US 20120074346A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2012/0074346 A1

Cook (43) Pub. Date: Mar. 29, 2012

(54) CORRECTIVE MEASURES AND DEVICES FOR BI-STABLE FLOW PHENOMENA IN FLUID VALVES

(75) Inventor: **Daniel S. Cook**, Terryville, CT (US)

(73) Assignee: **Enfield Technologies, LLC**

(21) Appl. No.: **13/135,351**

(22) Filed: **Jul. 1, 2011**

Related U.S. Application Data

(60) Provisional application No. 61/361,161, filed on Jul. 2, 2010.

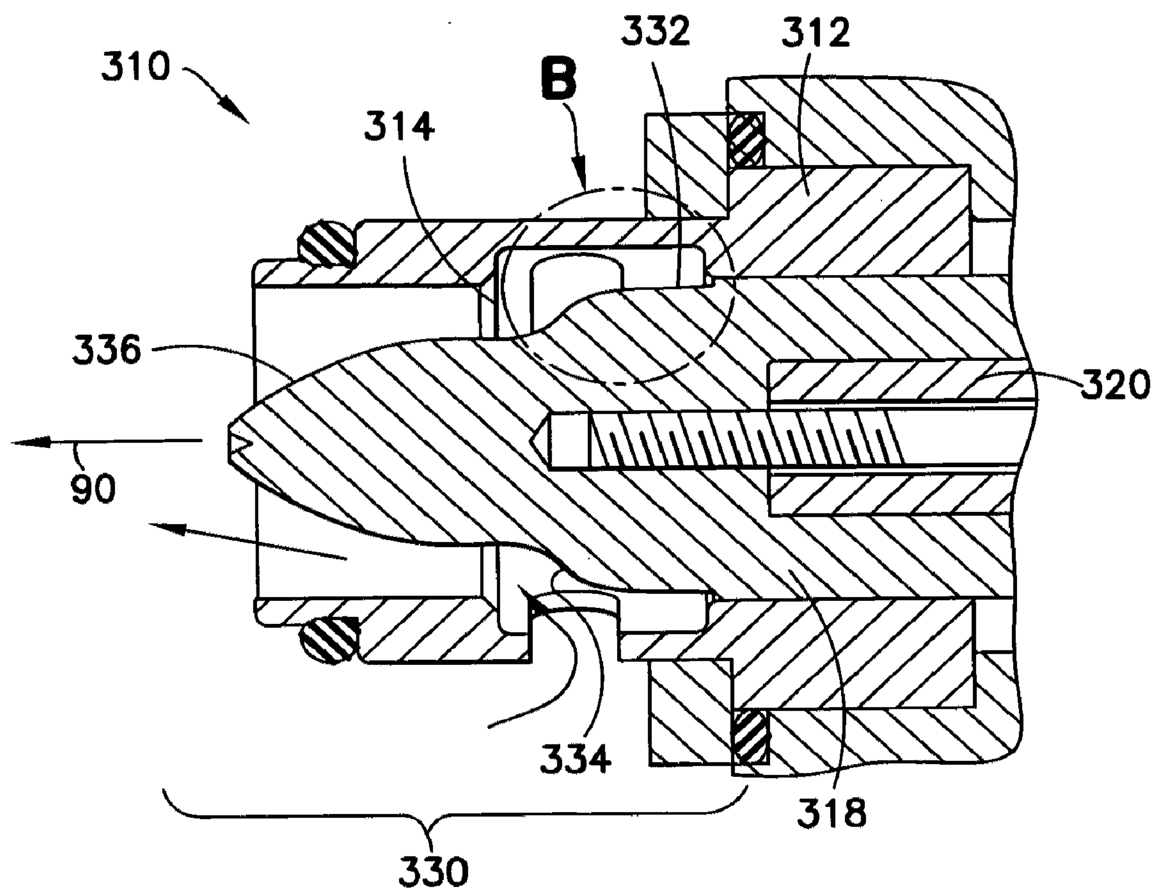
Publication Classification

(51) **Int. Cl.**
F16K 27/02 (2006.01)

(52) **U.S. Cl.** **251/366**

(57) **ABSTRACT**

In accordance with an example embodiment of the present invention, a valve is disclosed. The valve includes a valve body, a seat, a poppet, and a shaped portion. The valve body has an inlet portion and an outlet portion. The seat is between the inlet portion and the outlet portion. The poppet is proximate the seat. The poppet is adapted to modulate fluid flow between the inlet portion and the outlet portion. The shaped portion is downstream of the seat. The shaped portion is adapted to direct fluid flow, reduce cross flow interference, and allow for substantially parallel fluid flow jets at a majority of the inlet portion and the outlet portion when fluid is flowing through the valve.



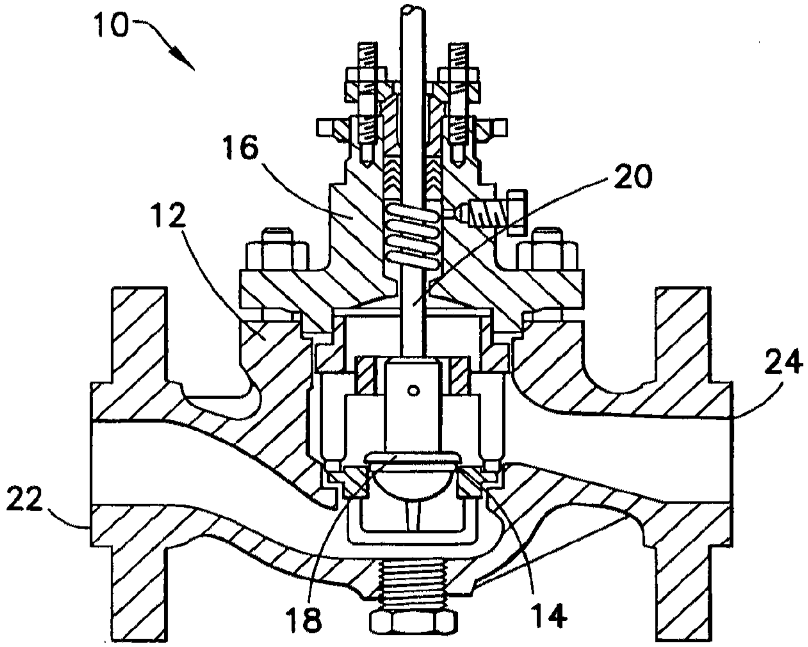


FIG.1
PRIOR ART

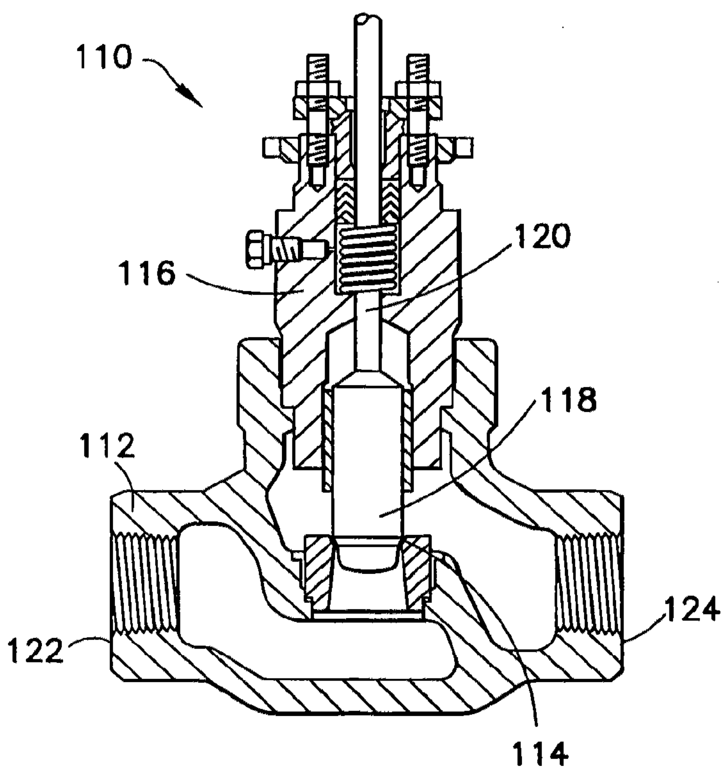


FIG.2
PRIOR ART

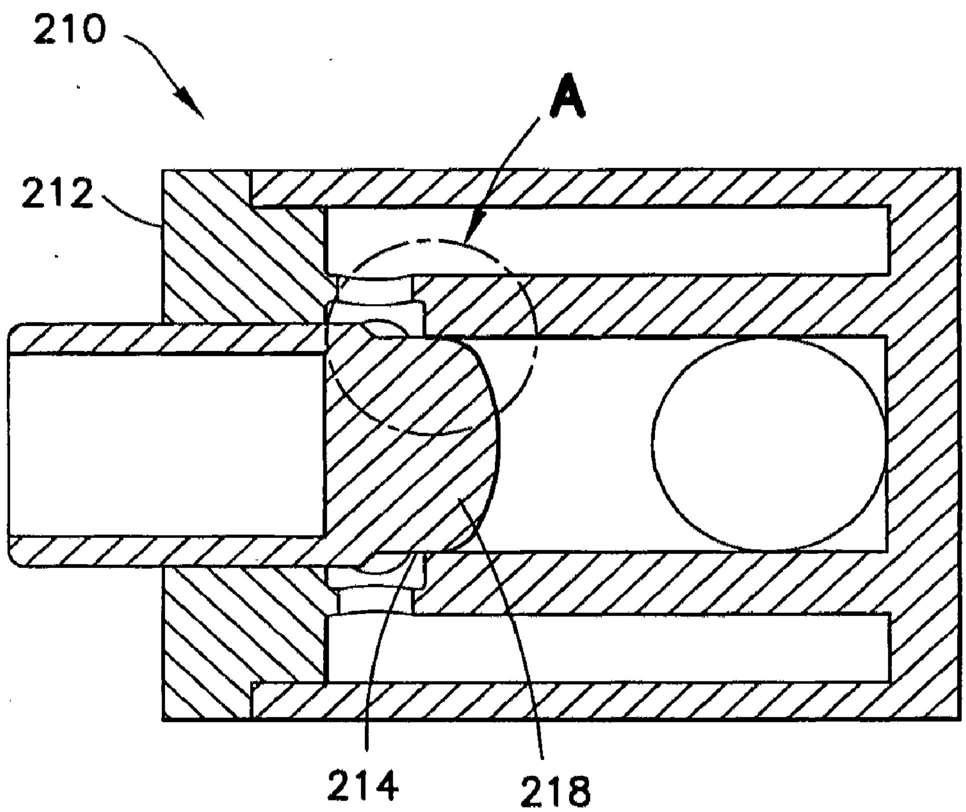


FIG.3
PRIOR ART

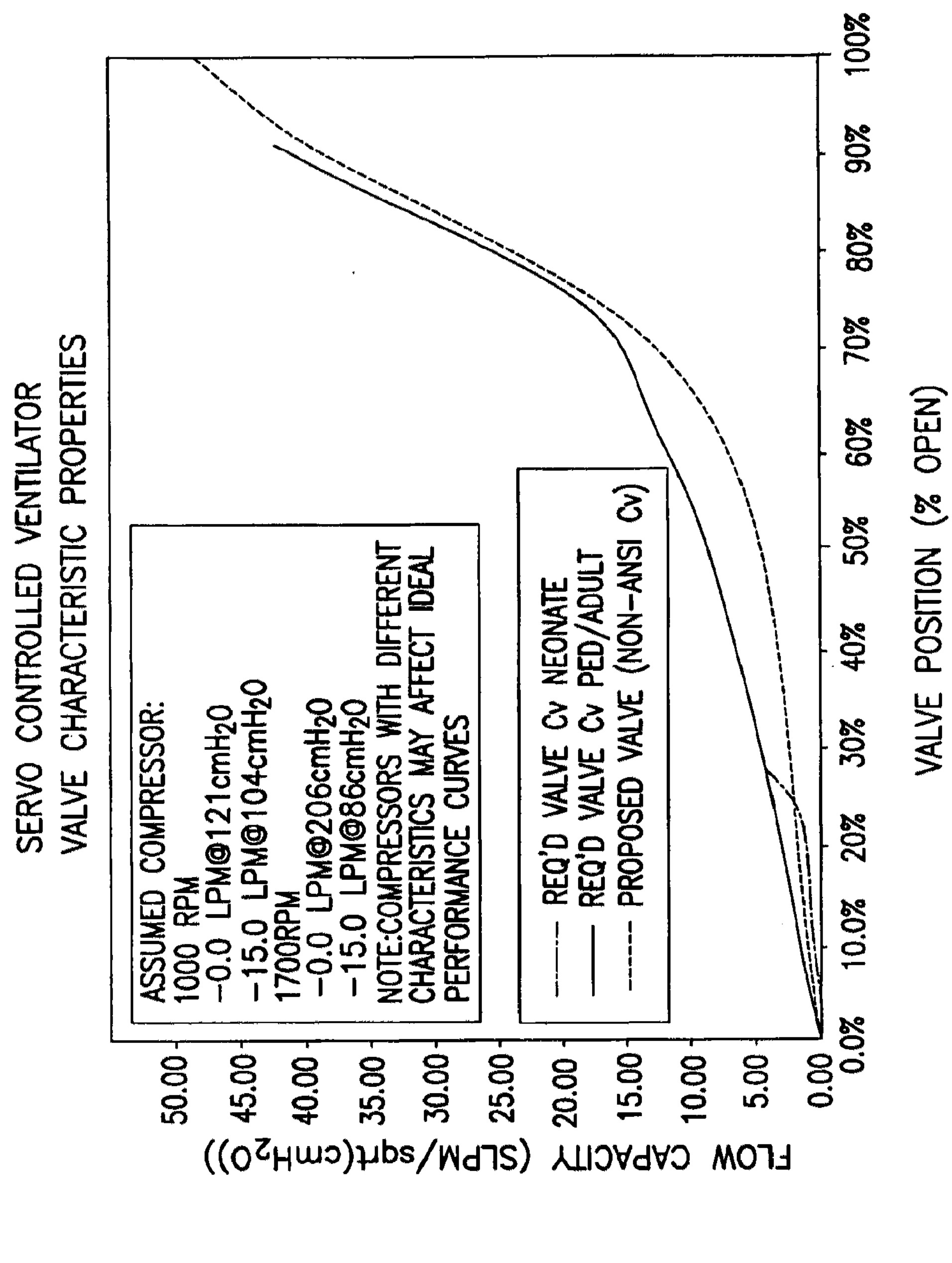

SERVO CONTROLLED VENTILATOR
VALVE CHARACTERISTIC PROPERTIES
ASSUMED COMPRESSOR:
1000 RPM
-0.0 LPM@121cmH2O
-15.0 LPM@104cmH2O
1700RPM
-0.0 LPM@206cmH2O
-15.0 LPM@86cmH2O
NOTE:COMPRESSORS WITH DIFFERENT CHARACTERISTICS MAY AFFECT IDEAL PERFORMANCE CURVES
REQ'D VALVE Cv NEONATE
REQ'D VALVE Cv PED/ADULT
PROPOSED VALVE (NON-ANSI Cv)
FLOW CAPACITY (SLPM/sqrt(cmH2O))
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0.0%
10.0%
20%
30%
40%
50%
60%
70%
80%
90%
100%
VALVE POSITION (% OPEN)

FIG. 4

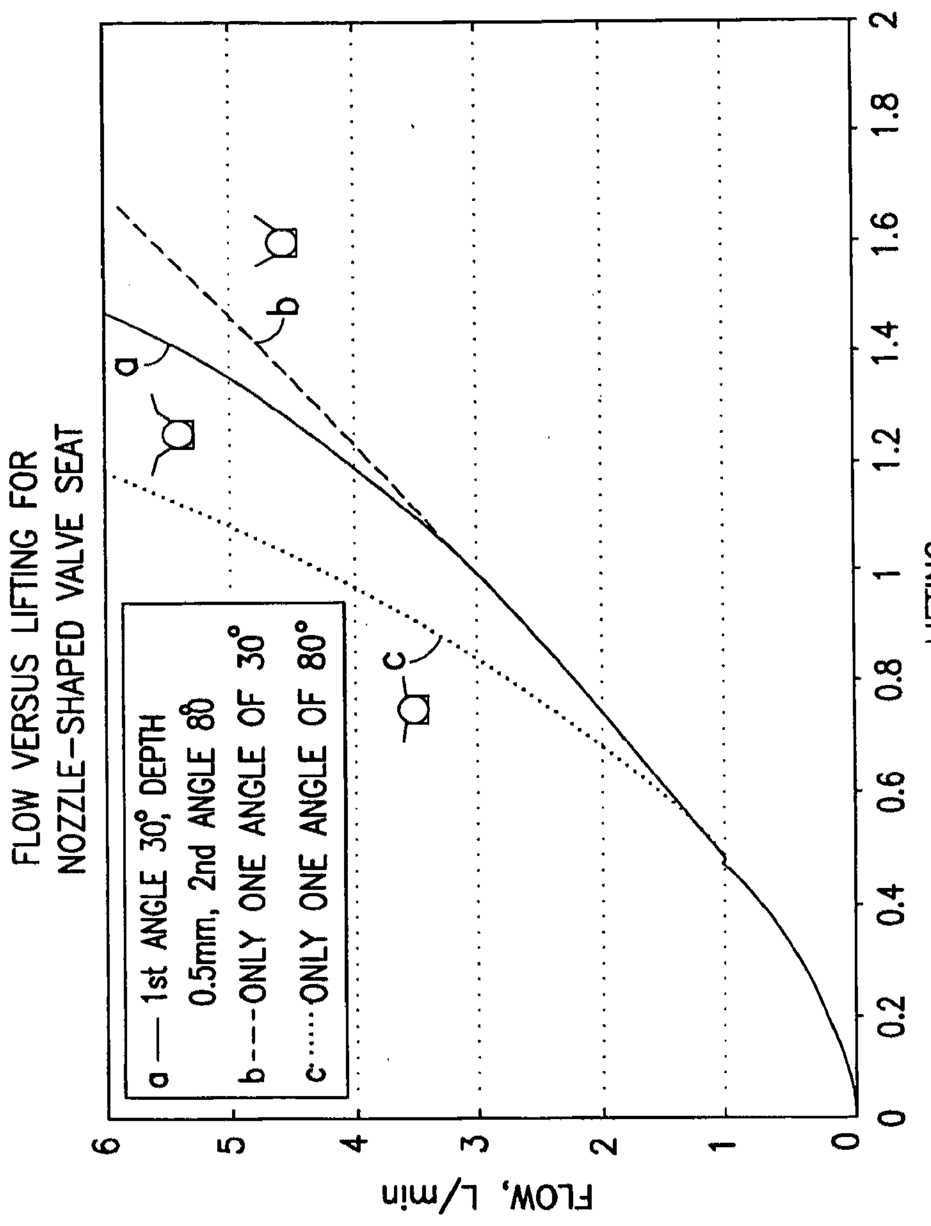

FLOW VERSUS LIFTING FOR
NOZZLE-SHAPED VALVE SEAT
a —— 1st ANGLE 30°, DEPTH
0.5mm, 2nd ANGLE 80°
b - - -ONLY ONE ANGLE OF 30°
c ······ONLY ONE ANGLE OF 80°
FLOW, L/min
LIFTING,mm
0
1
2
3
4
5
6
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
a
b
c

FIG.5

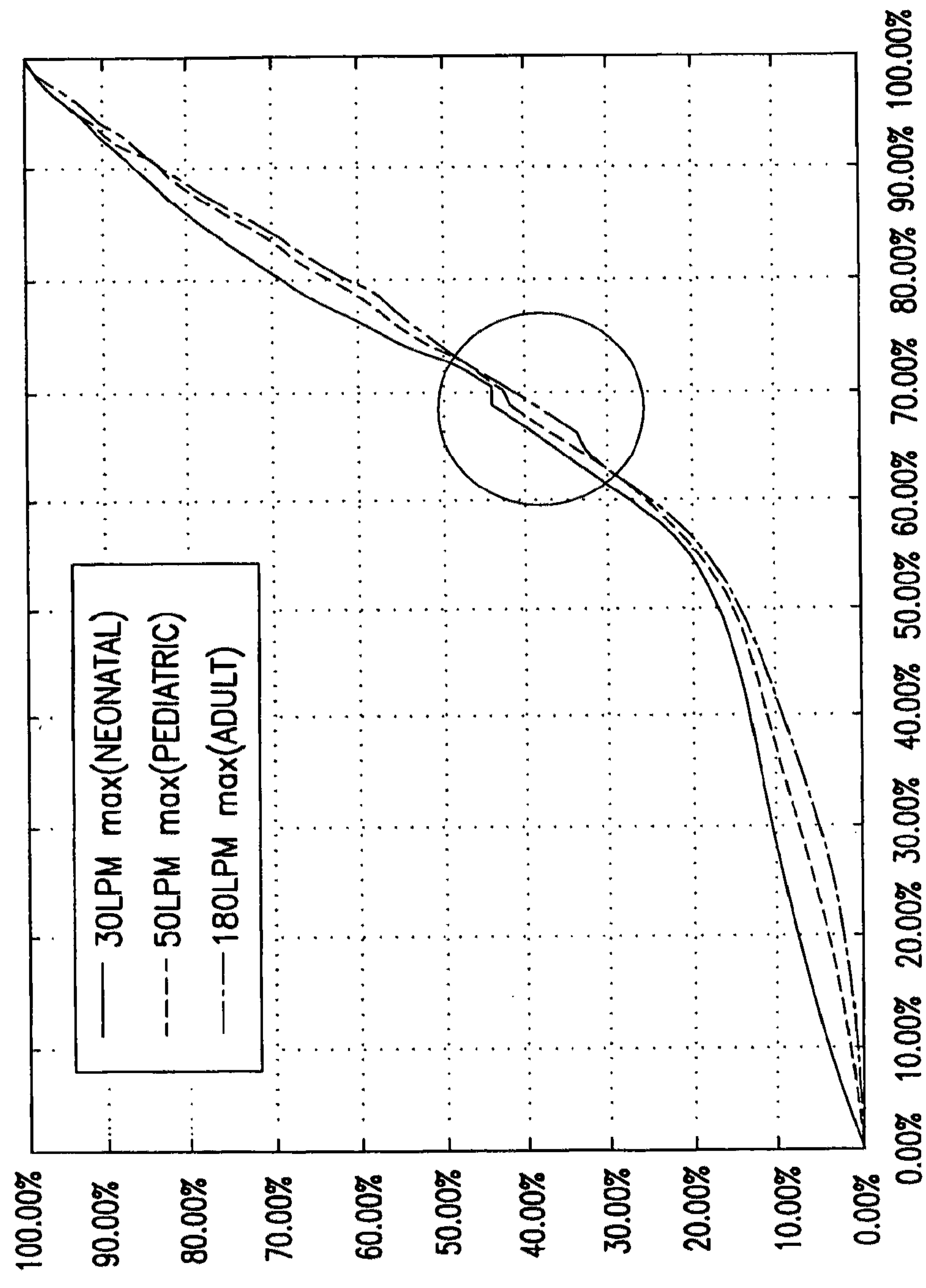

30LPM max(NEONATAL)
50LPM max(PEDIATRIC)
180LPM max(ADULT)
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
90.00%
100.00%

FIG.6

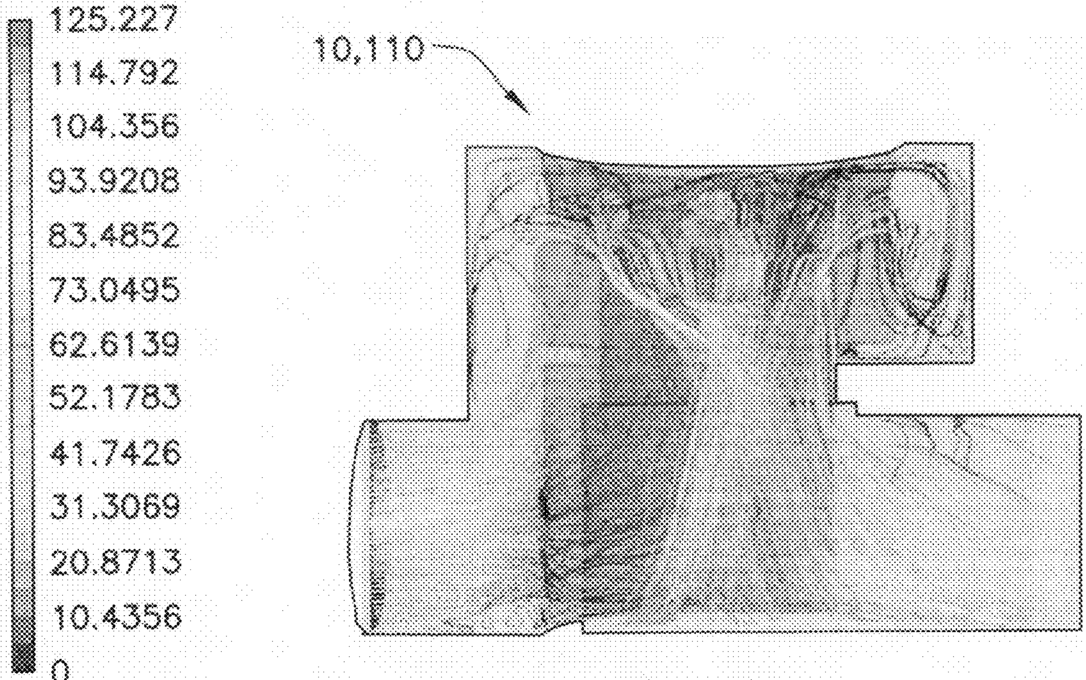

125.227
114.792
104.356
93.9208
83.4852
73.0495
62.6139
52.1783
41.7426
31.3069
20.8713
10.4356
0
10,110

FIG.7A

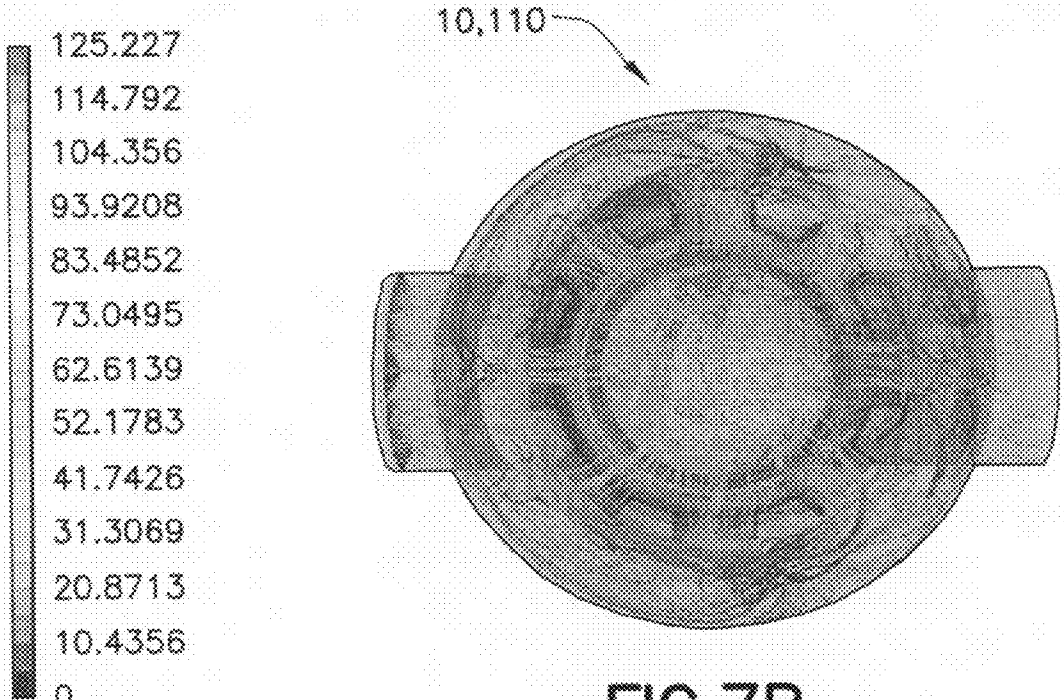

125.227
114.792
104.356
93.9208
83.4852
73.0495
62.6139
52.1783
41.7426
31.3069
20.8713
10.4356
0
10,110

FIG.7B

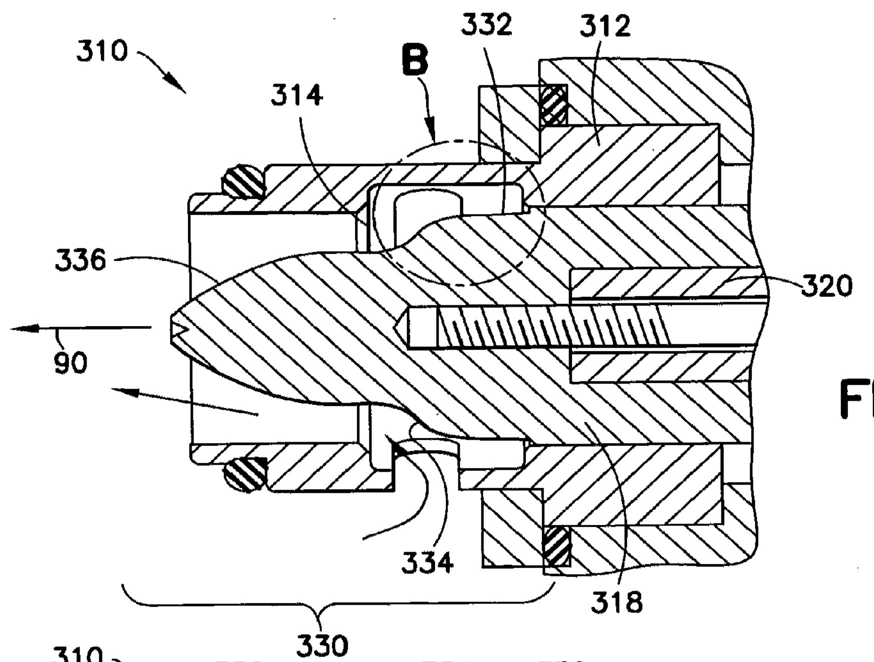

310
B
332
312
314
336
320
90
334
318
330

FIG.8A

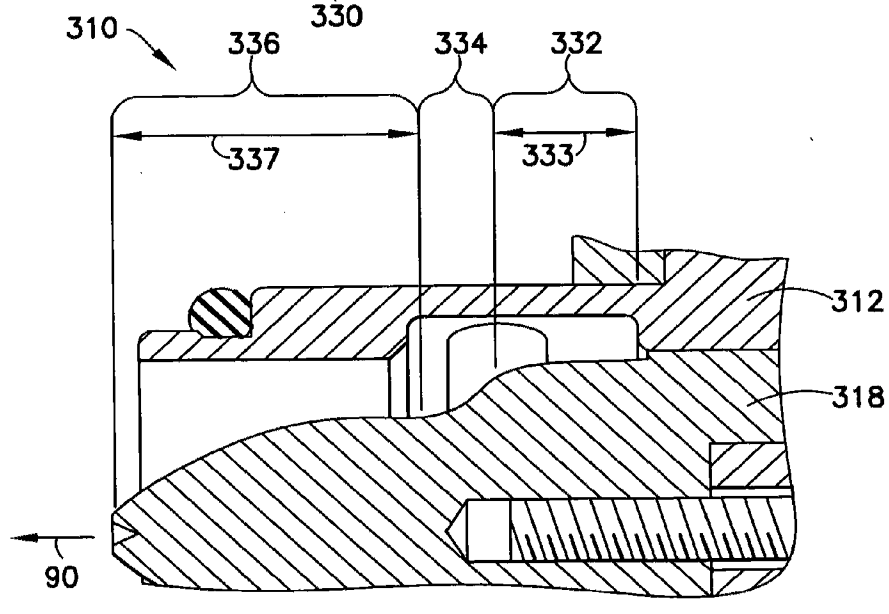

310
336
334
332
337
333
312
318
90

FIG.8B

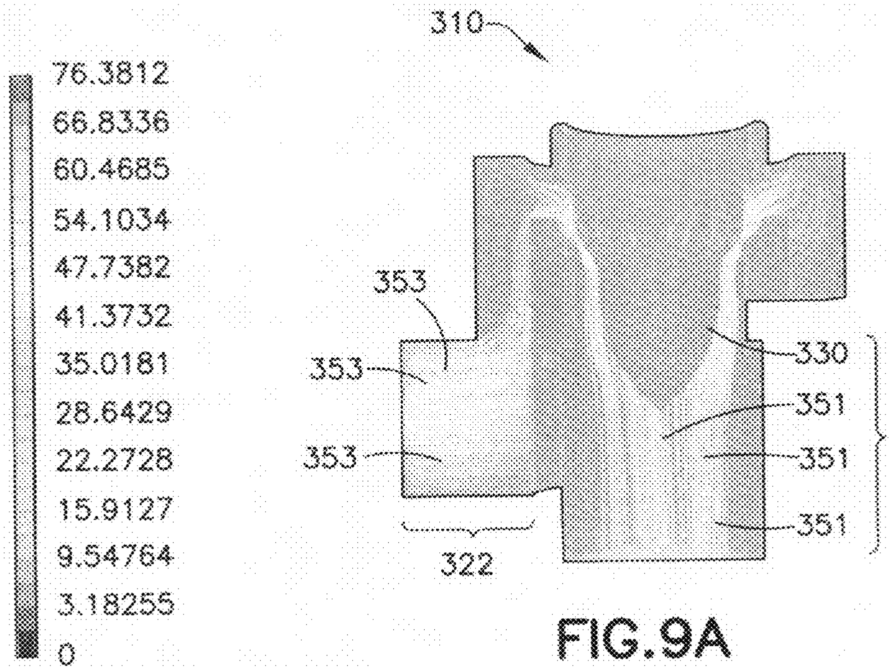

76.3812
66.8336
60.4685
54.1034
47.7382
41.3732
35.0181
28.6429
22.2728
15.9127
9.54764
3.18255
0
310
353
353
353
330
351
351
351
324
322

FIG.9A

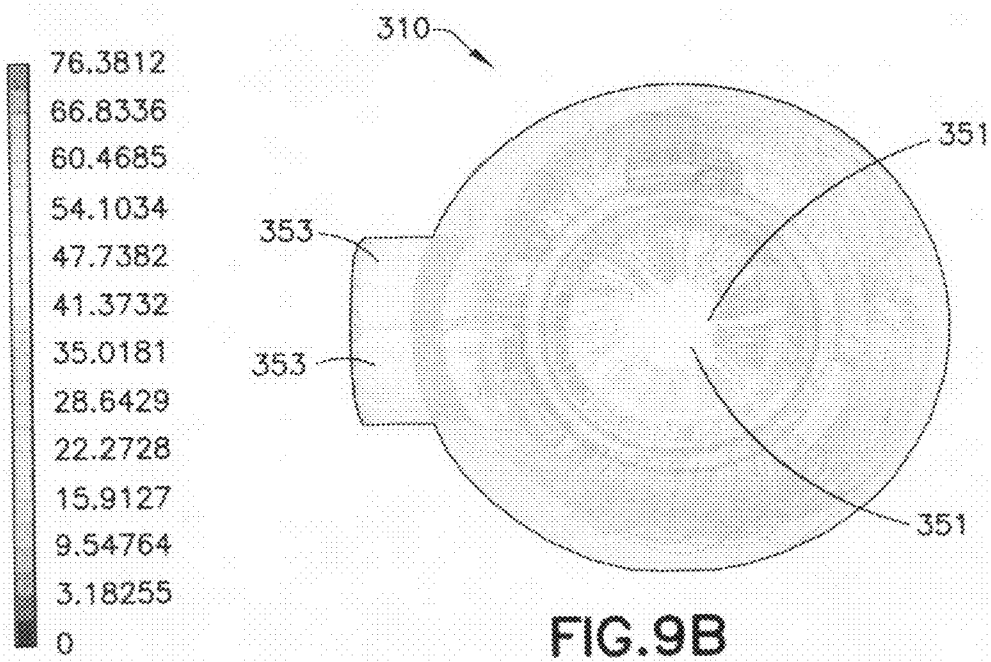

76.3812
66.8336
60.4685
54.1034
47.7382
41.3732
35.0181
28.6429
22.2728
15.9127
9.54764
3.18255
0
310
351
353
353
351

FIG.9B

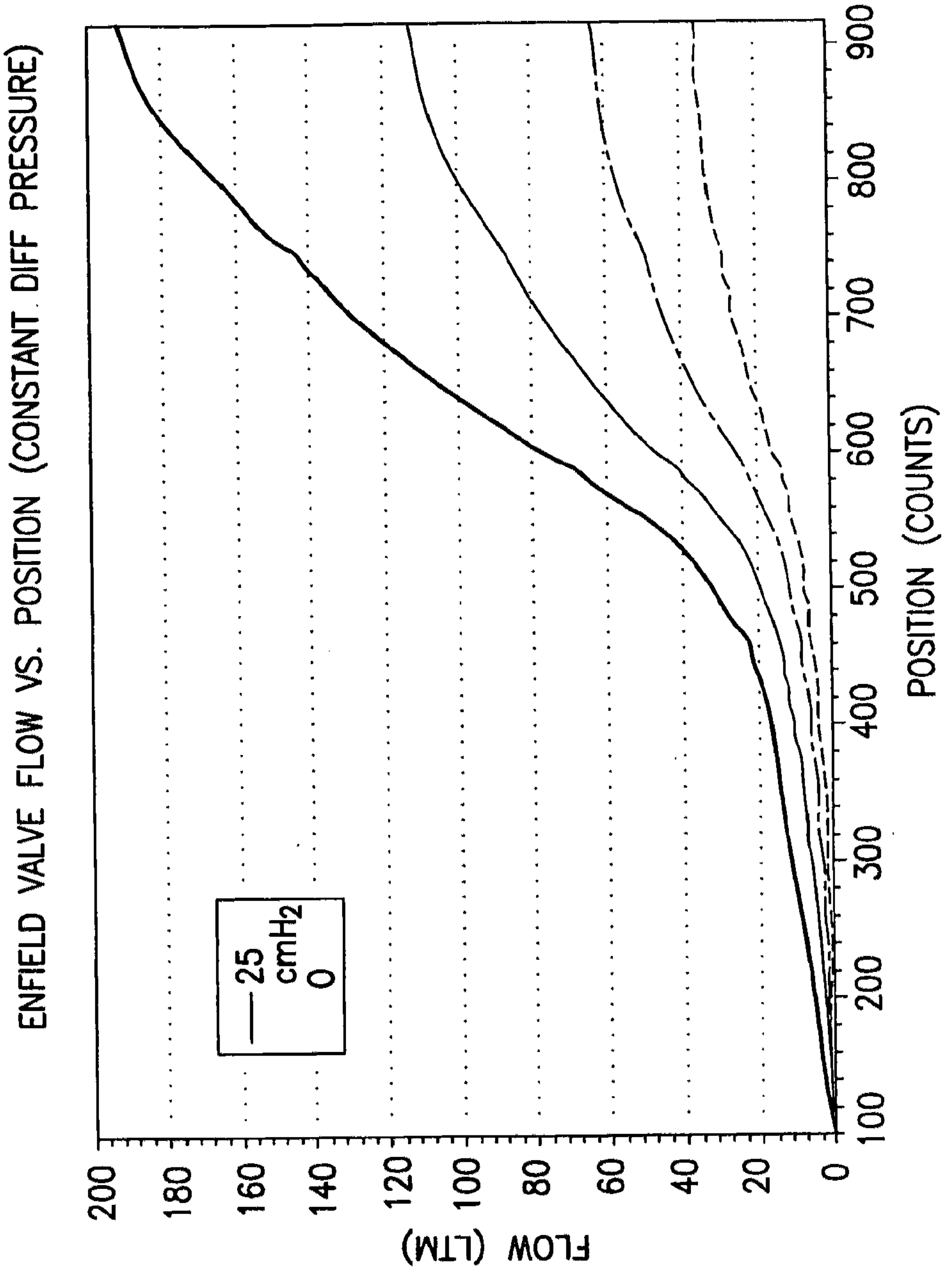

ENFIELD VALVE FLOW VS. POSITION (CONSTANT DIFF PRESSURE)
FLOW (LTM)
200
180
160
140
120
100
80
60
40
20
0
100
200
300
400
500
600
700
800
900
POSITION (COUNTS)
—25
cmH2
0

FIG.10

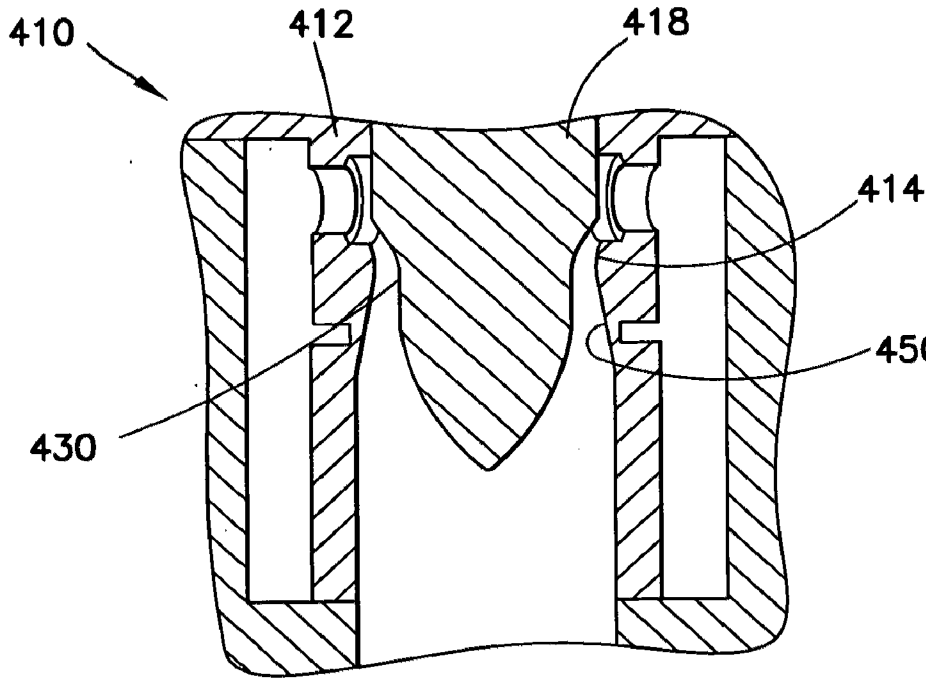


FIG.11

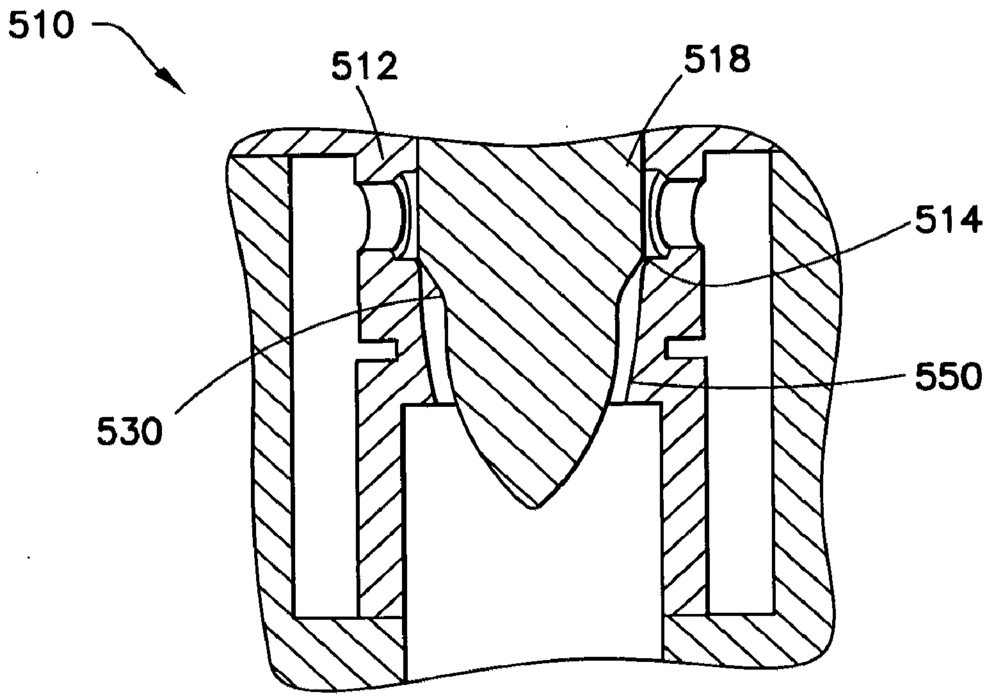


FIG.12

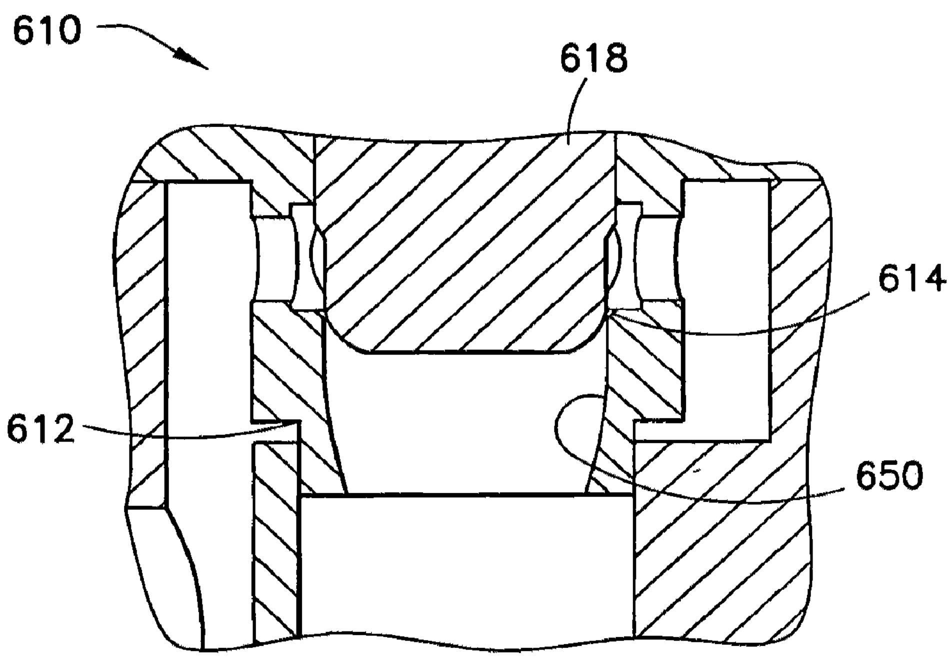


FIG.13

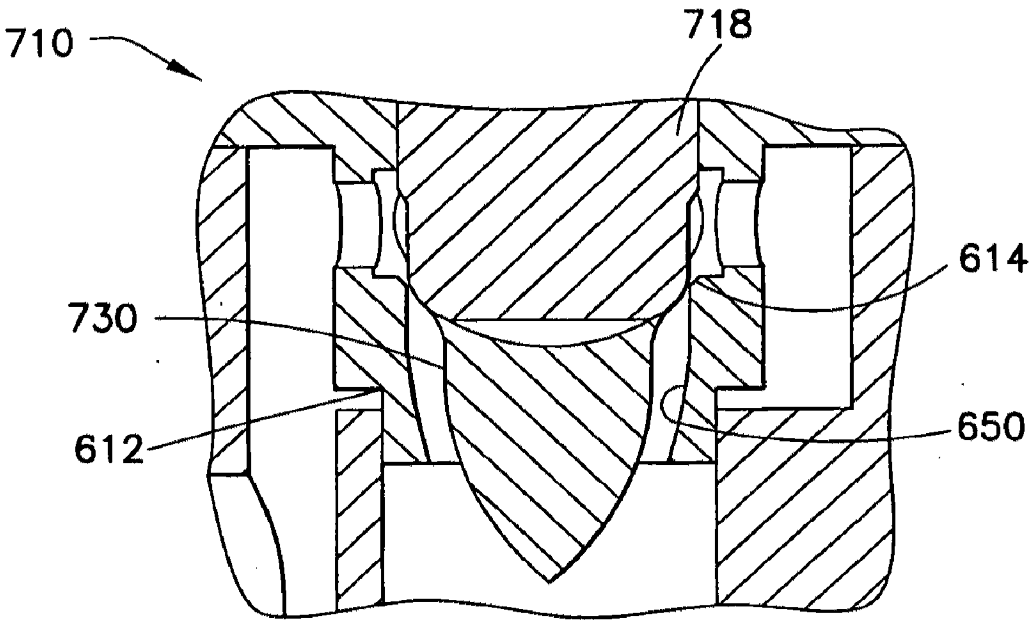


FIG.14

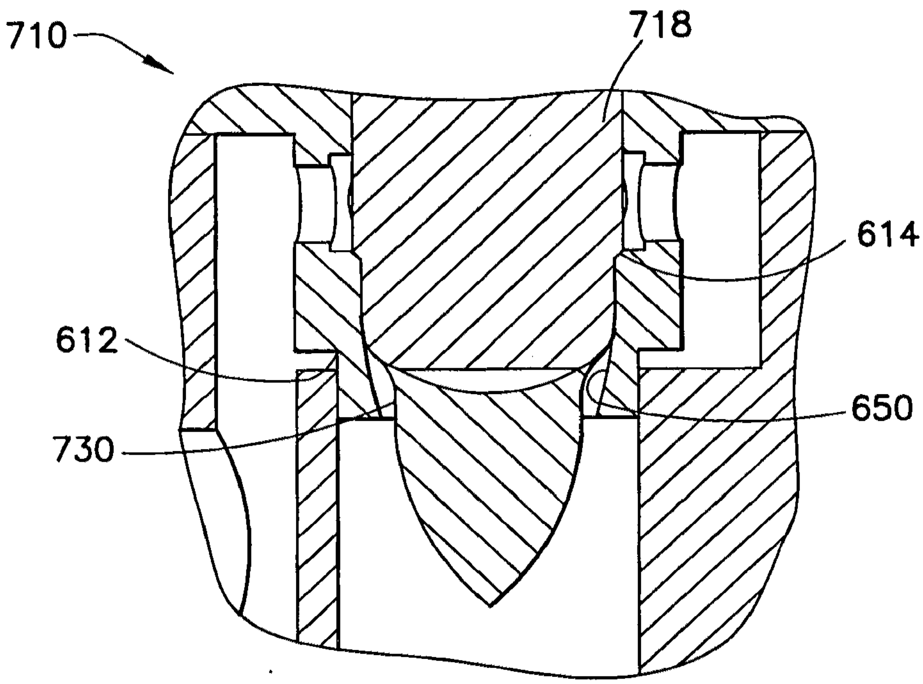


FIG.15

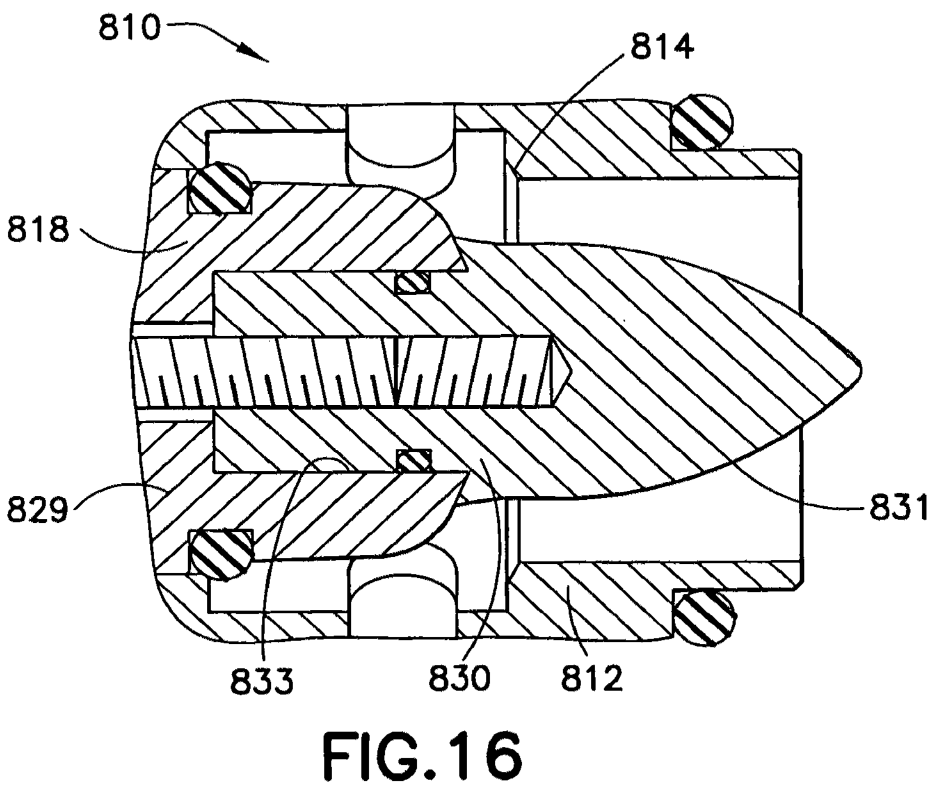


FIG.16

CORRECTIVE MEASURES AND DEVICES FOR BI-STABLE FLOW PHENOMENA IN FLUID VALVES

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims priority under 35 U.S.C. §119(e) to U.S. provisional patent application No. 61/361,161 filed Jul. 2, 2010 which is hereby incorporated by reference in its entirety.

BACKGROUND

[0002] 1. Field of the Invention

[0003] The invention relates to fluid valves and, more particularly, to bi-stable flow in fluid valves.

[0004] 2. Brief Description of Prior Developments

[0005] It is sometimes desirable to control the flow of compressed gases very precisely. Due to inherent limitations in sensors and control, much effort is still placed on proper mechanical design and valve geometry. In some cases, vortices can form during normal operation and can either be stable vortices or astable vortices; in any event, these vortices can often be predicted and managed by instituting geometry changes to the valve internal elements. There are other situations in which certain anomalies present themselves where prior knowledge and existing skills cannot adequately address the issue. In this particular case, an anomaly in the flow profile for a servo controlled proportional poppet valve was discovered. Conventional wisdom and design approaches were unsatisfactory in correcting the observed condition. Additionally, it is likely that this condition would go unnoticed in many other valve designs (for example as in US 2008/0185542 which is hereby incorporated by reference in its entirety) since the operating conditions and application demands required precise monotonic flow profiles from fully closed to fully open; most valves operate in either the fully open or fully closed state and only operate in an intermediate state during transitions. Another mitigating issue was the extremely low pressures coupled with the relatively high flows required; the net result in high velocities at very low pressures.

SUMMARY

[0006] In accordance with one aspect of the invention, a valve is disclosed. The valve includes a valve body, a seat, a poppet, and a shaped portion. The valve body has an inlet portion and an outlet portion. The seat is between the inlet portion and the outlet portion. The poppet is proximate the seat. The poppet is adapted to modulate fluid flow between the inlet portion and the outlet portion. The shaped portion is downstream of the seat. The shaped portion is adapted to direct fluid flow, reduce cross flow interference, and allow for substantially parallel fluid flow jets at a majority of the inlet portion and the outlet portion when fluid is flowing through the valve.

[0007] In accordance with another aspect of the invention, a valve is disclosed. The valve includes a valve body, a seat, and a poppet. The valve body has an inlet portion and an outlet portion. The seat is between the inlet portion and the outlet portion. The poppet has a base section and an extension section. The base section is adapted to modulate fluid flow between the inlet portion and the outlet portion. The extension section extends downstream of the seat. A length of the extension section is greater than a length of the base section.

[0008] In accordance with another aspect of the invention, a valve is disclosed. The valve includes a valve body, a seat, and a poppet. The valve body has an inlet portion and an outlet portion, and a downstream section. The seat is between the inlet portion and the outlet portion. The poppet is proximate the seat. The poppet is adapted to modulate fluid flow between the inlet portion and the outlet portion. The downstream section is between the seat and an outlet of the valve. The downstream section is adapted to direct fluid flow, reduce cross flow interference, and allow for substantially parallel fluid flow jets at a majority of the inlet portion and the outlet portion when fluid is flowing through the valve.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The foregoing aspects and other features of the invention are explained in the following description, taken in connection with the accompanying drawings, wherein:

[0010] FIG. **1** is a cross section view of a conventional valve;

[0011] FIG. **2** is a cross section view of another conventional valve;

[0012] FIG. **3** is a cross section view of another conventional valve;

[0013] FIG. **4** is a graphical representation of valve characteristics;

[0014] FIG. **5** is graphical representation of flow versus lifting for a valve seat;

[0015] FIG. **6** is a graphical representation of valve characteristics;

[0016] FIG. **7**A is a graphical representation of results from computational fluid dynamics analysis;

[0017] FIG. **7**B is a graphical representation of results from computational fluid dynamics analysis;

[0018] FIG. **8**A is a partial section view of a valve incorporating features of the invention;

[0019] FIG. **8**B is an enlarged partial section view of valve shown in FIG. **8**A;

[0020] FIG. **9**A is a graphical representation of results from computational fluid dynamics analysis;

[0021] FIG. **9**B is a graphical representation of results from computational fluid dynamics analysis;

[0022] FIG. **10** is a graphical representation of valve flow versus position;

[0023] FIG. **11** is a partial section view of another example valve incorporating features of the invention;

[0024] FIG. **12** is a partial section view of another example valve incorporating features of the invention;

[0025] FIG. **13** is a partial section view of another example valve incorporating features of the invention;

[0026] FIG. **14** is a partial section view of another example valve incorporating features of the invention;

[0027] FIG. **15** is another partial section view of the example valve shown in FIG. **14**; and

[0028] FIG. **16** is a partial section view of another example valve incorporating features of the invention.

DETAILED DESCRIPTION

[0029] In a typical medical respirator, high pressure gas (approximately 80 psi) is supplied to a control valve. The control valve is intended to position the valve element such that flow through the valve (and into the patient) is controlled.

Since the pressure in the patients' lungs is only slightly above atmospheric, the control valve will always function with a relatively high DP that will guarantee chocked flow conditions (Pds/Pus<0.528). A new design respirator is conceived where the air source is not from a bottle of stored high pressure gas but is instead from an integrated blower/compressor. The maximum discharge pressure of this blower is intended to be only slightly above atmospheric and only as required to ensure adequate air flow into the patient. This feature allows for high portability of the equipment with lower weight and storage footprint but places great demands on the control valve beyond what would normally be expected.

[0030] Due to the low discharge pressure of the compressor and only slightly lower patient lung pressure, the control valve must function with very low differential pressures yet pass very high flows. This is usually easily achieved with a straight section of tubing or pipe; however, the valve must be able to precisely modulate flow over the entire range from about zero percent (fully closed) to about one hundred percent (fully open). With these constraints, critical flow is not achieved and the pressure/flow relationships become highly non-linear (and more prone to instability). Additionally, the application required a very subtle flow profile versus position for the first fifty percent of valve motion in order to maximize controllability at low flow conditions but achieve high flows over the final fifty percent of stroke.

[0031] A typical poppet or globe valve **10** design is shown in FIG. **1**. The valve **10** comprises a body **12**, a seat **14**, a bonnet **16**, a disc (or poppet) **18**, and a stem **20**. The valve body **12** generally comprises an inlet (or inlet portion) **22** and an outlet (or outlet portion) **24**. A typical poppet **18** is not intended to be operated at intermediate positions so the functional criteria are maximum flow when open and minimum leakage when closed, however, throttling capabilities are limited and often discouraged to prevent premature valve wear. A properly designed throttling or control valve **110** is shown in FIG. **2**. Similar to the valve **10** described above, the valve **110** comprises a body **112**, a seat **114**, a bonnet **116**, a disc (or poppet) **118**, and a stem **120**. The valve body **112** generally comprises an inlet (or inlet portion) **122** and an outlet (or outlet portion) **124**. As shown in FIG. **2**, the cross-sectional area allowed for flow varies as stem **120** position varies and is directly controlled by the poppet/body geometry.

[0032] Shown in FIG. **3** is another typical poppet design. The valve **210**, is similar to the valves **10**, **110**. For the purposes of clarity, only a portion of the valve is illustrated. For example, enlarged views of a portion of the valve body **212**, the seat **214**, and the disc (or poppet **218**) are illustrated. As shown, one can see how the flow increases linearly as the poppet **218** opens (the cross-sectional area increases linearly with poppet position) until the valve is about fifty percent open. Once about fifty percent open, additional movement of the valve poppet **218** results in a rapidly increasing rate of flow since the cross-sectional area is increasing rapidly. The poppet profile (see area "A") shown provides a cross-sectional area vs. poppet position relationship as shown in FIG. **4**. Since area is proportional to flow for a set of pressure conditions, flow area is a good approximation of the expected flow through a component.

[0033] Referring to patent application US 2008/0185542 for reported test data showing similar effects on a different geometry yet no mention is made of this anomaly (anomaly is shown in FIG. **5** as an excerpt from US2008/0185542). Additionally, ABCM Article April-June 2006, Vol. XXVIII, No. 2 "Experimental Study of the Bistable Flow in Tube Arrays" discusses bi-stable flow and associated lab testing. Of particular interest is the closing paragraph "The origin of this phenomenon . . . is not completely understood". This research was restricted to tube arrays and not directly applicable to valve geometries of interest, however, it does provide some insight into a potential root cause.

[0034] During a customized valve design effort, several prototype valves were manufactured and tested. The valve element was mechanically positioned and pressure/flow conditions monitored to verify flow characteristics against predicted. As shown in FIG. **6**, measured flow tended to decrease suddenly around fifty percent valve open. Tests at other pressure conditions revealed similar results. Decreasing valve position immediately after witnessing the anomaly did not reverse the reduction in flow making it appear as though mechanical hysteresis was the cause.

[0035] Extensive Computational Fluid Dynamics (CFD) studies using state-of-the-art fluid analysis software were conducted on computer models in an effort to identify and isolate the root cause of the anomaly. Surprisingly, the CFD software was unable to replicate the phenomenon. It is believed that since the software converges for a single set of flow conditions for every element in the FEA model, it is incapable of predicting unstable flows due to purely pneumatic phenomenon since certain approximations are made during fully developed turbulent flow models and because the analysis inherently assumes a single snap shot in time. It was noticed during analysis at certain valve positions that the solver took longer (more computational iterations) to converge and approach to convergence was more oscillatory but resolving a definitive theory from this data alone would not be wise. By examination of the output of the CFD software using graphical visualization tools it was observed at certain valve positions that flow appeared to be quite disorderly and potentially interfering with flow from the opposite side of the channel (see FIGS. **7**A and **7**B).

[0036] By studying the geometry and intuitively evaluating the available data, it was theorized that the rapid transition from a slowly widening area to a faster expansion toward the rounded end of the poppet resulted in a sudden trajectory change on the dominant side of the valve poppet. This trajectory change resulted in a jet of high velocity gas impinging on the opposite wall of the flow channel, restricting flow from a portion of the poppet outlet on that side.

[0037] Classical solutions including, modifying the poppet profile in the region of interest or changing pressure/flow conditions were not acceptable due to the intended application. It was surmised that downstream flow behavior modifiers. The precise nature of these elements was not immediately apparent so several design were simulated in CFD. It should be understood that CFD output only provided an 'intuitive sense' of the nature of the design but could not prove that the anomaly was/was not corrected for any given geometry.

[0038] Referring to FIGS. **8**, **8***a*, there is shown a partial section view of a valve **310** incorporating features of the invention. Although the invention will be described with reference to the exemplary embodiments shown in the drawings, it should be understood that the invention can be embodied in many alternate forms of embodiments. In addition, any suitable size, shape or type of elements or materials could be used.

[0039] The valve **310**, is similar to the valves **10**, **110**, **210**, however the valve **310** includes features providing for improved flow through the valve such that flow is directed advantageously and allowed to rejoin with minimal cross flow interference. For the purposes of clarity, only a portion of the valve (which may be a poppet valve or a globe valve, for example) **310** is illustrated. For example, enlarged views of a portion of a body **312**, a seat **314**, a disc (or poppet) **318**, and a stem **320** of the valve **310** are shown. It should be noted the valve **310** can further have any suitable type of features as known in the art.

[0040] According to one example embodiment of the invention, the poppet **318** may comprise a poppet end portion (or poppet extension) **330** having a sloped section **332**, a radius edge section **334**, and a tip section **336**. The sloped section (or base section) **332**, may comprise a slope of about three degrees, for example. However, in alternate embodiments, any suitable slope dimension may be provided. The radius edge section **334** is between the tip section **336** and the sloped section **332**. The tip section (or extension section) **336** may comprise a general "bullet" shape. Additionally, according to one embodiment, the poppet end portion (or shaped portion) **330** may be integrally formed with the rest of the poppet **318** as a one piece member. However, in alternate embodiments, the poppet end portion (or shaped portion) may comprise a separate member attached to an end of the poppet **318**.

[0041] FIGS. **8**A, **8**B show one embodiment of a downstream poppet modification **330** (such as, at area "B", for example) that prevented undesired flow instabilities or vortices while preventing cross flow trajectories and maintained approximately the desired bulk flow profile characteristics. For example, the length **337** of the extension section **336** in a direction **90** of (downstream) fluid flow is greater than a length **333** of the base section **332** in the direction **90** of (downstream) fluid flow.

[0042] As seen in FIGS. **9**A, **9**B, the CFD output from the poppet extension **330** shows orderly and substantially parallel flow jets **351** (at the outlet portion **324**), **353** (at the inlet portion **322**) that do not interfere with other flow areas. Test prototypes incorporating the poppet extension **330** were constructed to verify the assumptions made regarding the mysterious pneumatic phenomenon and tested. The flow data shown in FIG. **10** shows that the valve performance was not degraded and the flow anomaly has been eliminated for various pressures.

[0043] While various exemplary embodiments of the invention have been described above in connection with the valve body shape and poppet shape shown in FIGS. **8**A, **8**B, one skilled in the art will appreciate that the invention is not necessarily so limited and that other shapes may be provided.

[0044] For example, and referring now also to FIG. **11**, a valve **410** in accordance with another embodiment of the invention is shown. The valve **410** is similar to the valve **310** and also includes features providing for improved flow through the valve such that flow is directed advantageously and allowed to rejoin with minimal cross flow interference. For the purposes of clarity, only a portion of the valve (which may be a poppet valve or a globe valve, for example) **410** is illustrated. For example, enlarged views of a portion of the body **412**, the seat **414**, and the disc (or poppet) **418** are shown. In this embodiment the poppet **418** comprises a poppet extension **430** (similar to the poppet extension **330**) having a general "bullet" shaped poppet tip. However, this embodiment further comprises a modification to the body **412**. The body **412** comprises an expanding downstream section (or shaped portion) **450** (which may be conical, for example).

[0045] Referring now also to FIG. **12**, a valve **510** in accordance with another embodiment of the invention is shown. The valve **510** is similar to the valve **310** and also includes features providing for improved flow through the valve such that flow is directed advantageously and allowed to rejoin with minimal cross flow interference. For the purposes of clarity, only a portion of the valve (which may be a poppet valve or a globe valve, for example) **510** is illustrated. For example, enlarged views of a portion of the body **512**, the seat **514**, and the disc (or poppet) **518** are shown. In this embodiment the poppet **518** comprises a poppet extension **530** (similar to the poppet extension **330**) having a general "bullet" shaped poppet tip. However, this embodiment further comprises a modification to the body **512**. The body **512** comprises a contracting downstream section (or shaped portion) **550** (which may be curvilinear, for example).

[0046] Referring now also to FIG. **13**, a valve **610** in accordance with another embodiment of the invention is shown. The valve **610** is similar to the valve **310** and also includes features providing for improved flow through the valve such that flow is directed advantageously and allowed to rejoin with minimal cross flow interference. For the purposes of clarity, only a portion of the valve (which may be a poppet valve or a globe valve, for example) **610** is illustrated. For example, enlarged views of a portion of the body **612**, the seat **614**, and the disc (or poppet) **618** are shown. In this embodiment the poppet **618** does not comprise a poppet extension. However, this embodiment comprises a modification to the body **612**. The body **612** comprises a downstream (constriction) section (or shaped portion) **650** having general torus and conical shape which creates a 'rejoin jet'.

[0047] Referring now also to FIGS. **14** and **15**, a valve **710** in accordance with another embodiment of the invention is shown. FIG. **14** illustrates the valve **710** in an open position, FIG. **15** illustrates the valve **710** in a closed position. The valve **710** is similar to the valve **610**. The valve **710** comprises the body **612** (having the constriction section **650**) and the seat **614**, however in this embodiment the poppet **718** comprises a poppet extension **730** (similar to the poppet extension **330**) having a general "bullet" shaped poppet tip.

[0048] Referring now also to FIG. **16**, a valve **810** in accordance with another embodiment of the invention is shown. The valve **810** is similar to the valve **310** and also includes features providing for improved flow through the valve such that flow is directed advantageously and allowed to rejoin with minimal cross flow interference. For the purposes of clarity, only a portion of the valve (which may be a poppet valve or a globe valve, for example) **810** is illustrated. For example, enlarged views of a portion of the body **812**, the seat **814**, and the disc (or poppet) **818** are shown. In this embodiment the poppet **818** comprises a two piece assembly wherein the poppet extension **830** is removable from a poppet base section **829**. The removable poppet extension **830** comprises a poppet fairing section **831** and a body section **833**. The body section **833** comprises a general straight cylindrical shape. The poppet fairing section **831** extends from the body section **833** and has a general "bullet" shape. The poppet base section **829** and the removable poppet extension (or fairing tip) **830** are separate members to allow for customization of outlet flow geometry by exchanging poppet fairing tips **830** of various geometries.

[0049] It should be noted that the various valve body and/or poppet shapes described above are provided as non-limiting examples. It should further be noted that although various exemplary embodiments of the invention have been described in connection with globe valves and poppet valves, alternate embodiments may comprise any other suitable type valve or equipment.

[0050] Below are provided further descriptions of various non-limiting, exemplary embodiments. The various aspects of one or more exemplary embodiments may be practiced in conjunction with one or more other aspects or exemplary embodiments. That is, the exemplary embodiments of the invention, such as those described immediately below, may be implemented, practiced or utilized in any combination (e.g., any combination that is suitable, practicable and/or feasible) and are not limited only to those combinations described herein and/or included in the appended claims.

[0051] In one exemplary embodiment, a pneumatic valve intended to be used in a servo or proportional manner comprising a modification to the end of the poppet downstream of the poppet and/or a modification to the geometry of the downstream valve body such that flow is directed advantageously and allowed to rejoin with minimal cross flow interference.

[0052] The geometry to accomplish this could take on many forms dependent on the specific application, flowing fluid, intended use, and other application specific features. Additionally, other internal geometry decisions may impact the required geometry.

[0053] The geometry should allow for at least two distinct flow regimes (low sensitivity and high sensitivity) that is accomplished by application of any portion or all portions of cones, spheres, cylinders, power function curves (x^2, x^3, $1/x^2$, etc), exponentials (e^x, k^x, etc), torroids, pyramid, regular solid, parallelepiped, cube, or helix. These shapes may be combined advantageously by combining (as shown above) a cylinder, a cone, a torus, another cylinder, a revolved arc.

[0054] The geometry additions could take the form as integrated part features or additional parts for add-on dependant on material requirements.

[0055] Use of these geometry changes are most advantageous in low pressure, high velocity applications but is not solely limited to these applications; these geometry alterations are likely beneficial in higher pressures or vacuum (particularly vacuum) where velocities in excess of Ma=0.1 is expected or the fluid compressibility and inertia are significant.

[0056] It should be understood that components of the invention can be operationally coupled or connected and that any number or combination of intervening elements can exist (including no intervening elements). The connections can be direct or indirect and additionally there can merely be a functional relationship between components.

[0057] Below are provided further descriptions of various non-limiting, exemplary embodiments. Various aspects of one or more exemplary embodiments may be practiced in conjunction with one or more other aspects or exemplary embodiments. That is, the exemplary embodiments of the invention, such as those described immediately below, may be implemented, practiced or utilized in any combination (e.g., any combination that is suitable, practicable and/or feasible) and are not limited only to those combinations described herein and/or included in the appended claims.

[0058] In one exemplary embodiment, a valve comprising a valve body having an inlet portion and an outlet portion, a seat between the inlet portion and the outlet portion, a poppet proximate the seat, wherein the poppet is adapted to modulate fluid flow between the inlet portion and the outlet portion, and a shaped portion downstream of the seat, wherein the shaped portion is adapted to direct fluid flow, reduce cross flow interference, and allow for substantially parallel fluid flow jets at a majority of the inlet portion and the outlet portion when fluid is flowing through the valve.

[0059] A valve as above, wherein the poppet comprises a poppet end portion, and wherein the poppet end portion comprises the shaped portion.

[0060] A valve as above, wherein the poppet end portion is integrally formed with the poppet.

[0061] A valve as above, wherein the poppet end portion is a separate member configured to be removable from the poppet.

[0062] A valve as above, wherein the valve body comprises the shaped portion.

[0063] A valve as above, wherein the shaped portion comprises a constriction section having a general torus and conical shape.

[0064] A valve as above, wherein the shaped portion comprises a general bullet shape.

[0065] A valve as above, wherein the shaped portion is adapted to allow for at least two distinct flow regimes.

[0066] A valve as above, wherein the shaped portion comprises a general cylinder shape, a general cone shape, a general torus shape, and/or a general revolved arc shape.

[0067] In another exemplary embodiment, a valve comprising a valve body having an inlet portion and an outlet portion, a seat between the inlet portion and the outlet portion, a poppet having a base section and an extension section, wherein the base section is adapted to modulate fluid flow between the inlet portion and the outlet portion, wherein the extension section extends downstream of the seat, and wherein a length of the extension section is greater than a length of the base section.

[0068] A valve as above, wherein the wherein a length of the extension section in a direction of fluid flow is greater than a length of the base section in the direction of fluid flow.

[0069] A valve as above, wherein the extension section is adapted to direct fluid flow, reduce cross flow interference, and allow for substantially parallel fluid flow jets at a majority of the inlet portion and the outlet portion when fluid is flowing through the valve.

[0070] A valve as above, wherein the extension section comprises a general bullet shape.

[0071] A valve as above, wherein the valve body comprises a shaped portion downstream of the seat.

[0072] A valve as above, wherein the extension section comprises a general cylinder shape, a general cone shape, a general torus shape, and/or a general revolved arc shape.

[0073] In another exemplary embodiment, a valve comprising a valve body having an inlet portion and an outlet portion, and a downstream section, a seat between the inlet portion and the outlet portion, a poppet proximate the seat, wherein the poppet is adapted to modulate fluid flow between the inlet portion and the outlet portion, wherein the downstream section is between the seat and an outlet of the valve, and wherein the downstream section is adapted to direct fluid flow, reduce cross flow interference, and allow for substantially parallel fluid flow jets at a majority of the inlet portion and the outlet portion when fluid is flowing through the valve.

[0074] A valve as above, wherein the downstream section comprises a general torus and conical shape.

[0075] A valve as above, wherein the downstream section comprises an expanding section having a general conical shape.

[0076] A valve as above, wherein the downstream section comprises a contracting section having a general curvilinear shape.

[0077] A valve as above, wherein the poppet further comprises a shaped portion downstream of the seat, wherein the shaped portion is adapted to direct fluid flow, reduce cross flow interference, and allow for substantially parallel fluid flow jets at a majority of the inlet portion and the outlet portion when fluid is flowing through the valve.

[0078] It should be understood that the foregoing description is only illustrative of the invention. Various alternatives and modifications can be devised by those skilled in the art without departing from the invention. Accordingly, the invention is intended to embrace all such alternatives, modifications and variances which fall within the scope of the appended claims.

What is claimed is:

1. A valve comprising:

a valve body having an inlet portion and an outlet portion;

a seat between the inlet portion and the outlet portion;

a poppet proximate the seat, wherein the poppet is adapted to modulate fluid flow between the inlet portion and the outlet portion; and

a shaped portion downstream of the seat, wherein the shaped portion is adapted to direct fluid flow, reduce cross flow interference, and allow for substantially parallel fluid flow jets at a majority of the inlet portion and the outlet portion when fluid is flowing through the valve.

2. A valve as in claim **1** wherein the poppet comprises a poppet end portion, and wherein the poppet end portion comprises the shaped portion.

3. A valve as in claim **2** wherein the poppet end portion is integrally formed with the poppet.

4. A valve as in claim **2** wherein the poppet end portion is a separate member configured to be removable from the poppet.

5. A valve as in claim **1** wherein the valve body comprises the shaped portion.

6. A valve as in claim **5** wherein the shaped portion comprises a constriction section having a general torus and conical shape.

7. A valve as in claim **1** wherein the shaped portion comprises a general bullet shape.

8. A valve as in claim **1** wherein the shaped portion is adapted to allow for at least two distinct flow regimes.

9. A valve as in claim **1** wherein the shaped portion comprises a general cylinder shape, a general cone shape, a general torus shape, and/or a general revolved arc shape.

10. A valve comprising:

a valve body having an inlet portion and an outlet portion;

a seat between the inlet portion and the outlet portion;

a poppet having a base section and an extension section, wherein the base section is adapted to modulate fluid flow between the inlet portion and the outlet portion, wherein the extension section extends downstream of the seat, and wherein a length of the extension section is greater than a length of the base section.

11. A valve as in claim **10** wherein the wherein a length of the extension section in a direction of fluid flow is greater than a length of the base section in the direction of fluid flow.

12. A valve as in claim **10** wherein the extension section is adapted to direct fluid flow, reduce cross flow interference, and allow for substantially parallel fluid flow jets at a majority of the inlet portion and the outlet portion when fluid is flowing through the valve.

13. A valve as in claim **10** wherein the extension section comprises a general bullet shape.

14. A valve as in claim **10** wherein the valve body comprises a shaped portion downstream of the seat.

15. A valve as in claim **10** wherein the extension section comprises a general cylinder shape, a general cone shape, a general torus shape, and/or a general revolved arc shape.

16. A valve comprising:

a valve body having an inlet portion and an outlet portion, and a downstream section;

a seat between the inlet portion and the outlet portion;

a poppet proximate the seat, wherein the poppet is adapted to modulate fluid flow between the inlet portion and the outlet portion;

wherein the downstream section is between the seat and an outlet of the valve, and wherein the downstream section is adapted to direct fluid flow, reduce cross flow interference, and allow for substantially parallel fluid flow jets at a majority of the inlet portion and the outlet portion when fluid is flowing through the valve.

17. A valve as in claim **16** wherein the downstream section comprises a general torus and conical shape.

18. A valve as in claim **16** wherein the downstream section comprises an expanding section having a general conical shape.

19. A valve as in claim **16** wherein the downstream section comprises a contracting section having a general curvilinear shape.

20. A valve as in claim **16** wherein the poppet further comprises a shaped portion downstream of the seat, wherein the shaped portion is adapted to direct fluid flow, reduce cross flow interference, and allow for substantially parallel fluid flow jets at a majority of the inlet portion and the outlet portion when fluid is flowing through the valve.

* * * * *