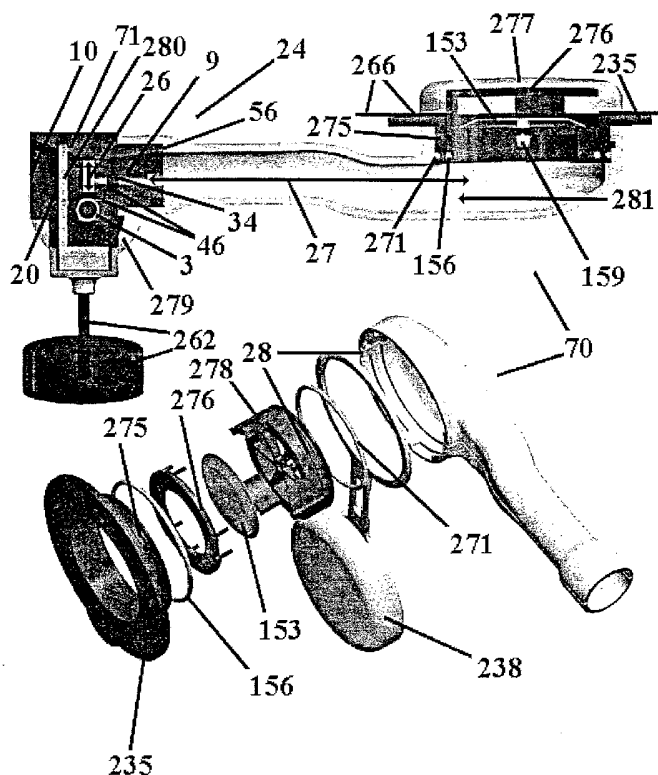
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(54) Title: GARMENT INTEGRATED, MANUALLY OPERATED, LOW-PRESSURE VOLUME-AMPLIFIED WITH
OPTIONAL VENT SEAL FOR HIGH PRESSURE 1:1 INFLATION AND OR VALVE FOR SEQUENTIAL INFLATION OF
LIFE JACKETS AND LIFE RAFTS



(57) Abstract: A wearable volume-amplified inflator for continuous or sequential inflation of PFDs, life rafts and Airhorns. The simplest inflator is a single-stage, twist to pierce, continuously operating, volume-amplifying inflator that includes the cylinder pierce mechanism or can retrofit existing inflators. A single-stage plastic inflator is appropriate for a highly compressed disposable Mylar raft. A garment integrated life raft inflator includes a manual ambient air vent allowing two-stage higher-pressure inflation. Extended survival raft includes a valve-regulated gas supply inflator for sequential inflation of life jacket, life raft then intermittent operation of a rescue air horn. A water-activated inflator provides default 1:1 inflation of the PFD, or manual operation of Venturi to conserve gas for latter conversion of the PFD into a water exit life raft. Raft mounted universal quick disconnect mounts volume amplified inflator, or back up hydrostatic pump, or expiratory inflator or range of over pressure valves and dumps.

GARMENT INTEGRATED, MANUALLY OPERATED, LOW-PRESSURE VOLUME-AMPLIFIED WITH OPTIONAL VENT SEAL FOR HIGH PRESSURE 1:1 INFLATION AND OR VALVE FOR SEQUENTIAL INFLATION OF LIFE JACKETS AND LIFE RAFTS

Field of the Invention

The present invention relates to the use of compressed gas for rapid high-pressure low-volume direct inflation or slow low-pressure high-volume indirect inflation or a range of intermediate rates and volumes for signaling during in-water emergency. In particular the current invention relates to the regulated use of high, low and intermediate pressure and inverse volumes for protection of the airway, for protection from hypothermia and for audible and visual signaling of rescue efforts.

Background of the Invention

Leonhard Euler (1707-1783) understood that as you increase velocity of a gas you simultaneously drop pressure but it was Daniel Bernoulli (1700-1782) whose name has attached to the principle. The Bernoulli Principle relies upon the conversation of energy and is the central principle in the Venturi inflator. Giovanni Battista Venturi (1746-1822) placed a constriction in a pipe, which accelerates flow. This acceleration of flow drops the pressure, creating the vacuum that draws ambient air in through one or more vents. This Venturi vacuum is at the heart of numerous devices. The Venturi vacuum sucks fuel into the carburetor of the internal combustion. The Venturi sucks up sand for sand blasters. The Venturi mixes fertilizers for Lutjens in 3,188,055. The Venturi sucks up paper debris for DeHart in 6,732,897. In Restive, 6,896,203 an additive is sucked into a sprayer by the Venturi effect. In 4,344,752 the Venturi effect emulsifies oil and water in an oil-burner boiler system. Blatt in 6,883,736 uses a Venturi section to entrain particulate matter into a forced air flow for distribution to a plurality of locations. Rozanski in 5,441,303 uses an explosive discharge to create the Venturi pressure drop to draw in ambient air for the automobile airbag.

For inflation purposes the Venturi has been used to rapidly inflate bladders have been around for some time. In 1955 Neigel in 2,859,908 presented a Venturi inflator to inflate "pneumatic jacks presently utilized for righting aircraft which have crashed on the flight deck of an aircraft carrier." Col 1 Line19. Notably, "This mixture is introduced into the inflatable structure (not shown) under a sufficiently high pressure to enable the

inflatable structure to exert a force useful for accomplishing work.” Col 3 Line 23. Pneumatic pistons and manual means open a seal down stream from the jet 49. In 1962 Marsh was issued patent 3,056,540 for what is an early if not first use of the Venturi effect to inflate “airborne inflatable dinghies and inflatable escape chutes for aircraft.” Col 1 Line 13. Marsh notes that previous efforts used compressed gas, he goes on to note “It has however been found that very large quantities of atmospheric air can be drawn into the inflatable equipment if an aspirator device is employed which uses the kinetic energy of the gas released from the storage container.” Col 1 Line 15.

Neigel / 2,859,908 is cited by Forsythe / 3,640,645. Forsythe was granted patent number 3,640,645 for shortening a 36” long Venturi inflator design Col 5 Line 19 by creating rings of jets occupying’ 27 square inches’, Col. 5 line 56. The two-stage inflation is based on distinct annular series of orifices as seen in Figures 5 and 6. Both Neigel and Forsythe inflators were designed for the rapid inflation. Forsythe’s intent was clearly stated, “rapidly inflating escape chutes and rafts” Col 1, Line 9. Because the plane can bear sufficient volume of high pressure gas Forsythe was able to include restrictive tubular sleeve check valves Col 2 line 58.

Heimovics was granted patent 4,368,009 for an aspirator also used to ‘inflate aircraft evacuation slides and rafts’ (abstract). Heimovics cites Crawford 2,772,829 and notes the intake check valves can be forced open by wave impact Col 1 Line 28. Heimovics also notes the use of an intake check valve can be “accidentally opened by a person or contact with some structure outside the inflatable body causing partial or complete release of inflation air from the flexible structure.” Col.1 Line 30. Heimovics also cites Fraebel / Patent 3,042,290 who attempted to rectify the vulnerability of the intake check valve by inclusion of a lock device. Col 1 line 35. Heimovics felt that an external lock created structural bulk with increased risk of snag and bladder damage Col.1 Line 38. To decrease the problem with leakage Heimovics incorporated inlet check valves. To open the inlet, pneumatic pressure pushes the jet array forward against bias spring 98 thereby unlocking valve members 24 covering the intake vent. To seal the raft or slide the spring bias pushes the array backwards re-locking the valve 24 from leakage of the rafts gas into the environs.

Moran in 6,004,176 has a locking intake vent similar to Fraebel, 3,042,290. The “the pair of check valves members is sufficiently rigid to resist deformation” Col 4 Line 28 further “A hinge support member both defines the inlet openings and supports the two check valves in a spring closing relation ship” Col 4 Line 18.

Baker in 6,877,698 clearly states the need for rapid inflation, "Emergencies at take-off and landing often demand swift removal of the passengers from the aircraft because of the potential from injuries from fire, explosion or sinking in water" Col 1 Line 17. Rapid inflation is emphasized frequently in patents involved in airline slide and life raft inflation. Exactly how fast is plotted by Galbraith in Figure 4 of 3,684,404. The USCG considers a life jacket blown up by mouth to be fully inflated at 0.6 psi this pressure is achieved in 3 seconds at which point the life raft is has acquired its final shape and by one definition can be considered fully inflated. This raft pressure occurs in less than 4 seconds. Additional gas influx raises the internal raft pressure. Depending on design the raft may include an Over Pressure Valve / OPV to protect from rupture. From Figure 4 it can be assumed that the OPV is set at 2.0 psi which is achieved in around 6 seconds. Col 5 Line 47. It would be hard to predict when passengers would start jumping out of a burning plane but I would consider it around 3-4 seconds if not sooner. This rapid rate of inflation of a multi-story slide capable of supporting a half dozen passengers requires robust inflators with a large amount of high pressure gas venting through wide open rings of high pressure jets. The inflatable evacuation slide needs to operate without critical supervision once the door is open as the airline staff will be fully occupied trying to organize the exit of hundreds of passengers. Galbraith refines the prior art inflators by using a pressure regulated supply at a constant pressure Col 2 Line 41 which allows optimization of the Venturi amplification. "A tube positioning cylinder and piston assembly 22 and a back pressure diaphragm 24" Col 2 Line 48 correlate mounting back pressure and falling supply pressure to regulate the orifice intake and finally close the intake. Addressing Galbraith's concerns about inlet valves opening after inflation he note his "design subjects the auto-closed intake to only lateral forces". Col 5 Line 10. This address the prior art problems with inlet check valves being forced opening by waves, entering passengers or flotsam and jetsam. Col 1 Line 12-24. Galbraith identifies the use of sequential check valves in 3,056,540.

The influx of additional gas results in the pressurization of the life raft. The pressure in the raft is called back pressure in that it opposes further in flux of additional air/gas. The operation of the Venturi is particularly sensitive to resistance to flow from any source. Back pressure is one source of resistance to Venturi operation. Back pressure begins to builds until it eventually stalls the Venturi. If the intake vent remains open the pressurized gas will then be re-routed and exit through the "intake vent". Venturi inflators designed to rapidly inflate evacuation slides and life rafts variously address the automatic conversion from rapid

low-pressure Venturi inflation to high-pressure topping off that takes over once Venturi stalls.

Galbraith / 3,684,404 has "A tube positioning cylinder and piston assembly 22 and a back pressure diaphragm 24" Col 2 Line 48. The Galbraith spring 84 creates 80 lbs of force. Col 5 line 53. Day in Re.27,860 has a displaceable cylinder spring biased closed which is opened under gas pressure Col1 line 63 to Col 2 Line 7. Hermmovics in 4,368,009 has nozzle assembly 70, which extends down stream in response to pneumatic pressure against biasing spring 98 which unlock intake vents, which eventually are closed, by back pressure. With loss of compressed gas, spring 98 pushes assembly 70 back to lock the intake flaps / valve members 24 closed. Lagen in 5,002,465 has piston 68, which extends aspirating tube 24 to open ambient air intake 30 to render the aspirator 10 operable. Wass in 6,071,084 has a telescopic mixing tube with a double piston or a piston within a piston. The telescopic tube has a L-Shaped or preferably a U-shaped wiper seal pneumatically opened against a spring bias.

In my earlier filed co-pending application or issued patents a garment integrated 3 dimension life raft constructed from 2 layers of supported or unsupported film or fabric has reduced to practice a life raft designed to be continuously worn. While jet pilots reportedly have an automatic Venturi inflated single place life raft that is inflated during descent, in air, inflation obviates the issue of water aspiration. Any automatically Venturi inflated raft has the issue of ambient air intake seals, pressure regulation, two stage inflation and over pressure protection and thus must have a level of complexity in order for it to operate independent of operator intervention.

Thus there remains a need for a simple volume amplified inflator small enough to be continuously carried on the person invisibly integrated into their garment integrated life raft-life jacket system. In place of an expensive, complex, heavy, bulky, pneumatic piston-driven automatic inflator designed for extremely rapid inflation of airplane evacuation slides the individual requires a highly efficient inflator. The ability of the disclosed volume amplified inflator to inflate a life raft from the same size cylinder currently used to inflate a life jacket is made in part by extending the time it takes to inflate the life raft. While inflation takes a minute or two compared to the 3-5 seconds it takes to inflate a jet slide, this extended inflation time is required to extract optimal amplification from a very small cylinder by a very simple inflator. It is to be noted that unlike a fuel fire in a plane the Man Over Board ("MOB") has few minutes exit the water in even the coldest oceans.

In place of the weight and cost of regulated gas supplies and automatic operation which requires pistons within pistons, water proof valving whose resistance can be borne by the high pressure extremely rapid evacuation slide inflators what the individual boater needs is a device that small enough and light enough to comfortably fit in the hand. Once the weight and cost of the mechanisms for automatic operation are removed, the inflator becomes totally dependent up the MOB to provide critical control. For in water use the operator must hold the inflator out of the water before piercing the compressed gas cylinder. Further, the ambient air vent must remain continuously held above the water's surface for several minutes during the operation of the volume amplifying inflator or the inflator will aspirate water into the raft. Certain compressed gases such as CO₂ are also sensitive to orientation and must be held upright during operation in order to be assured complete inflation of the life raft.

With the inclusion of a vent cover within the current invention, provide for manual two stage inflation. Once the raft is inflated the operator is responsible for closing or releasing a spring biased vent to close. This prevents the remaining compressed gas from being lost through the 'intake' vent due to back pressure stalled Venturi. The remaining N₂ gas in the supply cylinder bleeds through the very restricted orifice of the inflator. If the inflator is using CO₂ instead of N₂ surrounding water or air provide the calories needed over time to sublimate the CO₂ dry ice into CO₂ gas leading to a protracted second stage 1:1 direct high pressure topping off of the raft. Baker in 6,877,698 refers to this CO₂ problem at Col 1 Line 39 " a large drop in temperature occurs as the compressed gas expands, often causing ice to form, which can block the flow of gas." While the disclosed miniature, affordable, garment integrated inflator cannot afford the either the cost, bulk or local thermal protection needed to take advantage of Baker's solution to 'electrically ignited combustion of gas generating material that burst into a cylinder to raise the temperature to 1200 degrees needed to decompose Nitrous Oxide. The decomposition of N₂O is also an exothermic reaction both of which offset the endothermic boiling of CO₂ into CO₂ gas.' Col.5 Line 22 -44

Thus the second stage inflation is slow but because of its connection through a low resistance mushroom valve it continues to pressurize over hours. The compressed nitrogen cylinder remains a gas after the raft is inflated to .6 to 1.6 psi and the Venturi suffers back pressure stall, closing the vent cover allows 1:1 high pressure inflation which occurs in minutes rather than hours.

Proposed second stage inflation which boosts the raft pressure above the back pressure Venturi failure pressure, is manually initiated and terminated. Rather than having an elaborate automatic conversion the user must detect termination of the the first stage of inflation which relies upon the Venturi Effect. This is done by noting a slowing of inflation or the passage of gas out the intake vent. At that point the vent is closed and the raft entered. Minute or hours latter the volume amplified is inflator is manually removed and a secure sealed cap is manually placed over the gossamer large bore low restriction check valve. This responsibility of the user is the trade off for eliminating the expensive, heavy bulky, spring biased back pressure augmented vent closure systems required for automatic high speed airline evacuation slides.

When this ultra-light Venturi inflator is used with a dual function bladder that is first inflated as a life jacket, the inflator then must include an on-off valve to allow the residual gas to be saved. After the shock of water entry is negotiated, the inflator is turned back on in order to convert the life jacket bladder into a life raft or for other uses. A sophisticated inflator would have an adjustable valve allowing flow rate to be adjusted for slower but more efficient inflation of the life raft conserving more gas for signaling purposes. Operation of the signal air horn may require the adjustable valve to be set for maximum volume. Single use volume amplified inflator-life raft is cost sensitive where a device used for routine inflation of recreational inflatables can bear the costs of more sophisticated jet designs that would burden the simplest continuously operating Venturi inflator designed to inflate a highly compressed disposable "Mylar" or Low Linear Density PolyEthylene ("LLDPE") life raft

SUMMARY OF THE INVENTION

While standing watch alone the sailor is knocked off the sailboat by the boom. Hitting the water dazed, the water activated high-pressure low-pressure compressed gas inflator is actuated upon contact with the water to rapidly inflate the life jacket. An integrated audible alarm and the cold water arouse the semi-conscious MOB who positions themselves face up placing the inflator vents, which are normally spring closed, out of the water. Opening the air intake vents the volume amplification quickly completes filling the life jacket. A second audible alarm indicates off-gassing through the intake vents so the operator closes the inflator's valve to conserve the remaining gas and the vent cover springs closed.

The survivor removes a multi-function signal device from their garment and then transfers the compressed gas inflator and cylinder from their life jacket to the signal tube. When the inflator is held above the water, the volume amplified inflator valve is cracked opened. Flow rate is kept to an absolute minimum and the air intake vents are locked open. The volume-amplified inflator quickly inflates the SOS distress signal tube consuming very little compressed gas.

An audible signal alerts the MOB that the inflator has begun to off-gas through the air intake vent. The MOB releases the vent cover converting the inflator from low-pressure volume-amplified inflation into high-pressure direct inflation and the tube is topped off to 2.5 psi. The inflator valve is once again closed conserving the remaining compressed gas.

Due to the rapidly cooling temperature of the open Ocean water, the MOB knows they will need to achieve a water exit strategy if they are to survive for more than 30 to 60 minutes. The sailor suspects he may not be missed until the next watch comes on deck. Consequently the SOS marker is quickly converted into a Yoke Collar style PFD and donned freeing the garment integrated primary PFD bladder to be released from the garment. Once outside of the fabric configured cover the primary bladder is attached to the inflator. When held out of the water, the vent covers are locked opened and the inflator valve just cracked open. A barely perceptible hiss of compressed gas begins converting the Personal Flotation Device / PFD into a Personal Life Raft /PLR. The MOB is buoyed by their secondary bladder as the raft inflates. Once inflated the inflator vents are closed and the valve opened up converting the inflator into a high-pressure inflator to bring the raft pressure to 2.5 psi. Again the inflator valve and vents are closed.

Once in the raft the Yoke Collar PFD is removed and reconverted into a SOS Distress marker. The marker is orally inflated to the best of the MOB's ability. The inflator is then attached and with the air intake vents closed, the valve is opened so that the inflator acts as a high-pressure inflator. The SOS signal device is made rigid by 2.5 psi of internal pressure well above what the 0.6 psi MOB was capable of achieving with their lungs.

A tertiary, single-use, 'Mylar' multifunction bladder is removed from the MOB's jacket and orally inflated. The tertiary bladder is configured as a Yoke Collar PFD and donned. The bladder orally inflated to 0.6 psi. The ambient air intake vents closed setting up the inflator for high-pressure inflation. Once the valve is opened the PFD is quickly brought up to its 2.5-PSI structural operating pressure.

A small fishing vessel is spotted motoring across the horizon in the distance. A membrane air horn is attached to the quarter turn inflator and the valve cracked open for intermediate rate and pressures creating an ear piercing sound. The boat motors on and the MOB recalls that the survivor sees an average of 5 vessels pass them by before one spots their life raft adrift in the open Ocean.

Latter that day another fishing vessel motors onto the horizon and this time stops to fish a drop off. Once the sound of the motor stops, the MOB opens the inflator's valve supplying compressed gas to the air horn and the fishing vessel's rescue brings to a successful end the MOB's potentially life-threatening experience.

The mechanics of amplified inflation as seen above are best when they can be adjusted to a specific application. The use of a central stream of air to entrain ambient air is a trade off between the volume of air required to fill a bladder versus the need for rapid inflation. At one extreme, maximum volume would take infinitely long while at the other end life jackets according to the International Maritime Organization are expected to roll the unconscious victim into a face up position in 5 seconds and so require very fast inflation for the unconscious person.

To comply with international standards all current life jacket inflators rely upon direct expansion inflation in which the liquefied gas contained within a cylinder is released converting it to pure gas in seconds. Current life jacket inflators convert 1 gm of CO₂ into 1 lb. of displacement. This is accomplished manually by a sharp jerking motion driving the piercing pin or by a water-activated spring-driven piercing means that perforates the cylinder seal. Ideal the piercing means retracts leaving a large unobstructed opening and rapid conversion of liquefied gas to gas.

The water activated volume amplified inflator can be set up to function as a traditional 38 gm 5-second inflator for the unconscious victim. However if conscious the survivor can convert the water activated into manual and converse the compressed gas such that they can inflate several bladders including a life raft from the same cylinder.

Volume amplified inflator design whether injector, inspirator or Venturi enhanced includes many elements: the micro-pierce diameter, valve advance and valve orifice design, jet orifice and the absence or presence of a vacuum generating Venturi.

If present, the diameter of the Venturi throat, distance of the jet orifice to the Venturi throat, the angle of the Venturi intake as well as length and angle acuity of the Venturi exit all contribute to amount of ambient air that can be captured. The amount of high-pressure

gas directed through the Venturi determines the maximum internal bladder pressure that can be reached with air intake vents open. Once that internal bladder pressure is exceeded then the jet will begin to off-gas through the 'intake' vents rather than creating a vacuum to drawing air along as occurs when there is no back pressure.

Once gas begins to escape out the 'intake' vent the vent can be closed converting the low-pressure inflator into a high-pressure inflator with no volume amplification. Once the life jacket is fully inflated, the inflator valve is closed saving the remaining gas for secondary functions such as inflating distress marking tube, personal life raft or operating an air horn.

The maximum displacement generated per gram of compressed CO₂ available is not only a function of inflator design and duration of inflation but of associated valving and connector sizing.

The current life jacket inflator allows 1 gram of CO₂ to directly expand filling a bladder with pure CO₂ at 1-2 PSI generating 1 lb. of displacement. A simple volume amplified inspirator or injector generates about 2 lbs. and Venturi amplified inflator is capable of generating 4 to 10 or 20 lbs. of displacement.

If the survivor is not panicked and places the intake vents out of the water before actuating the inflator, if the CO₂ cylinder stays vertical so that no liquid CO₂ is passed out the inflator, if the inflator has a variable flow rate valve set to the lowest setting then a very limited amount of gas jets through the Venturi throat over a long period of time. While the rate of inflation is slower the amount of ambient air entrained is the greatest and consequently the final volume of air moved into the bladder is markedly amplified compared to current expansion inflation.

Finally, CO₂ is a small molecule that can escape through tire inner tubes or worn portions of laminated inflatables. When the CO₂ is used primarily as the driving gas the ambient gas becomes the predominant component in the final mixture. The high percentage of nitrogen and oxygen reduces the gradient driving CO₂ through the bladder wall resulting in less structural loss due to CO₂ escape in an extended survival scenario.

Thus there remains the need for an inflator that will quickly provide corrective turning for the unconscious victim, at the cost of consuming the entire 38 gm of CO₂ to generate 35 lbs of lift. However if the victim is conscious the inflator can be physically oriented in a vertical position out of the water then adjusted to inflate the life jacket at a slower rate entraining ambient air in a 4:1 to 20:1 ratio. Once the PFD is filled in the low

pressure mode it can be switched to the high pressure mode of operation to increase the pneumatic tension in the PFD. The inflator can then be turned off and detached and the remaining liquid CO₂ conserved for inflating the personal life raft. After detaching the inflator from the life raft an air horn attachment can be attached. The most efficient use of compressed gas to achieve the maximal amplification of the final volume of displacement requires the permanent or detachable valve and connecting fixtures to supply the least resistance to flow. A wide bore low durometer flapper valve supplies negligible resistance to the low-pressure flow. The inflator can be disconnected from the valve so a locking cap can provide a long term seal once the inflator had been removed for other low, intermediate or high-pressure applications such as production of high volume audible rescue signal.

BRIEF DESCRIPTIONS OF THE DRAWINGS

FIG.1 is a lateral view illustrating a seal then micro-pierce compressed gas inflator with valve. Manual or spring loaded vents converts the inflator between rapid high-pressure inflation and slower but high-volume inflation. Injector, inspirators or Venturi are selected by price and amount of amplification required. The micro-puncture inflator deforms the cylinder threads so that the spent cylinder with its nearly invisible perforation cannot inadvertently be re-installed;

FIG. 2 is a lateral view illustrating volume-amplified inflators of increasing efficacy from a simple continuously operating low pressure with minimal volume amplification. To a high pressure direct or low pressure with minimal amplification. To a Seal-Then-Pierce high or low-pressure, Venturi amplified high-volume inflator;

FIG. 3 is a lateral view illustrating a range of integrated valving mechanisms that allows stopping, restarting and regulation of the rate of flow of compressed gas. The shut off valve allows the same 16 gm CO₂ to inflate multiple survival devices;

FIG. 4 is a lateral view of a combined water or manually activated, fixed displacement or variable displacement, low or high pressure compressed gas inflator. Optional spring-loaded cam thread degrader retracts during loading of the cylinder but is forced out and degrades cylinder threads during removal of the spent cylinder;

FIG. 5 is a lateral view illustrating a volume-amplified inflator with integrated large bore check valve. A longitudinal valve compresses the gossamer mushroom valve against a valve seat, converting the check valve into a shut off valve. A three part inflator/ coupler / connector allows the inflator to be removed for other applications. The check valve/shut off

valve / coupler is also the oral inflate and large bore deflate valve. An air horn is powered by any excess gas;

FIG. 6 is a lateral view illustrating a range of spent cylinder detection means. Ideally, the spent cylinder threads are degraded to the point they not only indicate use but also mechanically prevent a second installation. Alternatively a simple plastic brilliant green cap which is removed during installation to reveal underlying red threads indicating a used status. A bi-refrangent crystalline coating, which changes color as the spent cylinder, collapses during off-gassing;

FIG 7 is a lateral view illustrating that a conscious user is required to hold the CO2 cylinder in the vertical position to prevent loss of liquid CO2 as well as to manually convert the rapid high-pressure low-volume inflator into a low-pressure volume amplified inflator by retracting the Venturi vent cover. The volume amplifying means in this case is a retrofit Venturi mounted between an existing UL Approved inflator and the life raft to be inflated. The inflator and cylinder were removed from the redundant chamber in the life jacket;

FIG 8 is lateral view of UL listed inflators that have been retrofitted with Venturi amplification;

FIG 9 is a lateral view illustrating a simple continuous operating volume amplified inflator with a cylinder thread degrading die;

FIG 10 is a lateral view illustrating an insert valve that integrates a mounting system for the Venturi inflator. Once the inflator is removed the insert valve can be used of oral inflation or deflation;

FIG 11 a cross section and exploded view illustrating the elements of a continuous discharge high-pressure 1:1 volume or low pressure amplified volume co-planar inflator which can be detached from a bladder integrated one-way check valve;

FIG 12 is an inferior and lateral view illustrating the locking and sealing of the bayonet or 1/4 turn mounting means of the volume amplified inflator onto the bladder mounted flange;

FIG 13 is a lateral view illustrating a range of attachments to the universal bladder mounted quick disconnect including over pressure valves, under water dump valves, a hosing adapter for respiratory inflation and a fabric adapter for hydrostatic or torque inflation;

FIG 14 is a lateral view illustrating an assembled and armed volume amplifying inflator sealed in a water tight fashion protecting the Venturi jet orifice until the inflator is held safely out of the water and ready to convert the life jacket into a life raft; and

FIG 15 is a sectional view of a two stage manually operated injection molded Venturi inflator. Injection molded component parts are ultrasonically welded.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 shows a combined low-pressure volume amplified and rapid high-pressure but minimal volume inflator 1 with and without the valve means that allows regulated flow and shut off capacity as required for inflating multiple bladders. The upper drawing is of a low-pressure high-volume valve-regulated inflator 23 in which the CO₂ cylinder is inserted into threaded cylinder receiver 33. The CO₂ cylinder is advanced by cylinder complementary threads 6 towards an over sized nylon thread section 7 of receiver 33. The increased resistance of the nylon threads 7 alerts the user to the location of the cylinder within the inflator 1. Upon reaching the nylon threads the user provides one last full twist to advance the cylinder into the locking nylon thread section which prevents the cylinder from vibrating out of position. The last full turn of the cylinder also places the cylinder against the primary low-durometer outer gasket seal 3.

On intent to inflate the life jacket the cylinder is twisted into the inflator receiver 33 of Figure 1 further compressing the soft primary O-Ring 3 which creates a secure pneumatic seal with the environment. Continued turning of the cylinder leads to compression of the secondary high-durometer central gasket seal 4 against rigid support 48. The secondary seal 4 is an integrated valve allowing intermittent operation of the volume-amplified inflator. As the operator continues to advance the cylinder into seal 4 the cylinder impales itself upon the micro-pierce means 5 which is embedded in a threaded mount 36. The threaded mount 36 supports the micro-pierce means 5, the primary O-Ring 3 and secondary valve seal 4. Once the cylinder seats against seal 4 backed by rigid support 48 and can no longer be advanced, the cylinder is then backed away from the secondary valve seal 4 and compressed gas flows through fenestration 8 in the Seal-Then-Pierce valve 2 into the conduit 46 through jet 34 as seen in the lower drawing of Figure 1. The compressed gas is consolidated as it passes through the jet orifice 9. The diameter of jet orifice 9 in part determines the volume of the high-speed compressed jet stream focused on the center of the Venturi 35. The particular volume of the jet stream is actively regulated by the Seal-Then-Pierce valve 2.

The jet stream then passes through the throat of Venturi 35. The performance of a particular Venturi is a balance of the Venturi throat diameter 26, throat angle 47, distance from jet orifice to throat 25, exit angle 26 and exit length 27. Restriction of Venturi length 27 to reduce the overall size of inflator 1 increases user compliance. Venturi design parameters are optimized for either quick inflation of a Personal Flotation Device or optimized to achieve maximum volume amplification as is required in order to inflate a life raft from a very small cylinder. Alternatively, valve 2 allows quick adjustment between rapid inflation and high-volume of inflation.

With a fixed Venturi design the inclusion of a valve such as the Seal-Then-Pierce valve 2 of Figure 1, or a quarter turn needle valve 101 of Figure 3 or a threaded spool valve such as 111 of Figure 3 allows the operator to start, stop and vary the flow rate through the volume amplified inflator 1. That is the operator can optimize rate over volume to quickly fill the life jacket. Once the life jacket is inflated the valve can reduce flow rate to now optimize inflator 23 for increased volume over rate as needed to fill a voluminous life raft.

The top drawing in Figure 1 of inflator 23 has longitudinal air intake vent cover 11 in the locked open position 21 so that the ambient air intake 10 is open to the environment. A rear quarter turn lock 14 holds cover 11 back against spring 12. On release cover 11 is pushed forward through quarter turn track 30 as spring 44 expands. The advance of cover 11 is arrested by stop 13. The vent cover 11 creates a seal by compressing rear O-Ring 15 and front O-Ring 17. Cover 11 rides up on forward support shelf 18 and abuts against forward stop 19 under spring tension 22 as seen in the lower drawing of Figure 1.

In the lower drawing of Figure 1 access to ambient air is blocked by vent cover 11 being in the forward or locked closed position 20. With the air intake 10 closed the inflator is now a high-pressure low volume inflator 24. Inflator 24 does not include a valve so upon micro-piercing of the cylinder, which is sealed from the ambient environment by single gasket 43, inflator 24 discharges continuously until the cylinder is spent. Such an economical inflator might be dedicated to the inflation of a life raft where the entire volume could be consumed by a single bladder. In the lower drawing the pierce means and fenestrations 45 are side by side.

The primary flow rate of volume amplified inflators is limited by the micro-pierce means 5 as seen in the upper drawing and lower insert drawing. This micro-pierce regulation leaves a nearly invisible perforation in the CO₂ cylinder making the re-installation of a spent cylinder even more likely. Consequently the receiver of inflator 24

has integrated non-complementary cutting threads 38 and hardened burring gouge 39 to destroy and deform the threads on the used cylinder. The upper drawing depicts the traditional use of a beveled entrance 42 to guide the cylinder into the receiver and to help start the threads. In the lower drawing the bevel has been eliminated and the first threads are at the upper limit of size so that only very clean threads are allowed to enter receiver 33.

Both inflators in Figure 1 are assembled from two pieces; the single piece cylinder receiver and jet-orifice 51 are threaded at 32 onto Venturi 35. When the inflator vent cover 11 is closed 20 the inflator functions as a high-pressure low-volume inflator 24 requiring that the joint between the jet-orifice and Venturi be sealed by O-Ring 31 to sustain the elevated pressures generated when inflator 1 functions as a high-pressure inflator.

In Figure 2 the upper drawing is of a very economical continuous discharge low-pressure volume amplified inflator 50. The intake vents are continuously open 52. A tubular pierce means 53 is press fit 54 into the single piece cylinder receiver-jet 51. The cylinder receiver-jet 51 is permanently attached to the vented inflator housing 55. The continuously vented inflator housing 55 creates simple injector volume amplification 57.

The center drawing of Figure 2 is an another simple continuous discharge volume-amplified inflator that can function as a low-pressure or high-pressure inflator 70 due to inclusion of an intake vent cover 72. The economy of inflator 70 is that the receiver and inflator are made from a single piece 74. The pierce and jet means 73 are threaded into the receiver-inflator body 74. In the middle drawing the rotating barrel vent cover 72 is in the open position 75. The simple volume amplified inflator 70 draws in ambient air through intake 10 and through orifice 81 in the barrel cover 72. Even without incorporation of a Venturi the high-pressure air stream from the jet orifice draws in sufficient ambient air to allow a small cylinder to fully inflate a single large bladder PFD.

The lower drawing is of an inflator with Venturi amplification 35, and an on / off / variable flow valve 2 with barrel vent cover 72 capable of converting the inflator between high or low-pressure operation. This combination of features creates a 1 to 1 high-pressure direct inflation or a Venturi amplified volume inflated, variable-pressure, variable discharge duration and rate, variable displacement, compressed gas inflator 80 depicted in the vent closed position 76. In the insert to the right the rotating barrel vent 72 is in the closed position 76 in which gasket 71 seals the cover 72 to inflator body allowing high-pressure operation. In the sealed closed position the inflator functions as a traditional high-pressure

low-volume inflator in which the final displacement is strictly limited to the amount of compressed gas available to expand once released from the cylinder.

In the lower drawing the inflator 80 is constructed from a single piece 51 threaded cylinder receiver 33 and jet 34 which is permanently attached such as by press fit or ultrasonic weld 82 to the Venturi component 35.

Figure 3 illustrates a range of valving mechanisms which add a level of complexity to manufacture and cost but allow the inflator to conserve the compressed gas resources of a single cylinder to inflate a series of bladders. Seal-Then-Pierce valve 2, needle valve 101 or spool valve 111 not only act as on-off valves allowing inflation of multiple bladders but the incorporation of a valve also allows regulation of flow rate which is inversely proportional to the final displacement generated per gram of CO₂.

The upper left hand drawing of Figure 3 is of a nested orifice, Venturi amplified volume, variable-pressure, variable discharge duration and rate, variable displacement compressed gas inflator 90. Compressed gas passes through fenestration 8 into passageway 94 between the pair of nested jets 91. The diameter of passageway 94 can be varied by threaded adjustment 92. The passageway 94 can be reduced until orifice shut off plug 93 prevents any pressurized gas from exiting the jet. The nested jet inflator is comprised of three parts, the Venturi end piece 96, the outer jet piece 97 and the cylinder-receiver piece 98.

In the upper left hand drawing of Figure 3 an oscillating means 99 is directed in towards the jet orifice such that if the downstream bladder is full the ambient air intake 10 is now converted to a pressurized air egress. As the gas moves from a zone of high pressure to ambient pressure an oscillating membrane 99 alerts the operator to convert the inflator 90 into a high pressure inflator by closing ambient air intake 10 with vent cover 11. Alternatively the operator can shut off the inflator by twisting the cylinder into the Seal Then Pierce / STP valve 2 or twist the nested jets 91 to shut off and thereby conserve the remaining pressurized gas for other survival devices such as distress markers, life rafts or air horns.

The upper right hand drawing of Figure 3 is of a volume amplified inflator 100, specifically a Venturi amplified volume, variable-pressure, variable discharge duration and rate, variable displacement compressed gas inflator with in-line shut off and flow adjustment valve. Needle valve 101 turns to align eccentric orifice 102 allowing regulated release of the compressed gas. The eccentric orifice allows for a very gradual release of 800

psi compressed CO₂. The needle valve 101 is sealed by needle valve O-Rings 103. The valve is held into the inflator body by valve retainer clip 104.

The lower right hand drawing of Figure 3 is of a thread advanced spool valve, Venturi amplified volume, variable-pressure, variable discharge duration and rate, variable displacement compressed gas inflator 110. As the spool valve 111 is turned threads 112 very gradually advance the spool valve passageway 113 past / off the spool valve on/off O-Ring 115 allowing compressed gas to flow into the jet conduit 46 and out the jet orifice 9 toward the Venturi end piece 96. An outer O-Ring 114 seals the high-pressure portions of the valve from the environment. In threaded spool valve inflator 110 the single piece threaded cylinder receiver and jet 51 houses the thread advanced valve and includes oversized finger grips 116 to facilitate mounting the cylinder and regulating the inflator without straining the connection to the fabric bladder.

Figure 4 is a pair of Water activated or manually activated Venturi amplified volume, variable-pressure, and variable displacement compressed gas inflators 130. In the inflator the water sensitive bobbin 131 is exposed or protected from access to water by sliding cover 134 which is sealed by O-Ring means 135. In the left hand drawing the cover is down exposing the fenestrations 133 to the environment and the inflator is set to function as a water or manually activated inflator 140. When cover 134 is in the up position as seen in the inflator on the right, the fenestrations 133 are sealed away from the environment and the inflator is in the manual-only activation mode 141.

In both inflators the moveable pierce means 136 is sealed by pierce means O-ring 137 to prevent loss of high pressure compressed gas. In both inflators the lower portion of the inflator 144 threads together with upper portion 145 at thread 138. During threading water sensitive bobbin 131 pushes driver 147 which is an extension of driver plate 146 which compresses spring 139. The water sensitive bobbin 131 holds spring 139 in a state of compression. If the fenestrations 133 are exposed to water the bobbin 131 deteriorates and the driver 146 advances through bobbin 131 driving pierce means 136 through the CO₂ cylinder seal.

The water-activated inflator on the right includes a default operation as a high pressure, 1:1 inflator of the jacket. in the event the individual falls unconscious into the water the inflator automatically comes on and will inflate the personal flotation device ("pfd"). If the user is anticipating water entry they can manually open vent cover 21 and depress valve 111 which closes off high pressure bypass port 148 thereby allowing the

individual to not only inflate their pfd but latter to use the same cylinder to inflate their life raft. When valve 101 is depressed against default spring bias, compressed gas is shifted to the restricted orifice of the Venturi 149. Spool valve 111 that allows the compressed gas jet stream to be turned off and on to allow inflation of multiple bladders. The ability to regulate rate of flow allows rapid inflation of the life jacket and then slower volume-amplified inflation as required to inflate a high volume bladder such as a personal life raft. During storage the fenestration cover 134 is in the closed position as seen in the right hand drawing of Figure 4. During storage which is 95-to 99% of the time for recreational life jackets, the silica gel bobbin 132 protects the water sensitive bobbin 131 from humidity extending the shelf life of the water sensitive inflator mechanism.

On the right side of Figure 4 at the receiver end of inflator 141 a spring positioned cam 142 allows the hardened thread cutter-degrader 143 to move out of way during installation of the CO2 cylinder. However as the cylinder is being removed the cutter 143 is forced into the exiting threads destroying the threads so that the micro-pierced spent cylinder cannot pass back over the low tolerance entrance threads 40.

In the left hand drawing in Figure 5 a full bore externally mounted radio frequency welded, coupler 150 slides over a standard RF weldable right angle connector 152. Specifically full bore fitting 151 slides over connector until dual function connector stop and valve seat 155 prevents further progress of coupler 151 over connector 152. Coupler 151 is a dual position externally mounted coupler that allows inflator integrated full bore check valve 153 to be operable in one position 154 then be compressed without twisting into a locked closed valve 163. A high flow check valve such as 153 is very soft and will fold upon itself if turned while contacting a surface. However a supple low resistance check valve such as 153 can be sealed by direct compression. The Inflator-coupler-check valve 157 integrates the check valve 153 at the end of the inflator. The inflator 157 includes quarter turn pin 28 that slides along the dual-position dual-locking quarter turn grooves 158 and high pressure seal is achieved by check valve O-Ring 156.

In the middle drawing of Figure 5 the custom molded coupler 161 is integrated into the manufacture of the tubing connector 160. The coupler-connector is fused 162 during manufacture. In the second drawing the check valve is compressed 163 against seat 155.

In the right hand drawing of Figure 5 an independent full bore inflate/deflate/check valve-coupler 170 includes finger grips 171. The coupler can be used separately as an oral inflate valve, removed to be a wide bore deflate valve or locked closed by compression

against stop/ valve seat 155. The mushroom flapper valve 153 mounts by way of mushroom valve post 159 onto coupler 170.

In the lower left hand corner of Figure 5 inflator 157 is connected via inflator mount means 28 to a combined oral / compressed gas air horn 172 and quarter turn mount means 177 on the air horn 172. The air horn 172 is self orienting due to inclusion and positioning of ballast moment 173 and buoyant moment 174. Valve 101 provides flow/ volume control for air horn 172. Nano-pierce orifice 176 further reduces the flow rate from volume amplified inflators. Compressed gas cylinders such as O₂ or CO₂ supply the pressure that is coupled through inflator 157 and valve 101 to air horn 172. An oral check valve 175 allows oral use of the air horn 172 if there is no remaining compressed gas. Either oral or cylinder compressed gas vibrates membrane 178 producing a piercing audible alarm.

In the lower right hand insert of Figure 5 shows a detail of the dual-position quarter turn safety lock coupler or valve-coupler 180. The quarter turn entrance 182 leads to the quarter turn right angle groove 186. At the end of the quarter turn groove the inflator 157 or coupler 170 is pulled back over locking ridge 181 into the check valve operating position 185 or pushed forward over locking ridge into a continuously tensioned compressed-closed position 184. The locking ridge applies continuous pressure against the valve and seat converting the check valve into a secure shut off valve. Two locking ridges 181 create friction locks to secure the full bore amplified volume inflator check valve 157 or the full bore valve coupler 170 in either the locked open position 185 or locked closed 184. In either the locked open 185 or locked closed 186 position the side safety lock 183 prevents the inflator or coupler from turning left or right.

In Figure 6 the micro-pierced cylinder 202 when re-installed contributes to the high rate of failure of fielded inflatable products. The most economical solution is to degrade the threads 200 on installation or removal so that the micro-pierced cylinder cannot be installed a second time yet the volume amplified inflator can be reliably and economically operated with off the shelf CO₂ cylinders. In the top row the full CO₂ cylinder 201 is capped with a brilliant green cap which is removed before or during installation. Under the green coating can be a normal cylinder 202 or red anodized threads further visually indicating a cylinder's used status. In the lower row on the left of Figure 6 is a full cylinder which has been dipped in a bi-refrigrant coating 204. Upon release of the 800 PSI of gas the cylinder diameter reduces sufficiently to create a change in the iridescent coating signaling a spent cylinder

205. Alternatively a plastic collar 206 is removed during installation helping visually impaired or nocturnal re-arming.

In Figure 7 Man Over Board / MOB 249 is manually orienting the cylinder 230. MOB 249 is responsible for keeping the pierced cylinder vertical 231 regardless of the size of the direction of size of the waves 234. Simultaneously the MOB 249 is converting the default mode of operation, high-pressure low-volume, into a high-volume low-pressure inflator by manually holding the Venturi cover 11 in the open position 232, thereby exposing the ambient air intake 10. The operator is responsible for assuring that air rather than water is entrained during inflation of raft 236. By holding the cylinder vertical 231, the remaining Liquid compressed CO₂ stays at the bottom of the cylinder 248 at the opposite end from the pierced orifice in the cylinder seal.

In Figure 7 the MOB 249 is wearing a double chambered inflatable PFD such as a Safety Of Life At Sea/ SOLAS PFD 241. The SOLAS PFD is required to have two chambers in this case an upper chamber 244 which is automatically inflated upon contact with the water. An existing UL Approved water activated inflator 242 has been retrofitted with a valve and Venturi so that if the operator so chooses the upper chamber can be slowly inflated utilizing the Venturi conserving the vast majority of the compressed liquid CO₂ 233 for use in inflating other devices or operating an air horn. Of note the optional Venturi operation requires the operator to keep the cylinder vertical and free of water while the ambient air intake is held open. In addition a pivoting CO₂ manifold 246 allows the cylinder to be positioned vertically so that only gas and not compress liquid gas can be passed through the inflator. A middle gas retentive layer 243 divides the upper chamber 244 from the lower chamber 245. Since the upper chamber 244 and lower chamber 245 share a common wall 243 this dual chamber design can only benefit from inflation of a single chamber. Given reliable operation of the water activated inflation system and chamber, the redundant manual inflator 237 can be removed from the lower chamber 245 and used to inflate raft 236. The UL listed manual inflator 237 is retrofitted with a simple continuous discharge, single use, low-pressure volume amplified inflator 240. This volume amplifying add on is similar to item 50 in Figure 2. That is once the UL listed inflator is jerked to pierce the cylinder the entire contents will be passed through the inflator and retrofit Venturi until spent. Raft 236 provides 300 lb of displacement yet can be fully inflated by a volume amplified 38 gm CO₂. Of note the same 38 gm CO₂ when used in the default or traditional rapid, high-pressure, low-volume mode of operation it only generates 35 lbs of

displacement. If the MOB 249 elects to manually inflate the lower chamber 245 of his PFD 241 and then manually inflates the majority of his raft, use of the upper inflator which includes an on-off valve a small portion of high pressure gas to be used to top of the raft to 2.5 psi. Once the raft is rigid the operator can turn off the gas with inflator 242 preserving the residual gas 233 for operation of the air horn 172 as seen in Figure 5.

Once the raft 236 is inflated in Figure 7, the regulated Venturi retrofit inflator 242 is disconnected by quick disconnect means 28 from the bladder mount quick disconnect means 235 and cap 238 used to provide secure pneumatic seal. The remaining compressed gas is then available for operating other safety gear.

Figure 8 is lateral view of UL listed inflators that have been retrofitted with Venturi amplification. A UL listed water activated inflator 260 is seen in the lower drawing of Figure 8. After puncture of the cylinder the compressed gas enters the Venturi through the usual orifice 265 in inflator 260. It passes through valve 101 then through jet orifice 9. The stream of high speed gas pulls in ambient air through intake 10 that is open because the rotating barrel cover 75 which is aligned to the orifice in the barrel cover 81 is aligned over the ambient air intake orifice 10 in the Venturi. A releasable pneumatic coupler sleeve 269 is O-ring sealed 271 to RF welded pivoting adapter mount 267 with its internally mounted mushroom valve 153. The pivoting mount 267 is RF welded to bladder 266. A mushroom check valve 153 is mounted on post 159. The Quick Release sleeve 269 is locked onto the pivoting adapter mount 267 by keeping the locking balls 270 tight with groove 268 in the manifold stem 275. The locking sleeve 269 allows the inflator to pivot about the quick disconnect manifold stem 275 by the weight of the cylinder and gas 239.

In the upper corner of Figure 8 UL listed manual inflator 261 is mounted onto a threaded chamber 264 that receives the compressed gas. UL listed nut 263 secures the retrofitted simple Venturi 240 in place on the existing manual inflator 261. Quick disconnect means 28 allows the retrofitted manual inflator to mount onto a pivoting coupler 274 with an integrated check valve. The connection is sealed with O-ring 273. A permanent snap lock cover 272 allows for pivoting of the Venturi inflator about bladder check valve. Quarter turn entrance groove 182 receives quick disconnect mounting means 28 built into the end of the Venturi inflator. Once the raft is inflated a sealing cap 238 can be mounted and sealed by O-ring 273 to prevent slow leaks through mushroom valve 153 as identified in the lower drawing.

In Figure 9 an CO2 inflator of any type with cylinder thread degrader/ eraser with cylinder position indicator 290 has a drive pin 291 that is pushed up as the cylinder is threaded in. The force is turned about a pivot 292 to force a die cutter 293 along a cam 296 into a position tight about the neck of the cylinder. The die cutter has a transition thread section 294 which changes into the new thread section 295. As the force applied during threading the cylinder into the inflator 290 is re-directed into relocating the cutter tie. A locking cog 297 keeps the cutting die 293 in place as the cylinder is removed. A release 298 is operable only after the spent cylinder is free of the inflator 290. After removal of the spent cylinder with degraded threads the inflator the cylinder will fall away being unable to engage with the fine threads 40.

As the same drive pin 291 advances a red color 299 indicating the cylinder is out of position converts to green 300. An indicator window 301 allows the user to quickly determine if the inflator has a good cylinder in the correct position.

In Figure 10 insert valve 321 is found inside oral inflation tube 322. The valve is in the normally closed position 323. Insert valve 321 has been modified to include quarter turn track 30 allowing the inflator mounting means 28 to hold the Venturi nozzle 325 in place which concurrently holds the valve in the open position 324 so that the least resistance possible opposes the low pressure ambient air entrained inflation.

In FIG 11 a continuous discharge, high-pressure 1:1 volume or low pressure amplified volume inflator 70 is cut in cross section illustrating the N2 compressed gas cylinder 279 suspend below the section with environmental O-Ring seal 3 which keeps pressurized nitrogen gas in conduit 46 leading to jet 34 then out through orifice 9. The combined vent cover and cylinder piercing cam means 280 allows the user to open the ambient air intake 10 at the same time as piercing the seal on the compressed gas cylinder. This is accomplished by holding the inflator vertical out of the water with one hand and jerking up on the pull tab 262 with the other hand. This single- hand, single-step operation converts the inflator from the locked closed position 20 as in the upper drawing of Figure 11 into the first stage operational mode where gas is supplied to jet 34. The draw vent gasket seal 71 embedded in combined perpendicular vent cover and cylinder piercing cam 280 keeps water out of the inflator during initial water entry. As seen in Figure 7, only after the man over board has oriented himself and is able to locate and elevate the inflator 70 above waves at the water's surface 234 of the water and into a vertical position 231, is he ready to jerk pull tab 262 up, opening cover 280, piercing the compressed gas cylinder 250 and begin

inflating the life raft. For a two stage personal inflator, the operator determines when the back pressure has risen close to the stall pressure by observing that air has stopped flowing into the raft. If the stall pressure is exceeded the pressurized gas reverses its direction and flows out of the 'intake vent' 10. Once the operator closes the perpendicular vent cover 280 the inflator is converted into a high-pressure low-volume continuous discharge inflator 24. In Figure 11 if a valve was included in the high pressure conduit 46 then the compressed gas left in cylinder 279 could be saved and used for other applications by disconnecting the volume amplified inflator 70 from the RF welded manifold stem 275. Barrel seal O-Ring 271 serves to seal both the inflator 70 and cap 228. In the upper drawing the cap is numbered 277 because of the unusual perspective of hanging down from the assembly. In the lower drawing the cap 238 is shown from a less confusing perspective. During operation and after removal of the inflator 70 mushroom check valve 153 which is held in place by the mushroom valve post 159 keeps gas from escaping from bladder wall 266 which is welded to universal bladder mounted quick disconnect 235. The universal bladder mounted quick disconnect 235 has a manifold stem 275 that rises up from the bladder and has quarter turn bayonet mounts barrel sealed by O-Ring 271 on the outside for mounting cap 238 and inflator 70. The bayonet mounts on the inside of the bladder mounted flange 235 are sealed by barrel seal O-Ring 156 for the removable hermetically sealed valve core 278 mounting mushroom check valve 153.

In Figure 11, the inflator 70 is mounted co-planar 281 with bladder mounted quick disconnect 235 and its check valve 153. This requires an offset in the throat to exit length 27. Each Venturi is a compilation of specific intake, to throat to exit diameter, flare and lengths. The relationship between these characteristics are specified in order to optimize the mass flow ratio index for that particular Venturi design based on a primary gas pressure and flow. Most Venturi inflators for rafts locate the exit tube within the raft. In the present case the entire Venturi inflator including the exit tube is located outside of the raft so that the inflator can be moved from bladder to bladder to air horn. The disclosed co-planar design reduces the depth of the Venturi system, minimizing packed bulk which improves acceptability and therefore compliance with actually wearing the personal life raft.

In the exploded view in the lower drawing of Figure 11 the relationship of the attachment of the exit pipe to raft check valve is shown. The check valve 153 mounts on a removable hermetically sealed check valve core 287. Barrel seal 156 is located between the valve core 287 manifold stem 275 of the bladder mounted disconnect 235.

Figure 12 is a close up of the locking quick disconnect attachment 352 and the universal bladder mount 235. The bladder mounted disconnect 235 has a perpendicular manifold stem 275 which has quick disconnect means 28 that enters Venturi at quarter turn entrance 182. Then the inflator is turned in groove 186 until notch 353 comes to rest upon locking ridge 181. Four interlocking ridges 181 and notches 353 secure the inflator to the raft. The weight of the inflator and cylinder assist in keeping the inflator in position. In addition a hook and loop cradle locks the cylinder to the raft (not shown). The O-Ring 271 reside in mounting recess 350 and seals against sealing surface 351.

In Figure 13 the universal bladder mounted quick disconnect 235 is shown with some of the other devices that can be mounted besides the Venturi inflator. The cap 238 is barrel sealed to prevent any air leaking around gossamer check valve 153. The superior mass flow ratio required of a Venturi inflator in order to inflate a life raft off the same size cylinder used to inflate a life jacket depends on optimizing every element of the entire system. In the upper row right is a SCUBA diving manual dump valve 360 in which pull 362 over comes a spring biased seal allowing bladder air to escape through vent 361. It is necessary to continuously vent air out of a salvage bag during ascent to prevent a runaway situation.

Shown in the middle row, right hand drawing of Figure 13 is the gossamer low resistance mushroom valve 153 which seals around the perimeter at 364. Because the mushroom check valve is of such low durometer it must be supported across the field by support bridges 363 or back pressure in the raft would cause it to cave in and leak. The advantage of a gossamer check valve 153 is that it supplies very little resistance to the passage of Venturi amplified air. The Venturi effect is very sensitive to any resistance and a check valve especially a rigid or spring loaded check valve lower the Mass Flow Ratio or efficacy of the inflator. In the left hand drawing of the middle row of Figure 13 an Over Pressure Valve 371 is shown mounted on universal bladder mounted disconnect 235.

The pending inflator could not open the prior art check valves or if it could it could it would loose a significant amount of its volume amplification because the work it would take to keep that 'rigid door' held open against the strong 'closure spring' (80 lb). Prior art raft inflators would designed to inflate the life raft in 3 seconds to full, in 5 seconds they rafts were hard because of the internal pressure was several PSI above the Venturi stall pressure. The prior art inflators were driven by massive high pressure air supplies so they

had access to the energy consumed opening "Rigid" check valves or spring biased check valves.

The pending application squeezes each drop of performance out of both the cylinder and inflator. It spreads the high pressure stream out over 90 seconds instead of 3 seconds and relies upon a filamentous check valve to temporarily keep the air inside. Once the first stage Venturi operation has stalled and the ambient intake vent cover is manually closed, the CO₂ or Dry Ice sublimates into gaseous CO₂ and drives the pressure above the Venturi stall pressure. The vent cover is sealed by an embedded O-Ring. Only when the Venturi inflator has been removed is the light weight check valve solely responsible for sealing the pressurized air inside the raft. Immediately after removing the cover sealed Venturi, the user installs the attached O-Ring sealed cap to guard prevent any leakage through the check valve.

During development first flapper valves were of such low durometer that they were squeezed between the spoke of the wagon wheel. By raising the durometer a few points the unsupported film that forms the check valve was then just able to span the spokes without failure of the perimeter seal. Such a lightweight check valve has extremely low resistance to flow which helps the mass flow ratio index, a measure of the amount of drive gas to entrained gas, this ratio is a measure of volume amplification of a particular Venturi.

In the left hand lower row of Figure 13 is an expiratory pump 368. The corrugated hose 369 is connected to universal bladder mount 235 by way of hose coupler 370. The right hand drawing of the lower row illustrates a hydrostatic pump or torque pump 367. Fabric laminated on the outside as well as the inside 365 allows the fabric mounted coupler 366 to be welded to the outside of the hydrostatic pump 367. The fabric mounted coupler 366 mounts over the outside of universal bladder mount 235.

Figure 14 is a fully assembled and armed two stage volume amplified inflator 390. The components are designed to be injection molded and ultrasonically welded, which can provide a uniquely affordable Venturi inflator. The nitrogen cylinder 279 has a wholesale cost which is three times as expensive as the inflator 279. An indicator clip 391 is placed after re-arming with a new cylinder. As seen from the side the perpendicular vent cover 280 keeps the inflator sealed during water entry until the inflator 70 is lifted above the water's surface. At which point jerking up on lanyard and pull 262 pierces the cylinder while moving the cover 280 up and out of the way opening ambient air intake vent 10. Compressed gas entrain ambient air and the mix flows down Venturi throat to exit length 27

where it passes through gossamer check valve mounted in side universal bladder mount 235. 90 seconds latter compressed gas begins to pass out the intake vent 10 indicating to close perpendicular vent cover 280. At which point the residual nitrogen gas passes into the raft driving the internal pressure above the Venturi stall pressure.

Figure 15 is a sectional view of a two stage manually operated Venturi inflator 70. The injection molded jet conduit 46 and jet 34 is ultrasonically welded to the glass reinforced plastic inflator body. The ambient air intake 10 is sealed off by cover 280 and embedded seal 71. The cylinder piercing pin 401 is held back by biasing spring 402. The spring is over come by the jerking force applied to pull and lanyard 262 seen in Figure 14.

Index of Reference Numerals:

- 1 Combined High-Pressure Low-Volume Low-Pressure Volume-Amplified Intermittent Inflator
- 2 Seal-then-pierce valve
- 3 Primary low-durometer outer gasket seal
- 4 Secondary high-durometer central gasket seal
- 5 Micro-pierce flow regulator means
- 6 Compressed gas cylinder complementary mounting threads
- 7 Nylon oversized sealing threads
- 8 Seal and pierce fenestration
- 9 Jet orifice
- 10 Ambient air intake vent
- 11 Longitudinal air intake vent cover
- 12 Vent cover spring compressed
- 13 Vent cover stop
- 14 Vent cover rear 1/4 turn locked open
- 15 Vent cover front 1/4 lock closed
- 16 Vent cover rear O-Ring seal
- 17 Vent cover front O-Ring seal
- 18 Vent cover forward support self
- 19 Vent cover forward stop
- 20 Vent cover locked closed
- 21 Vent cover locked open
- 22 Vent cover handle

- 23 Low pressure high volume intermittent discharge inflator
- 24 High pressure low volume continuous discharge inflator
- 25 Venturi throat to orifice distance
- 26 Venturi throat diameter
- 27 Venturi throat to exit length
- 28 Inflator quick disconnect mount means
- 29 Venturi angle
- 30 Quarter turn track
- 31 Receiver-jet/orifice to Venturi O-Ring seal
- 32 Receiver-jet/orifice to Venturi threads
- 33 Threaded cylinder receiver
- 34 Jet
- 35 Venturi
- 36 Thread mounted seal then pierce valve
- 37 Embedded thread degrading receiver
- 38 Non-complementary cutting threads
- 39 Hardened burring gouge
- 40 Maximum size starting thread,
- 41 No starting bevel
- 42 Traditional thread starting bevel
- 43 Sole cylinder gasket
- 44 Vent cover spring compressed
- 45 Receiver fenestrations
- 46 Jet conduit
- 47 Venturi throat angle
- 48 Rigid seat supporting shut off seal
- 50 Simple continuous discharge low-pressure volume amplified inflator
- 51 Single piece threaded cylinder receiver and jet
- 52 Continuously open draw vents
- 53 Tubular pierce means
- 54 Pierce means pressed mounted
- 55 Vented inflator housing
- 56 Ultrasonic weld or permanent attachment means

- 57 Simple injector volume amplification
- 58 Barbed volume amplified inflator attachment means
- 70 Two-stage continuous discharge high-pressure 1:1 volume or low-pressure volume-amplified inflator
- 71 Draw vent gasket seal
- 72 Rotating barrel vent cover / vent fenestration
- 73 Thread mounted jet and pierce means
- 74 Single piece threaded cylinder receiver and vented inflator housing
- 75 Rotating barrel vent cover in the air intake open position
- 76 Rotating barrel vent cover in the air intake closed position
- 80 Venturi amplified volume, variable-pressure, variable discharge duration and rate, variable displacement compressed gas inflator
- 81 Barrel cover orifice
- 82 Press fit / permanent attachment between receiver and inflator body
- 90 Nested orifice, Venturi amplified volume, variable-pressure, variable discharge duration and rate, variable displacement compressed gas inflator
- 91 Nesting jets
- 92 Threaded adjustment for nested jets
- 93 Orifice shut off plug
- 94 Nested jets passageway
- 96 Venturi end piece
- 97 Outer jet piece
- 98 Cylinder receiver piece
- 99 Off-gassing audible reed alarm
- 100 Venturi amplified volume, variable-pressure, variable discharge duration and rate, variable displacement compressed gas inflator with in-line shut off and flow adjustment valve
- 101 Needle valve
- 102 Eccentric valve orifice
- 103 Needle valve O-Rings
- 104 Valve retainer clip
- 110 Thread advanced spool valve Venturi amplified volume, variable-pressure, variable discharge duration and rate, variable displacement compressed gas inflator

- 111 Spool valve
- 112 Spool valve threads
- 113 Spool valve passageway
- 114 Spool valve outer O-Ring
- 115 Spool valve on / off O-Ring
- 116 Inflator grasp flange
- 130 Water activated or manual activated Venturi amplified volume, variable-pressure, variable displacement compressed gas inflator
- 131 Water sensitive bobbin
- 132 Silica gel bobbin
- 133 Water access fenestrations
- 134 Water access fenestration cover
- 135 Water access fenestration cover O-Ring
- 136 Manual or spring driven cylinder seal moveable pierce means
- 137 Pierce O-Ring seal
- 138 Spring compression threads
- 139 Piercing spring
- 140 Water activated inflator
- 141 Manually activated water proof inflator
- 142 Spring positioned cam
- 143 Hardened thread cutter / degrader
- 144 Lower portion of water activated inflator
- 145 Upper portion of water activated inflator
- 146 Driver plate
- 147 Spring loaded, bobbin retained driver
- 148 Default high pressure by-pass
- 149 Optional volume amplified operation
- 150 Full-bore radio frequency welded coupler-connector
- 151 Dual position externally mounted full-bore coupler-check valve seat
- 152 Standard radio frequency weldable right angle connector
- 153 Mushroom check valve
- 154 Check valve in operable position
- 155 Coupler insertion stop and check valve seat

- 156 Barrel seal O-Ring for check valve
- 157 Inflator-coupler-check valve
- 158 Dual-position dual-locking quarter turn grooves
- 159 Mushroom valve post
- 160 Composite manufactured connector-coupler
- 161 Custom molder coupler
- 162 Coupler and connector fused during manufacture
- 163 Check valve compressed closed
- 170 Full bore inflate/deflate/check valve-coupler
- 171 Finger grips
- 172 Oral or compressed gas signal air horn
- 173 Self-Orienting integrated ballast moment
- 174 Self-Orienting integrated buoyant moment
- 175 Oral check valve
- 176 Nano-pierce regulator
- 177 Locking open quarter turn mount
- 178 Oscillating membrane
- 179 Compressed gas cylinder
- 180 Dual position quarter turn safety lock coupler or valve-coupler
- 181 Locking ridge
- 182 Quarter turn entrance groove
- 183 Quarter turn side safety lock
- 184 Continuously tensioned compressed-closed position
- 185 Locked open position
- 186 Right angle quarter turn groove
- 200 Degraded threads on spent cylinder
- 201 Green thick soft plastic coating
- 202 Normal uncoated threads
- 203 Red anodized under coat
- 204 Bi-refrigrant coating applied to distended full cylinder
- 205 Collapsed empty cylinder alters light sensitive coating
- 206 Thin plastic disc, diameter of cylinder
- 230 Manually oriented and operated volume amplified inflator

- 231 Operator oriented vertical compressed liquid CO2 cylinder
- 232 Venturi vent cover manually held open
- 233 Residual liquid propane at bottom because vertical
- 234 Waves at water's surface
- 235 Universal bladder mounted quick disconnect
- 236 Partially inflated life raft
- 237 UL listed manual CO2 inflator retrofitted with volume amplification means
- 238 Sealing cover cap
- 239 Weight of cylinder and gas allow establishment and maintenance of the vertical operational orientation.
- 240 Retrofit simple continuous discharge, single use, low-pressure volume amplified inflator(see 50)
- 241 Safety Of Life At Sea / SOLAS class dual chambered 35 lb life jacket
- 242 UL listed water activated / manual inflator retrofitted with valve regulation and volume amplification Venturi
- 243 Middle layer of fabric separating the chambers
- 244 Upper water activated chamber, inflated
- 245 Lower manually activate chamber reserve chamber, not inflated
- 246 Pivoting inflator mounting means combined with manifold means
- 247 Venturi inflator/ pivoting manifold placed high on PFD positioning it out of the water
- 248 Operator responsible for keeping liquid CO2 at bottom of cylinder, away from pierced orifice in cylinder seal
- 249 Man Over Board
- 250 38 gm CO2
- 260 UL listed 6F water activated CO2 inflator
- 261 UL listed manual inflator
- 262 Manual pull lanyard and jerk tab
- 263 UL Approved nut
- 264 Threaded compressed gas chamber
- 265 Compressed gas chamber entrance orifice
- 266 Bladder wall
- 267 RF welded mount for pivoting coupler
- 268 Grooves in pivoting manifold

- 269 Locking sleeve of releasable pneumatic coupler
- 270 Locking balls held in position by spring loaded cover
- 271 Barrel seal O-Ring for cap, Venturi, hydrostatic inflator
- 272 Snap lock cover cap
- 273 O-Ring
- 274 Pivoting Venturi coupler with integrated low resistance wide-bore check valve coupler
- 275 Manifold stem
- 276 Flapper valve guard
- 277 Cap hanging below flapper valve
- 278 Removable hermetically sealed check valve core
- 279 Nitrogen compressed gas cylinder
- 280 Perpendicular vent cover and cylinder piercing cam (a single step that both pierces the cylinder while opening the vent intake)
- 281 Co-planar orientation of inflator and check valve
- 290 Generic inflator with cylinder thread degrader/ eraser and cylinder position indicator
- 291 Drive pin
- 292 Pivot
- 293 Cutting Die
- 294 Transitional cutting teeth
- 295 New thread pattern
- 296 Cam drives die into position
- 297 Locking advance cogged wheel
- 298 Lock release
- 299 Red visual indicator cylinder is out of position
- 300 Green visual indicator cylinder is in position
- 301 Cylinder position indicator window
- 320 Combined insert valve and Venturi inflator mount
- 321 Insert oral inflation valve
- 322 Oral inflation tube
- 323 Valve in normally closed position
- 324 Valve held in the open position
- 325 Nozzle end of Venturi
- 350 O-Ring mounting recess

- 351 O-Ring sealing surface
- 352 Locking quick disconnect
- 353 Locking notch
- 360 Dump valve
- 361 Air vents for dumped air
- 362 Manual pull for dump valve
- 363 Support bridge for check valve
- 364 Perimeter seal for check valve
- 365 Bladder fabric laminated on outside as well as inside
- 366 Fabric mounted coupler
- 367 Hydrostatic or torque pump
- 368 Expiratory pump
- 369 Corrugated hose
- 370 Locking quick disconnect hose coupler
- 371 Quick Disconnect Over Pressure valve
- 390 Armed high-volume low-pressure or low volume high pressure compressed gas inflator
- 391 Safety clip and indicator inflator is armed
- 400 Glass Re-enforced Plastic Injection molded Inflator body
- 401 Cylinder piercing pin
- 402 Spring biasing piercing pin

Some of the advantages of the present invention include, but are not limited to:

(1) A Venturi inflator that is (a) capable of being worn continuously; (b) simplicity of construction; (c) lightweight for compliance, (i.e. will wear it); (d) low bulk for compliance (i.e. will wear it); and (e) variable pressure Venturi eliminates a pressure regulating device. (2) Hermetically sealed inflator keeps debris and water out of inflator and jet orifice until the user is holding inflator out of the water and ready to pierce the cylinder and start the Venturi amplified inflation. (3) Opening intake vent is combined with cylinder piercing means, single operation opens intake vent as cylinder is pierced. (4) After Venturi stalls piercing lanyard is pull to close vent. (5) No intake check valve, unimpeded air entrance, less resistance to air intake greater volume amplification. (6) Absence of pressure regulator means jet pressures range from about 850 psi to about 0 psi. (7) Unregulated high pressure requires the orifice to be very small to restrict the flow of gas otherwise it would all pass out. However as the pressure falls off the small orifice restricts the flow and rate falls.

Consequently it takes longer to inflate the raft but can be accomplished with a wearable inflator-cylinder combination. (8) Contrary to Prior Art, is totally dependent upon a user for successful operation. (9) Can manually remove inflator to securely seal the check valve with a cap. (10) Vent opening can be oriented away from water or dirt and debris. (11) N2 can is not positionally restricted, CO2 must be held upright.

Further advantages, include but are not limited to: (1) Ultra-light, small compact, portable, continuously worn, all plastic Venturi inflator. (2) User dependent operation Located-can be kept out of the water. On land can be kept out of the dirt, leaves, debris.

A conscious person if using the inflator in the water or the water can be aspirated into the raft and the raft may not inflate: The N2 cylinder before piercing can first be removed from the water and located in the air. The CO2 cylinder has more user restrictions, CO2 cylinders require more knowledge for effective use than the N2 cylinder. The CO2 cylinder must not only be located out of the water but must also be 'oriented' ie held upright to keep the liquefied CO2 away from the orifice. If not held up right the liquefied gas will be blown out. Loss of a little liquid CO2 is equivalent to the loss of a lot of gaseous CO2 which in turn means the Venturi will not run as long and consequently there will less amplification and the raft will not be fully inflated.

N2 On Land Use / Hand-Held Volume Amplified Inflator No Restrictions (While CO2 is liquid at 850 psi N2 remains gas at 3000 psi and so on land does not need to be either located i.e. kept out of the water or oriented i.e. held upright as is the case with CO2 on land or in the water. If CO2 is allowed to turn sideways or upside down the CO2 liquid is blown out of the cylinder and the total volume of gas is drastically reduced)

Other advantages include but are not limited to:

(1) Continuously worn versus Hand Held vs / Ultra-light volume-amplified single stage, low-pressure inflator (device for use on land to inflate);

(2) Hand held volume amplified inflator of (1) in preceding paragraph ("(1)") dual stage operation with a manually operated ambient air vent cover (The addition of a vent cover to claim 1 converts the inflator from a Venturi volume amplified inflator into direct pressure inflator. Rather than spring biased pressure switches the person decides when to close the vent in order to prevent loss of pressurized gas out the "intake" which occurs once the back pressure inside the raft builds to and exceeds the Venturi stall point. A manually closable cover will allow residual gas N2 or CO2 dry ice which will eventually sublime and convert to pressurized CO2 gas, to elevate the pressure in the raft above the stall point.

Closure of the ambient air vent cover prevents gas from escaping out the intake vent as back pressure builds once the bladder is full);

(3) Hand held volume amplified inflator of (1) with on off valve (save gas & change applications);

(4) Hand held volume amplified inflator of (1) with on off and variable flow valve (save gas & change applications run low, medium or high pressure devices);

(5) Hand held volume amplified inflator of (1) of single piece construction with one way valve;

(6) Hand held volume amplified inflator of (1) of two piece construction with one way valve permanently attached to receptacle;

(7) Hand held volume amplified inflator of claim (1) with transferable mount (to change applications ie inflate PFD then run air horn or inflate raft);

(8) Hand held volume amplified inflator of (1) with piercing and valve mechanism combined (twist and pierce);

(9) Hand held volume amplified inflator of (1) that can attach to existing cylinder piercing mechanisms;

(10) Hand held volume amplified inflator of (1) that is continuously operating, twist to pierce compressed gas inflator;

(11) Hand held volume amplified inflator of (1) intermittently operating with twist to seal and pierce compressed gas inflator;

(12) Hand held volume amplified inflator of (1) water activated continuously worn / Ultra-light, low-pressure inflator volume amplified compressed gas inflator;

(13) Hand held volume amplified inflator of (1) integrated with default water activated PFD inflator including manual on-off valve override converting to volume amplified inflator for sequential inflation of series of bladders;

(13a) Hand held volume amplified inflator of (1) with gossamer raft mounted check valve protected from over pressure failure by rigid support;

(14) Hand held volume amplified inflator of (1) mounted exterior to bladder with transferable, quick release hermetically sealed mounting means;

(15) Hand held volume amplified inflator of (1) injection molded, glass reinforced plastic, ultrasonically welded disposable single use Venturi inflator;

(16) Hand held volume amplified inflator of (1) in which the inflator is in or near the plane of the ultra-low resistance check valve;

(17) Hand held volume amplified inflator of (1) of such low durometer the downstream check valve requires rigid field support as well as a rigid perimeter for sealing.

Bladder mounted universal flange for reversibly mounting compatible: check valve, volume amplified inflator, hermetically sealed cap, overpressure valve, manually operated dump valve, fabric mounted hermetically sealed coupler for manual inflation, expiratory gas collection system, compressed gas coupler

N2 In water Use / Hand-Held Inflator Single Restriction: Located ie held out of the water

10a Hand held volume amplified inflator whose ambient air vent must manually be placed and maintained out of water (Inflator for used in water, prior art has flotation collars to place the air intake above the water's surface. Current invention relies upon the user to remove from the water prior to actuation. The user must continue to hold the inflator out of the water during operation of the Venturi or it will aspirate water into the raft with loss of inflation.);

11a Hand held volume amplified inflator of 10a which can convert to non-amplified high pressure inflator (has vent cover that can close of inflator to the ambient air thereby preventing gas from escaping as back pressure builds once the bladder is full);

12a Hand held volume amplified inflator of 10a with on off valve (save gas & change applications);

13a Hand held volume amplified inflator of 10a with on off and variable flow valve (save gas & change applications run low, medium or high pressure devices);

14a Hand held volume amplified inflator of 10a of single piece construction with one way valve;

15a Hand held volume amplified inflator of 10a of single piece construction with one way valve permanently attached to receptacle;

16a Hand held volume amplified inflator of 10a with transferable mount (to change applications i.e. inflate PFD then run air horn or inflate raft);

17a Hand held volume amplified inflator of 10a with piercing and valve mechanism combined (twist and pierce);

18 Hand held volume amplified inflator of 10a that can attach to existing cylinder piercing mechanisms;

CO2 In Water Hand-Held Inflator: Two Restrictions: Manually Located out of water and Oriented ie held up right (CO2 cylinders because they have liquid inside must be held

upright on land or in the water of the liquid CO₂ will blow out and volume amplification drastically reduced)

19 Hand-held volume-amplified inflator which must be vertically oriented by the user on land or in the water. (Any liquefied gas containing cylinder such as CO₂, must be positioned vertically with orifice held straight up on land and in the water. CO₂ cylinders when used on land or water to inflate are positionally sensitive whereas, N₂ is not liquid and thus is not positionally sensitive, that is if N₂ cylinder are held horizontal or inverted it will not effect their efficacy at amplifying volume)

20 Hand held volume amplified inflator of 19 which can convert to non-amplified high pressure inflator (has vent cover that can close of inflator to the ambient air thereby preventing gas from escaping as back pressure builds once the bladder is full)

21 Hand held volume amplified inflator of 19 with on off valve (save gas & change applications)

22 Hand held volume amplified inflator of 19 with on off and variable flow valve (save gas & change applications run low, medium or high pressure devices)

23 Hand held volume amplified inflator of 19 of single piece construction with one way valve

24 Hand held volume amplified inflator of 19 of single piece construction with one way valve permanently attached to receptacle

25 Hand held volume amplified inflator of 19 with transferable mount (to change applications i.e. inflate PFD then run air horn or inflate raft)

26 Hand held volume amplified inflator of 19 with piercing and valve mechanism combined (twist and pierce)

27 Hand held volume amplified inflator of 19 that can attach to existing cylinder piercing mechanisms

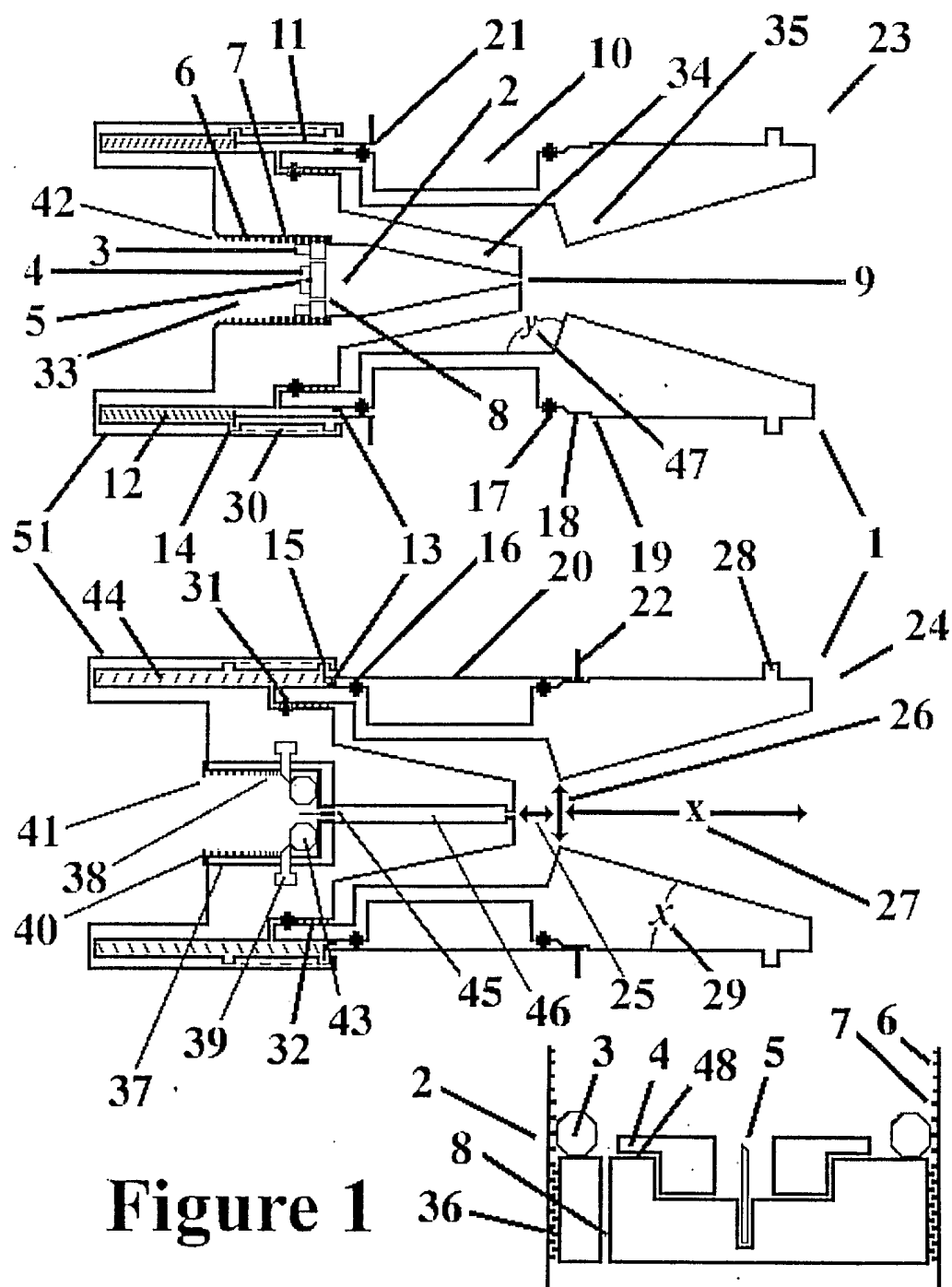
The instant invention has been shown and described herein in what is considered to be the most practical and preferred embodiment. It is recognized, however, that departures may be made therefrom within the scope of the invention and that obvious modifications will occur to a person skilled in the art.

CLAIMS

What is claimed is:

1. A compressed gas inflator, comprising:
 - a compressed gas cylinder receiver having an internal channel containing a plurality of threads;
 - a cylinder piercing assembly disposed within the internal channel;
 - a valve in communication with said internal channel;
 - a Venturi body member defining an internal passageway in communication with said valve; and
 - an air intake vent assembly in communication with the internal passageway of said Venturi, said air intake vent assembly including a movable cover to allow the air intake vent assembly to be in either an open position to allow ambient air intake or in a closed position for high-pressure low-volume use.
2. The compressed gas inflator of claim 1 wherein said Venturi body member is attached to said compressed gas cylinder receiver.
3. The compressed gas inflator of claim 1 wherein said cylinder piercing assembly includes a primary low-durometer outer gasket seal, a secondary high-durometer central gasket sear and a micro-pierce flow member.
4. The compressed gas inflator of claim 1 wherein said valve is a seal-then-pierce valve.
5. The compressed gas inflator of claim 1 wherein said plurality of threads includes a first portion of compress gas cylinder complementary mounting threads and a second portion of nylon oversized sealing threads.
6. The compressed gas inflator of claim 1 wherein said plurality of threads includes a first portion of starting threads and a second portion of non-complementary cutting threads.

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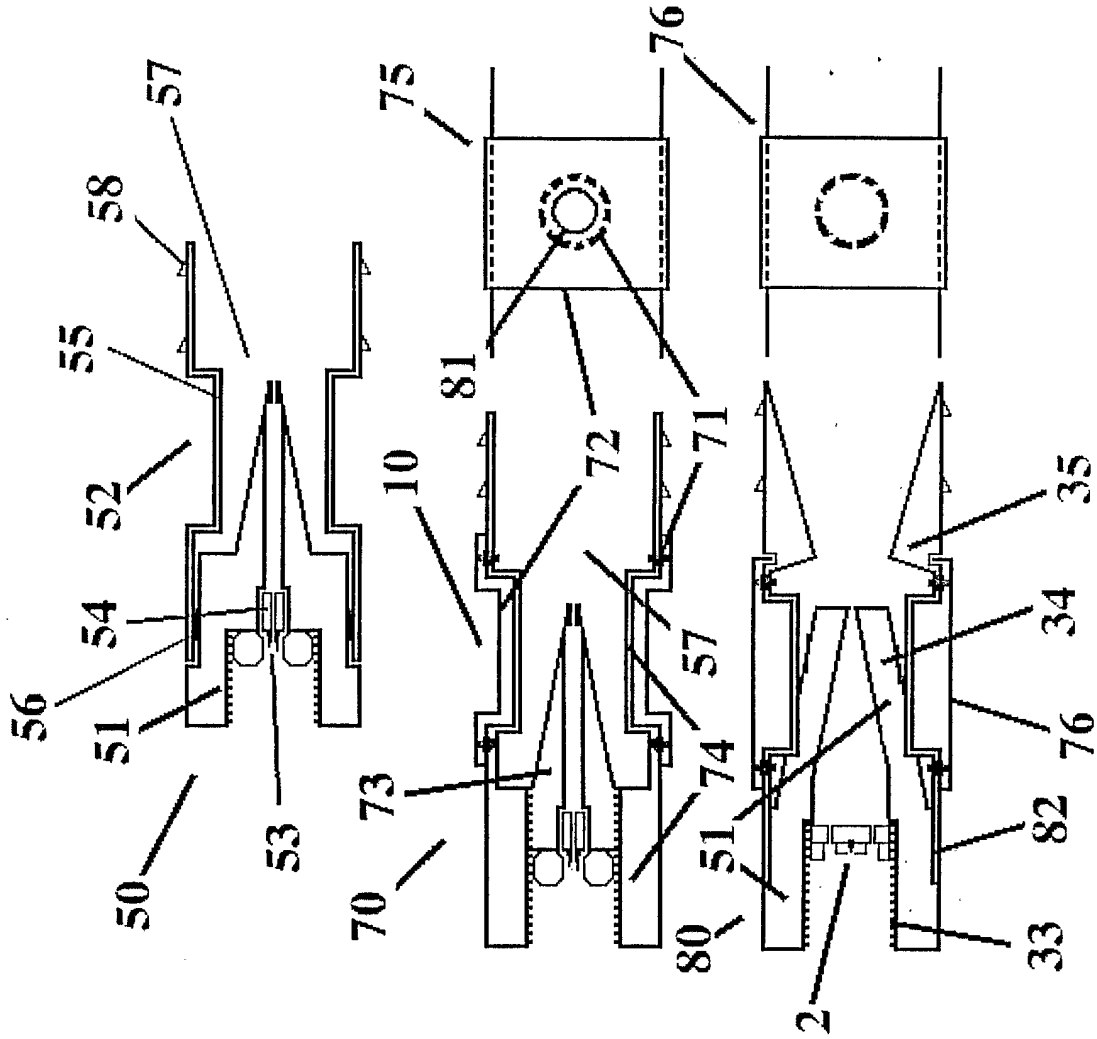


Figure 2

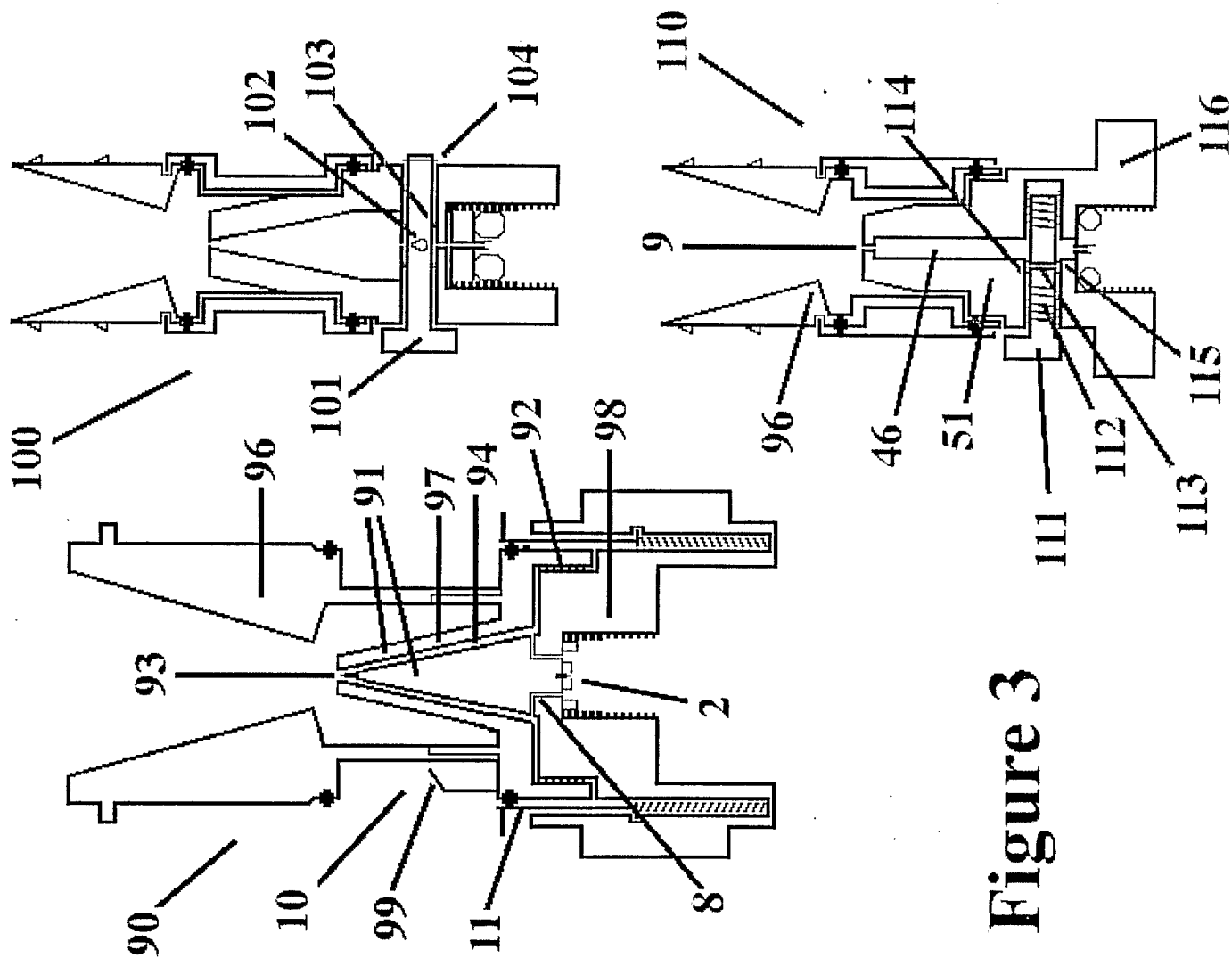


Figure 3

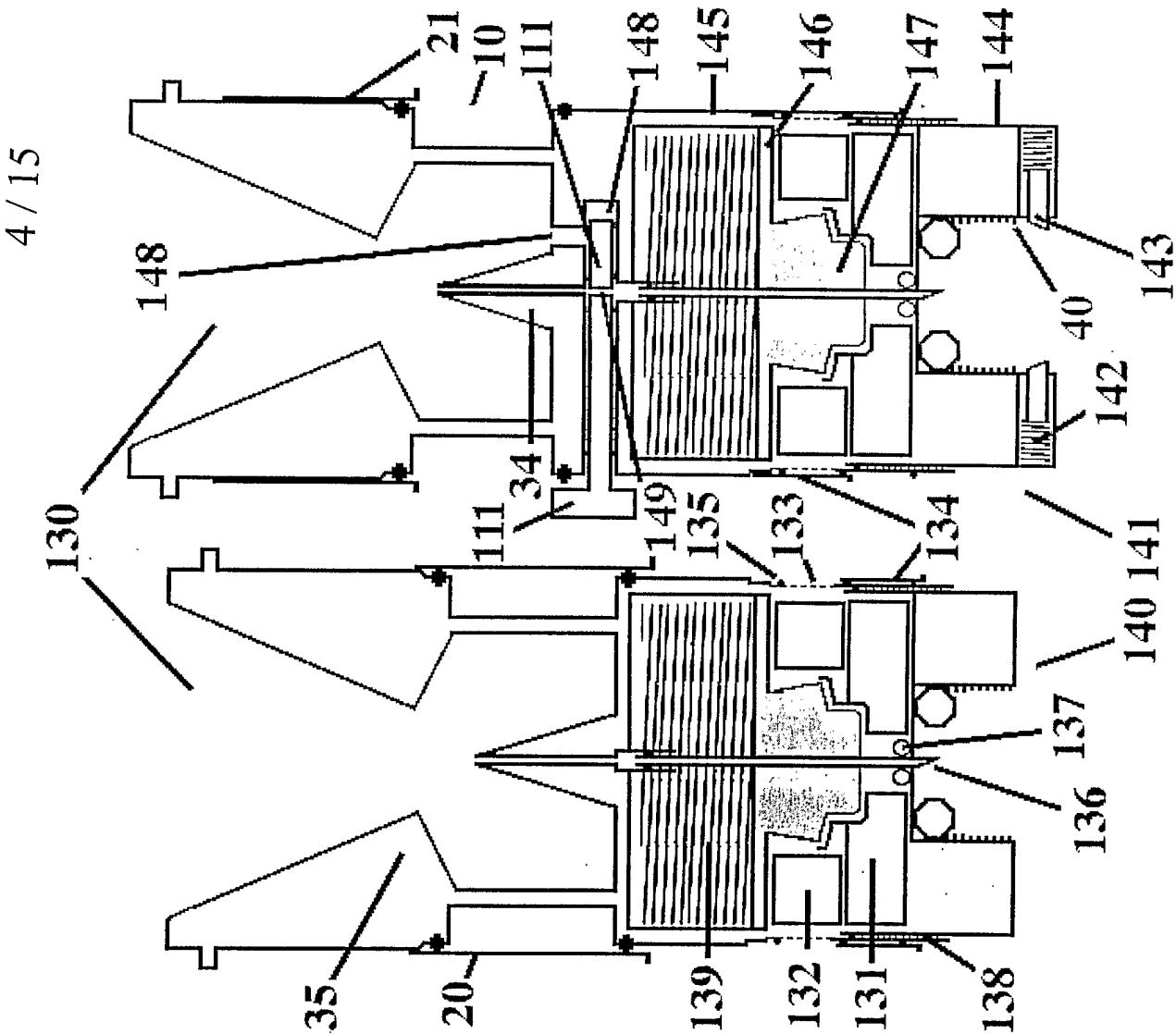
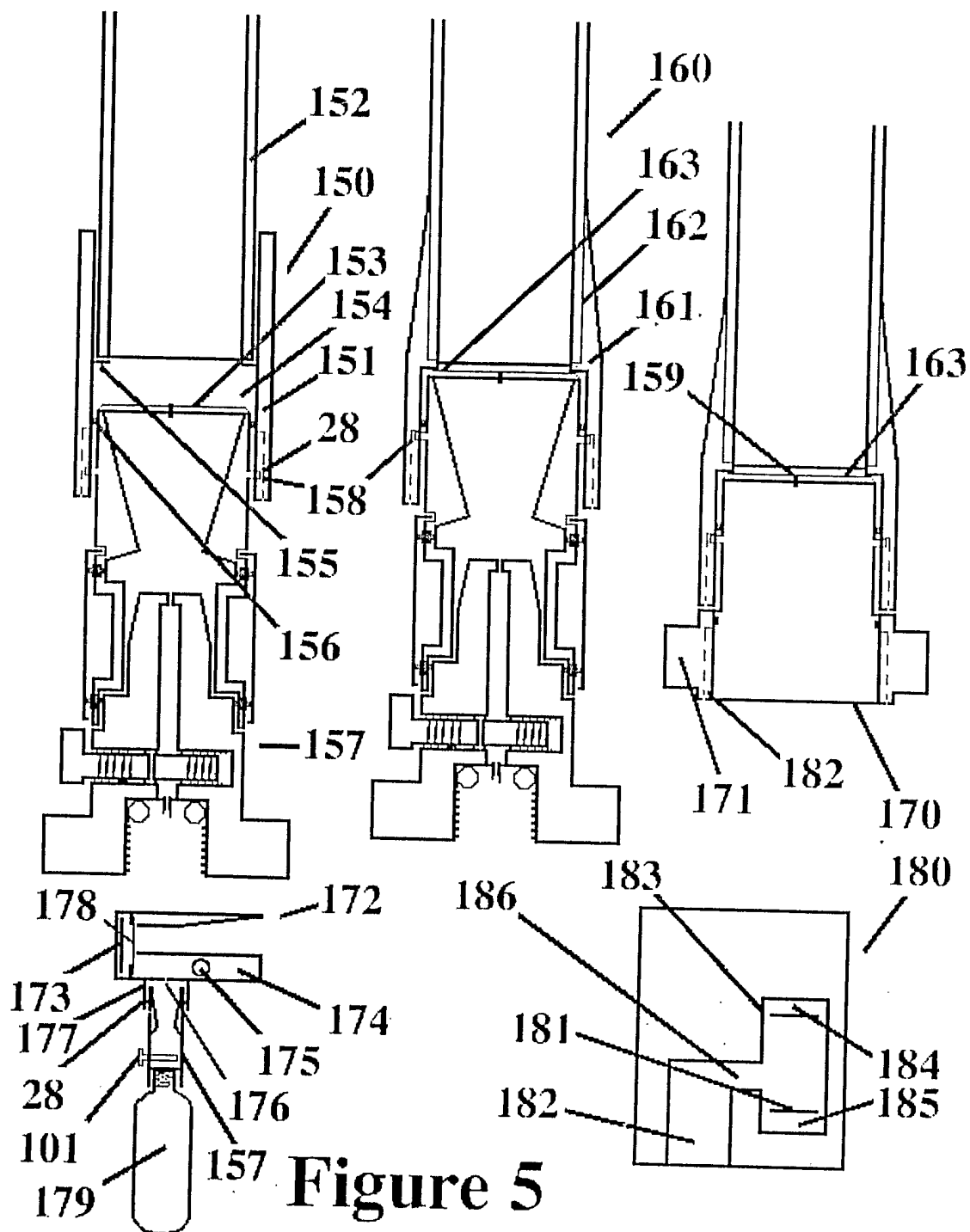


Figure 4

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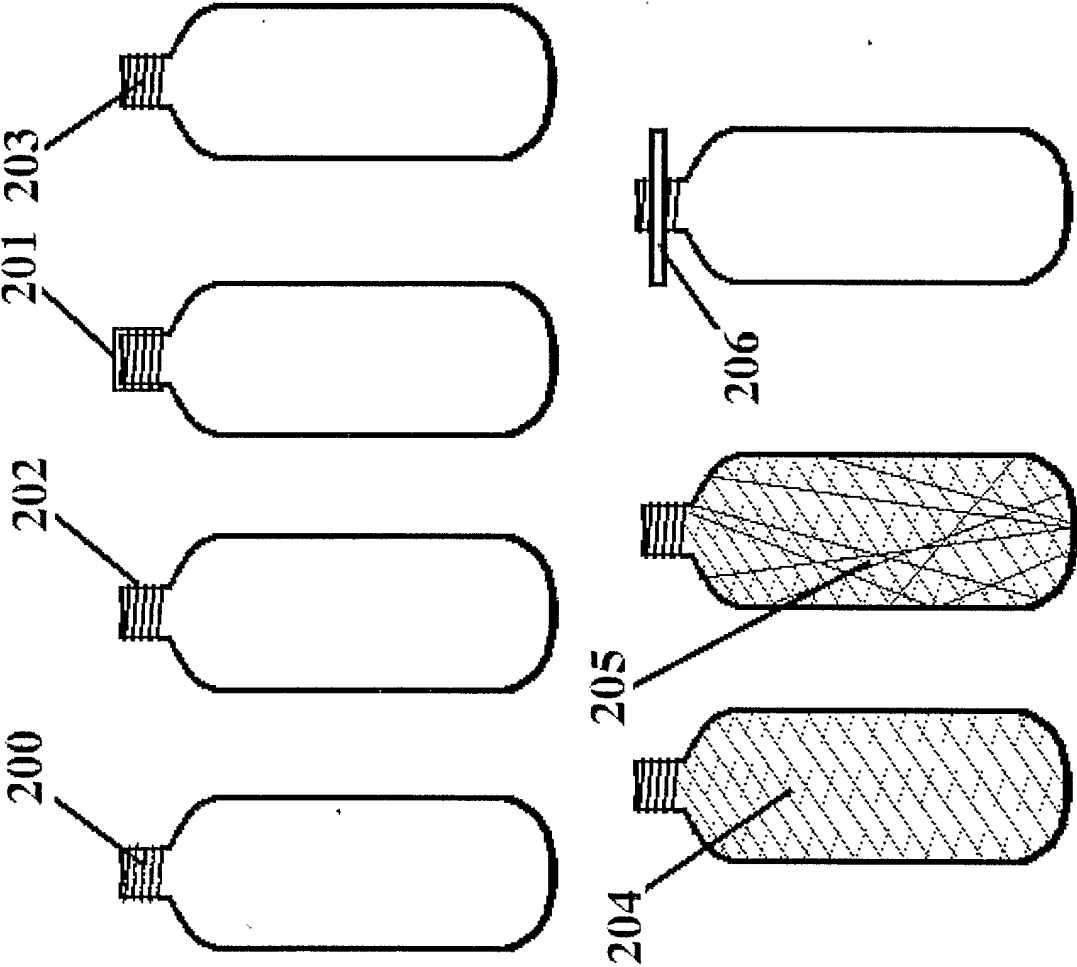


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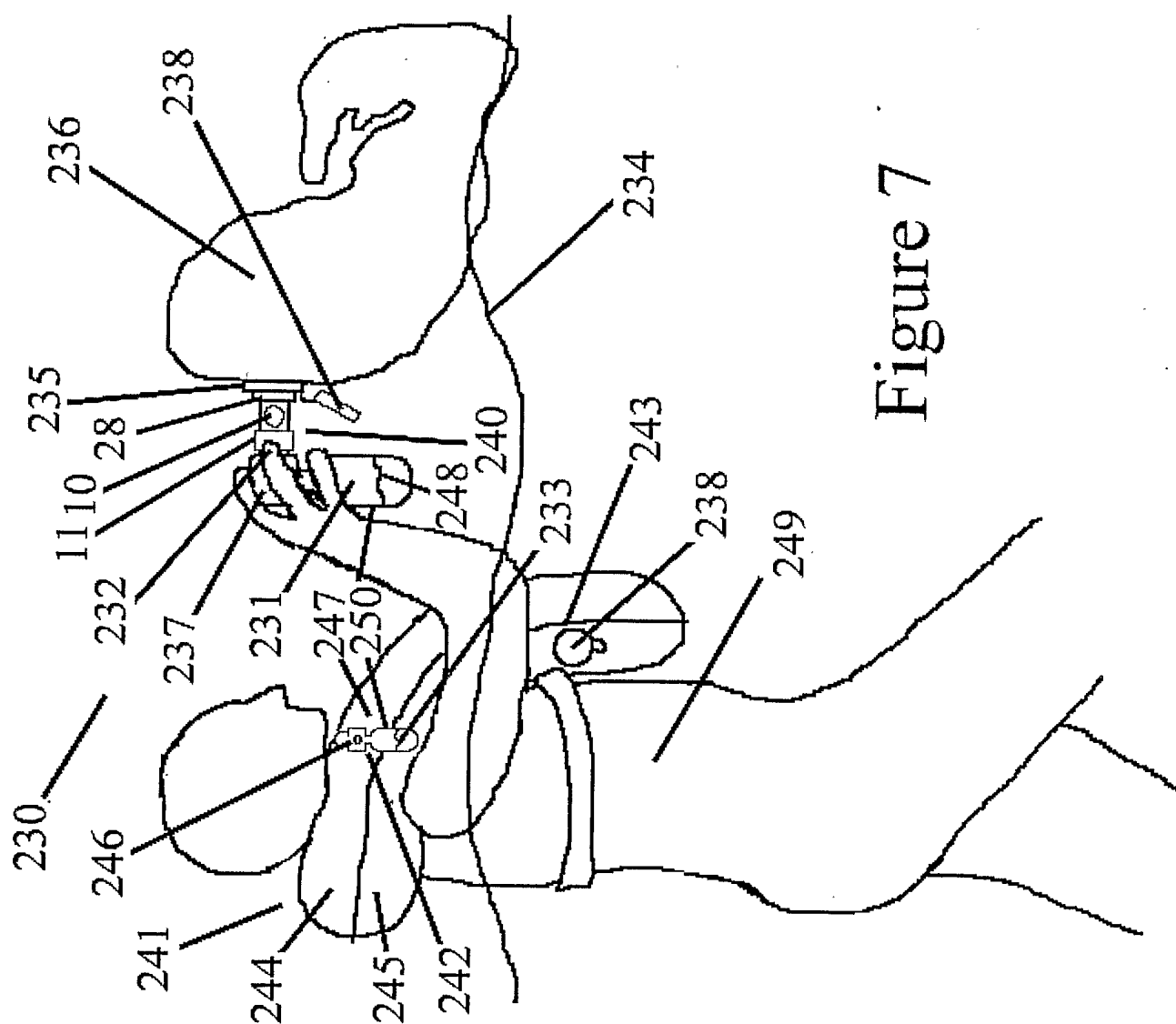


Figure 7

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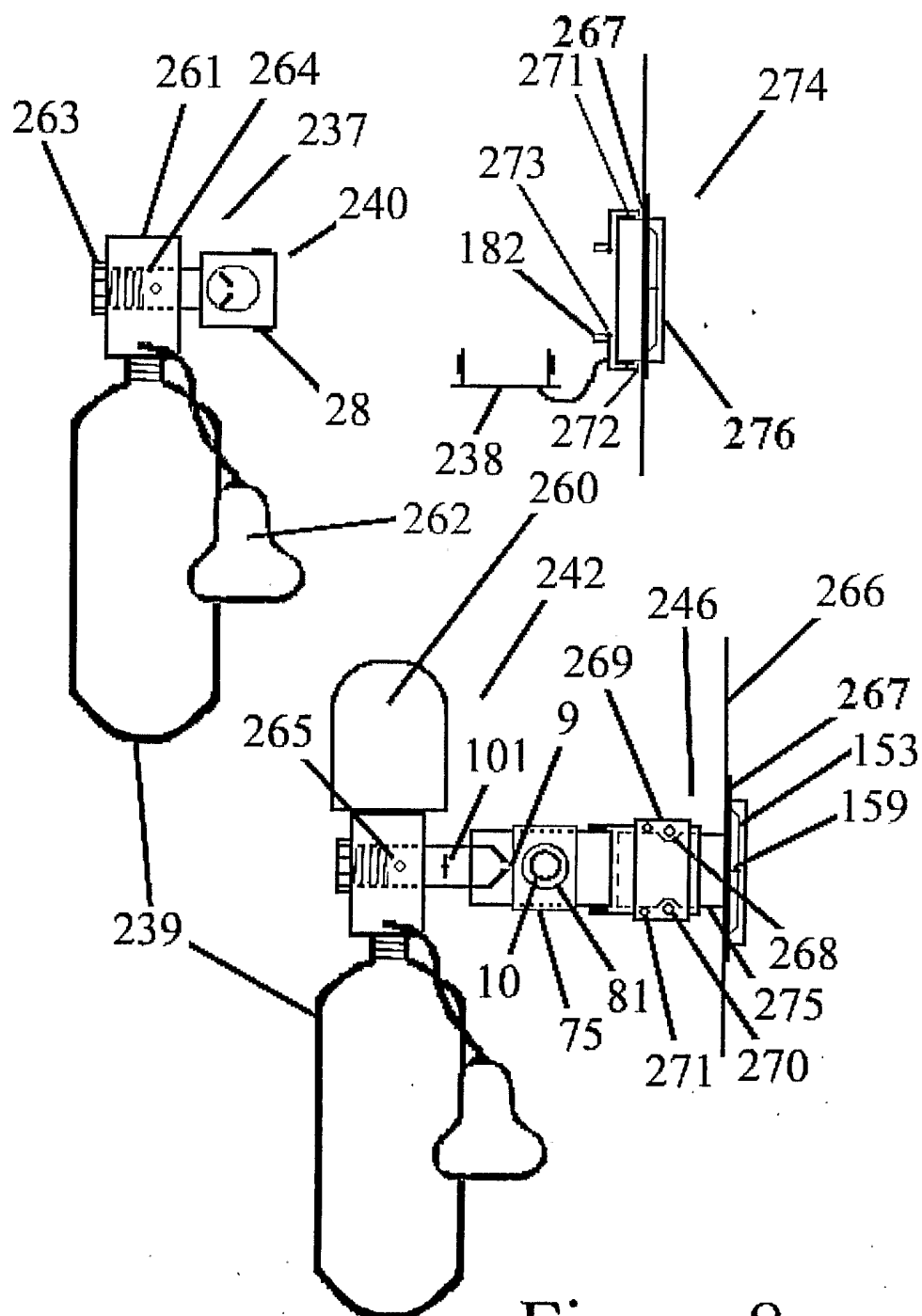


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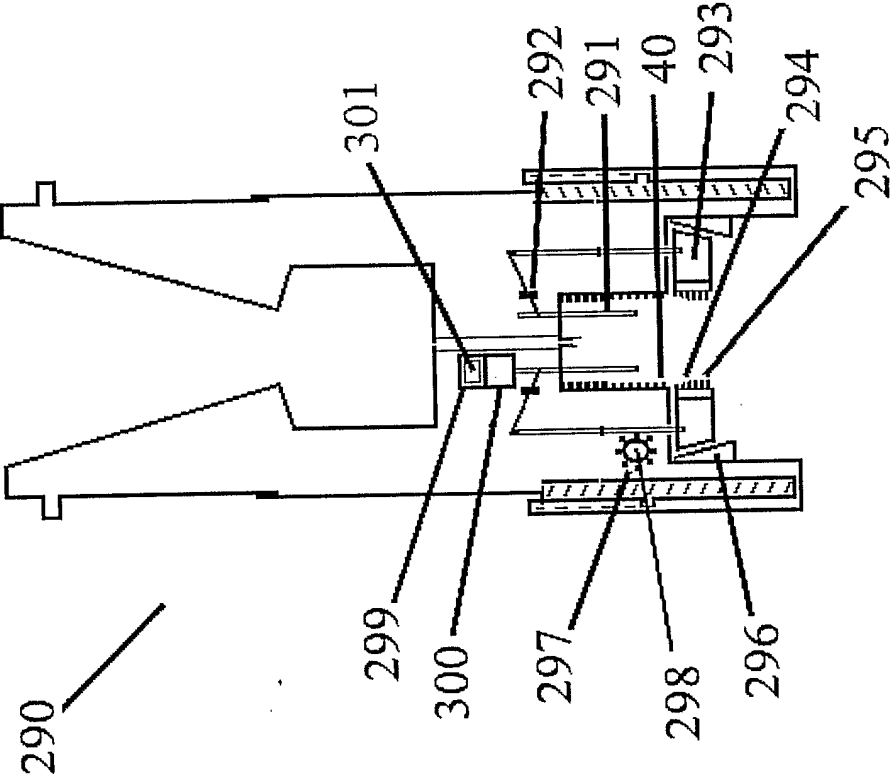


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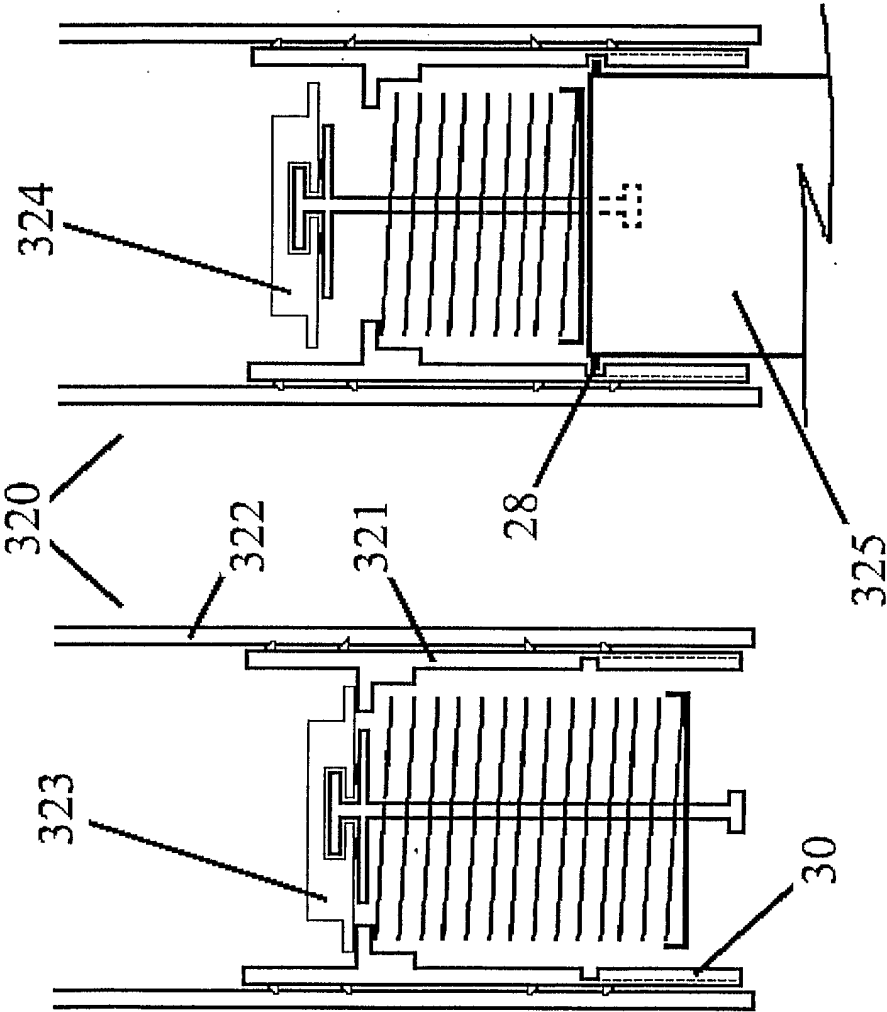


Figure 10

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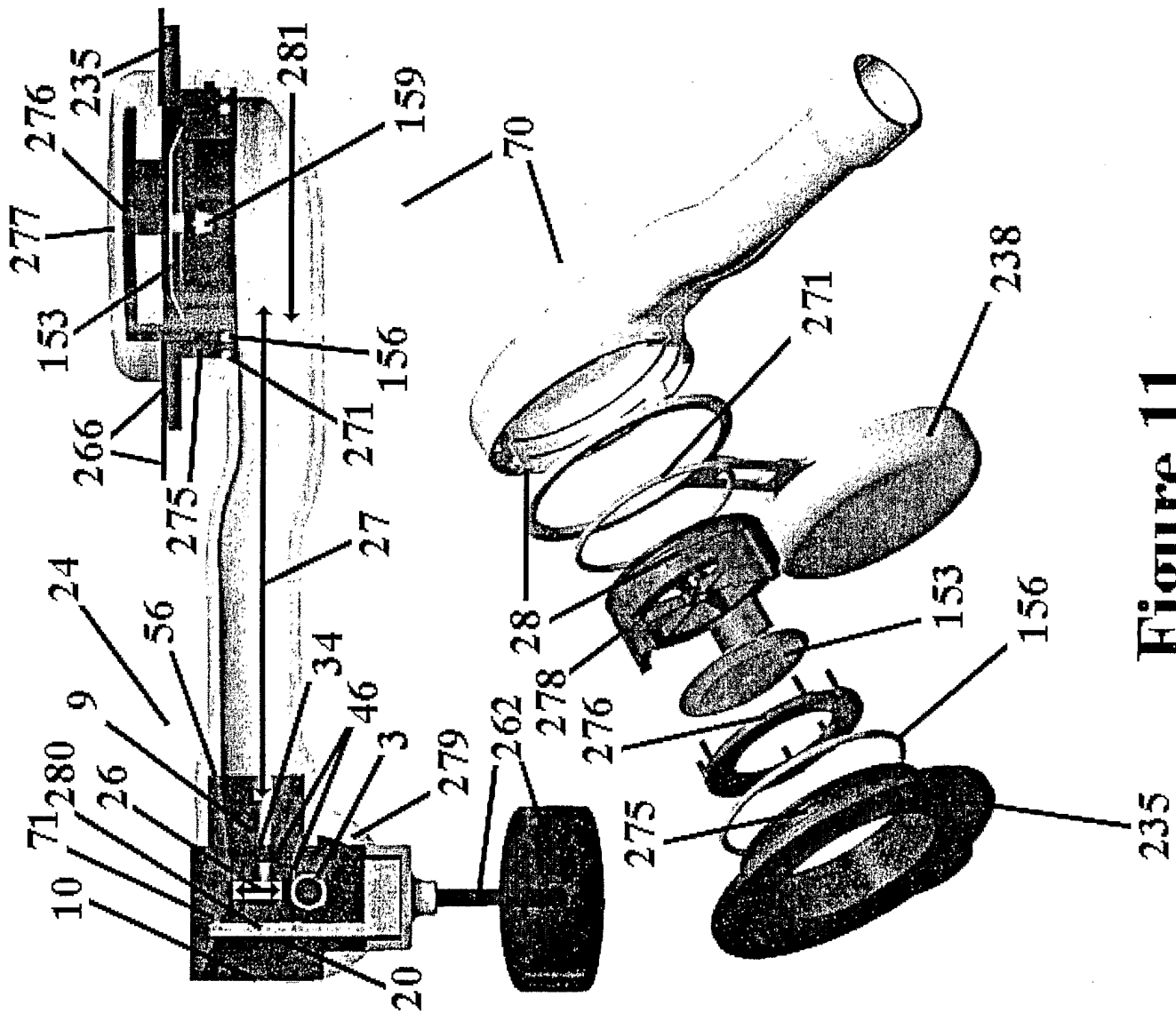


Figure 11

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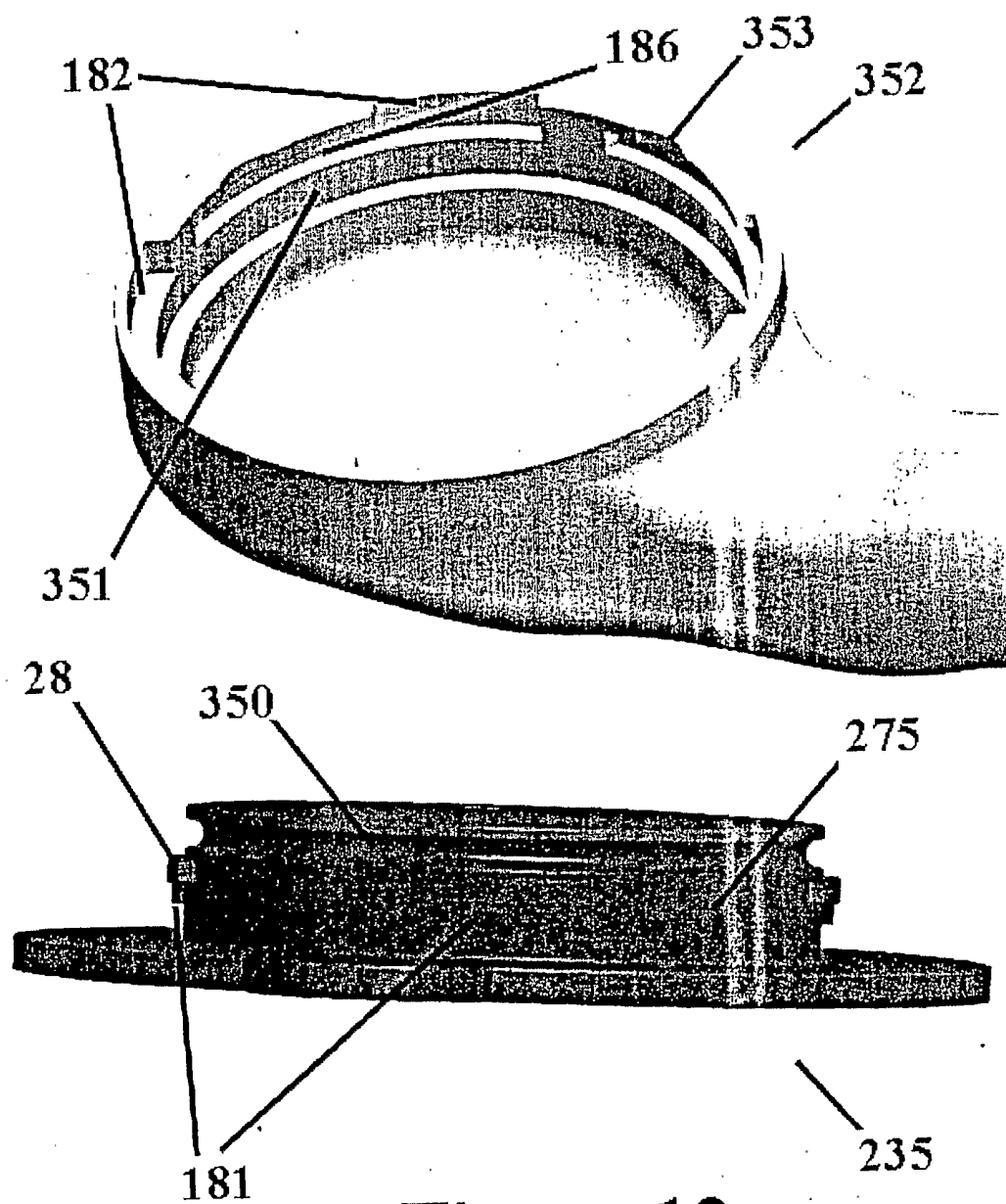


Figure 12

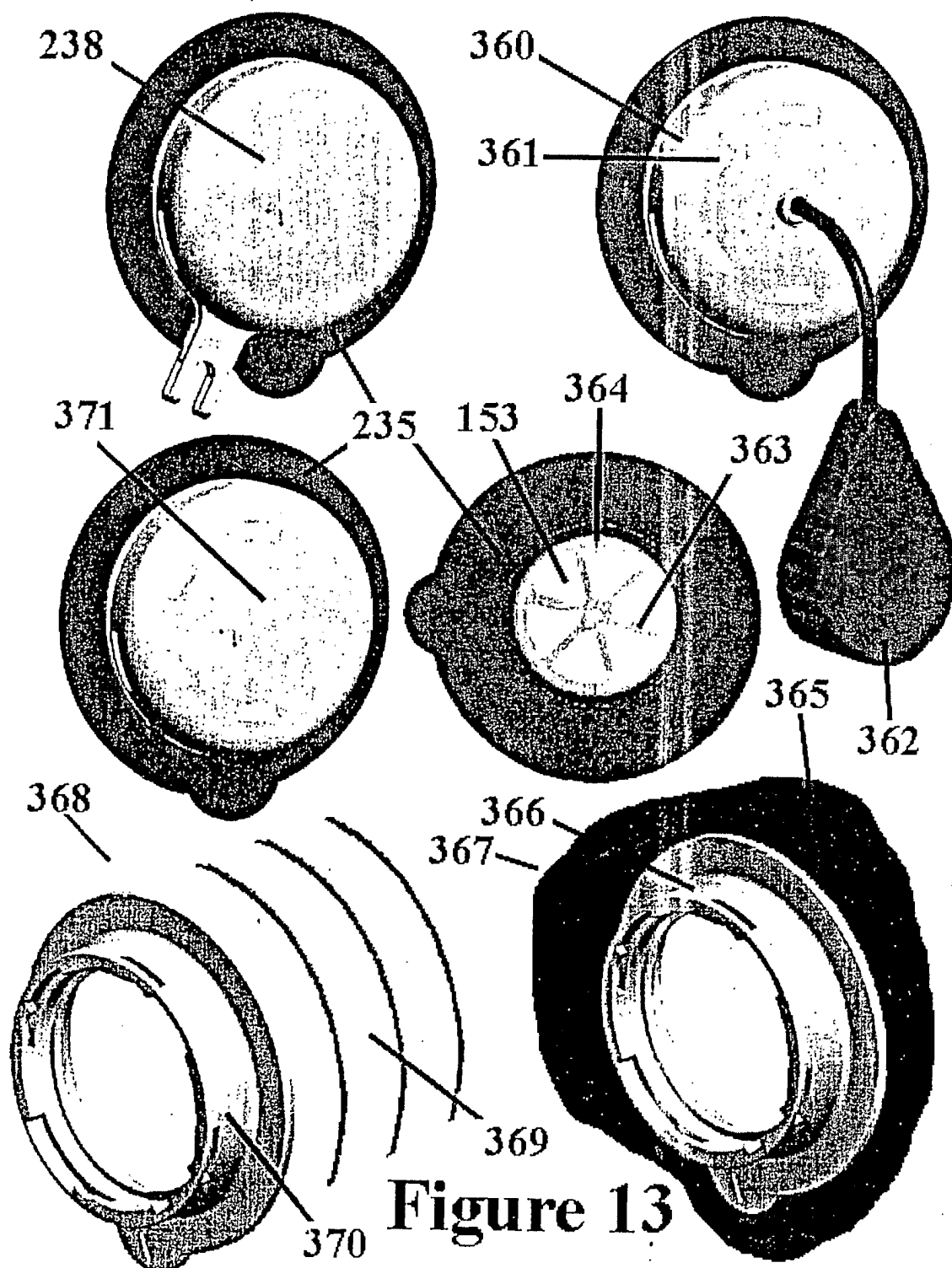


Figure 13

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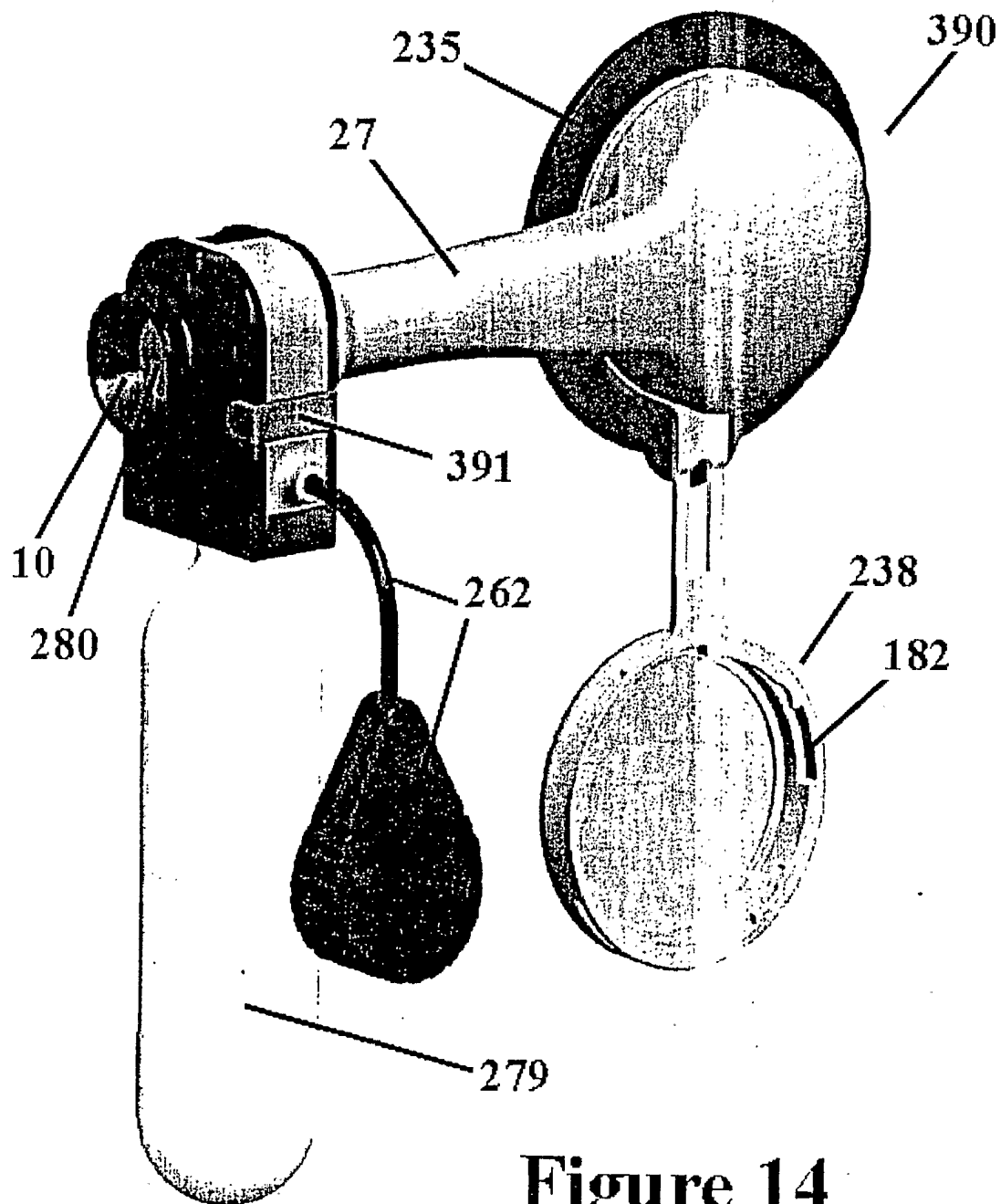


Figure 14

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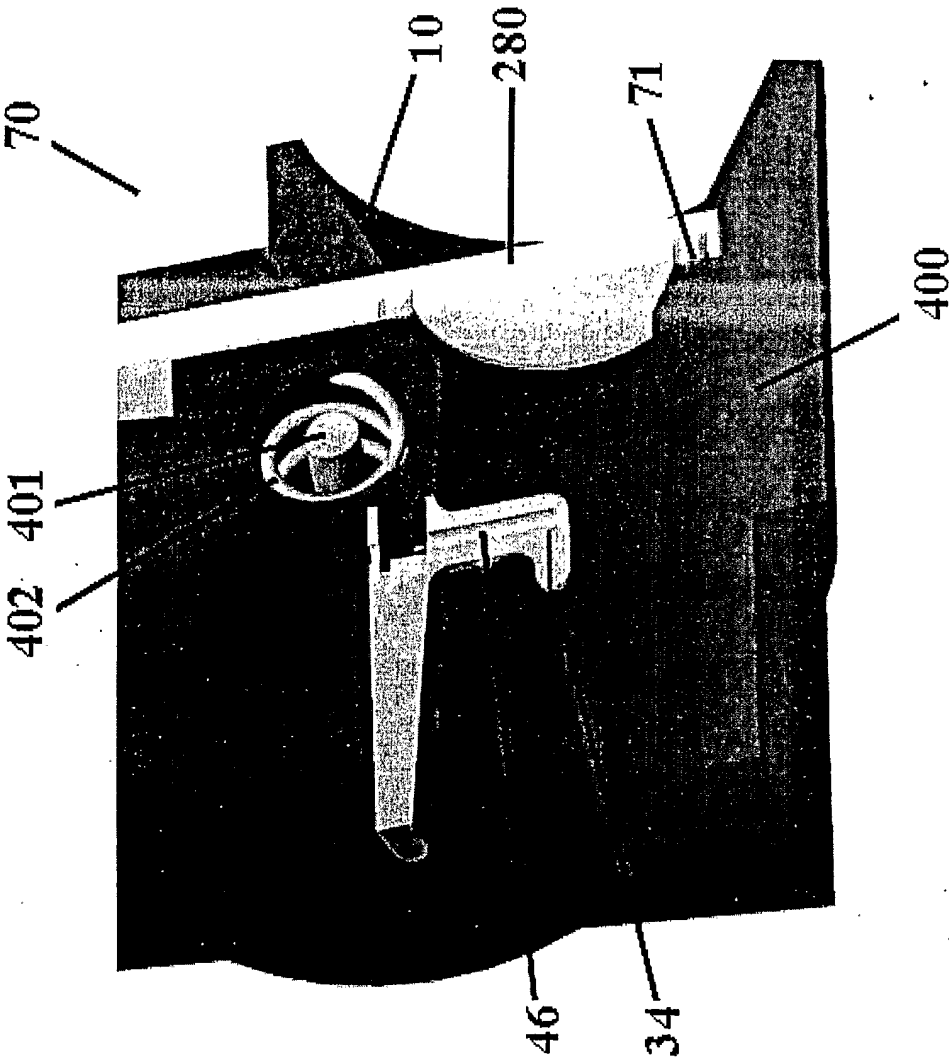


Figure 15