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(54) Benævnelse: **Selvrensende dobbelt blokerings- og udluftningsventil**

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DESCRIPTION

BACKGROUND

[0001] Double block and bleed valves are commonly used in the oil and gas industry. Also known as a DBB plug valves, the DBB valve provides the ability to simultaneously block upstream and downstream flows while also providing the ability to bleed off fluid from the downstream side of the valve. Commonly used in a variety of applications, the DBB valve is an effective mechanism for isolating or blocking fluid flow through a system.

[0002] As known to those skilled in the art, a DBB valve includes a valve body and a rotatable plug such as depicted in FIGS 1-2. Rotation of the plug from a first closed position to a second open position allows for fluid flow through the valve by aligning a central passage in the plug with the inlet and outlet of the valve. As depicted in FIGS 1-2, when in the open position, the dimensions of the plug closely conform to the interior of the valve thereby providing efficient flow through the plug with little to no fluid loss to the interior of the valve. As known to those skilled in the art, slips (not shown) carrying resilient seals retract away from the valve body as the plug transitions from the closed to the open configuration. With the plug in the open position, rotation of the hand wheel will close the valve by rotating the plug and moving the plug downward resulting in obstruction of the valve body by the plug and outwardly expanding slips carried by the plug. The slips force the resilient seal against the valve body over the inlet and outlet thereby providing a positive closure of the valve to fluid flow. In order to accommodate the downward movement of the plug, the design of the valve body requires a cavity beneath the plug. Over time, the cavity fills with sediment, debris or sludge. The buildup of sediment, debris or sludge in the cavity will eventually preclude smooth operation of the valve and may lead to failure of the valve.

[0003] US 1473210 A discloses a valve. CN 2806913 Y discloses a full-sealing plug valve. US 5,181,539 discloses a plug according to the preamble of claim 1.

SUMMARY

[0004] The plug of the invention is defined by the features of claim 1. Further aspects of the invention are provided in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005]

Figure 1 depicts a side cut away view of a prior art valve.

Figure 2 depicts a side cut away view of a prior art valve showing the configuration of a conventional plug arrange to permit fluid flow through the valve.

Figure 3 is a top view of a valve incorporating the improvements disclosed herein.

Figure 4 is a side cut away view of the valve depicted in Figure 3 taken along lines 4-4.

Figure 5 is a side cut away view of the valve depicted in Figure 3 taken along lines 5-5.

Figure 6 is a detail view of Detail Area 6 in Figure 4.

Figure 7 is a detail view of Detail Area 7 in Figure 4.

Figure 8 depicts an embodiment of the present invention wherein the fluid diverting lip has been omitted from the plug.

Figure 8A depicts an enlarged detail view of the gap defining the outlet for the second continuous flow path.

Figure 8B depicts an enlarged detail view of the gap defining the inlet for the second continuous flow path.

Figure 8C depicts an enlarged detail view of the top of the outlet gap.

Figure 9 provides a comparison of a prior art plug, FIG. 9A, to embodiments of FIGS. 9B and 9C of the improved valve disclosed herein.

Figure 10 depicts the level of sediment following the analysis of the plug depicted in FIG. 9A with the dashed line representing pre-test sediment level.

Figure 11 depicts fluid pressure within a valve utilizing the plug depicted in FIG. 9A with flow from right to left through the valve at a rate of 2m/s.

Figure 12 depicts fluid velocity through a valve utilizing the plug depicted in FIG. 9A with flow from right to left through the valve at a rate of 2m/s.

Figure 13 depicts velocity vectors at 5 s analysis time, i.e. 5 seconds after initiation of fluid flow, in a valve utilizing the plug depicted in FIG. 9A.

Figure 14 depicts the level of sediment remaining after evaluating the plug depicted in FIG. 9B.

Figure 15 depicts fluid pressure within a valve using the plug depicted in FIG. 9B, i.e. lacking fluid diverting lips, with flow from right to left through the valve at a rate of 2m/s.

Figure 16 depicts fluid velocity through a valve using the plug depicted in FIG. 9B with flow from right to left through the valve at a rate of 2m/s.

Figures 17, 17A and 17B depicts velocity vectors at 5 s analysis time, i.e. 5 seconds after initiation of fluid flow, in a valve utilizing the plug depicted in FIG. 9B.

Figure 18 depicts fluid pressure taken 1.875 seconds after initiation fluid flow within a valve utilizing the plug depicted in FIG. 9C, i.e. a plug having fluid diverting lips, with flow from right to left through the valve at a rate of 2m/s.

Figure 19 depicts fluid velocity taken 1.875 seconds after initiation fluid flow through a valve utilizing the plug depicted in FIG. 9C with flow from right to left through the valve at a rate of 2m/s.

Figures 20 and 20A depict fluid vector analysis taken 1.875 seconds after initiation fluid flow through a valve utilizing the plug depicted in FIG. 9C.

Figure 21 depicts the level of sediment remaining after evaluating the plug depicted in FIG. 9C after 1.875 seconds of fluid flow.

Figures 22A-22C provide a comparison of the sediment flushing capabilities of the plugs depicted in FIGS. 9A, 9B and 9C taken after 5 seconds of fluid flow at a rate of 2m/s.

DETAILED DESCRIPTION

[0006] This disclosure provides an improved self-flushing double block and bleed valve 50. Referred to herein as DBB valve 50 or valve 50. With reference to FIGS. 4 and 5, DBB valve 50 includes conventional components such as a hand wheel 46, worm shaft 10 and upper stem 03. Table 1 below identifies the primary components of DBB valve 50 as depicted by FIGS. 4-8. Since the configuration, components and operation of a double block and bleed valve such as that depicted in FIGS. 1-2 (prior art) are well known, the following discussion will focus on those components that provide the self-flushing characteristics to the improved DBB valve 50.

Table 1

Element Name	Element No.
Operator housing	1
O-ring	2
Upper stem	3
lower stem roller	4
indicator shaft assembly	6
circlip/angle adjust ball bearing	8
circlip	9
worm shaft	10
taper roller bearing	11
taper roller bearing	12
gear assembly	13

Element Name	Element No.
Key/worm gear	14
key/worm gear	15
bearing cap	17
hex screw	18
screw	19
protector adaptor	20
ball bearing	21
hex screw	22
hex nut	23
body	24
stud	25A
stud	25
bearing	26
hex nut	27
cap-upper	28
O-ring	29
gasket	30
plug (FIG. 1)	31
slip	32
cap-lower	33
seal packing	34
o-ring	35
o-ring	36
gland packing	37
stud	38
hex nut	39
pin	40
flag	41
protector tube	43
protector cap	44
half moon key	45
hand wheel	46
washer	47
hex bolt	48
guide pin	49

Element Name	**Element No.**
Valve	50
Valve body	60
Valve body inlet opening	62
Valve body outlet opening	64
Lower cap	66
Interior surface of the lower cap	68
Upper cap	72
Central opening in upper cap	74
Rotatable plug (FIGS. 4-9)	80
Top stem	82
Bottom portion of the rotatable plug	84
First opening or inlet of plug	86
Second opening or outlet of plug	88
Central passage through plug	90
Continuous flow path through valve body and plug	92
First upwardly projecting lip	94
Lowest portion of central passage of plug	96
Second upwardly projecting lip	98
Second continuous flow path	102
Cavities	104
Gap	106

[0007] As depicted in FIGS. 4 and 5, DBB valve 50 includes a valve body 60. Valve body 60 defines or carries an inlet opening 62 and defines or carries an outlet opening 64. Valve body 60 carries lower cap 66 secured to the bottom of valve body 60 and upper cap 72 secured to the top of valve body 60The alignment of a rotatable plug 80 determines the functionality, i.e. open or closed, of DBB valve 50. Rotatable plug 80 has a top stem 82 passing through a central opening 74 of upper cap 72. Top stem 82 is pinned to or otherwise secured to upper stem 3. Thus, as known to those skilled in the art, rotation of hand wheel 46 controls movement of rotatable plug 80. Rotatable plug 80 further has a first opening 86 and a second opening 88. Openings 86 and 88 define a central passage 90 through rotatable plug 80.

[0008] Hand wheel 46 controls movement and alignment of plug 80. Alignment of central passage 90 with inlet opening 62 and an outlet opening 64 provides a first continuous fluid path 92 through DBB valve 50. Rotation of hand wheel 46 will transition plug 80 through ninety degrees of movement and move plug 80 downward thereby blocking fluid flow through plug 80.

Upon seating of plug 80 at the lowest point, further rotation of hand wheel 46 will extend the slips (not shown) thereby sealing valve inlet 62 and outlet 64. With plug 80 turned to block fluid flow through DBB valve 50, a singular annular cavity 104 exists below plug 80 in lower cap 33.

[0009] Cavity 104 frequently collects sediment, debris and sludge. Over time, cavity 104 will fill sufficiently to preclude efficient operation of DBB valve 50. Disassembly and reassembly of DBB valve 50 to clean cavity 104 requires halting operations of the line served by DBB valve 50.

[0010] To alleviate the deposition of material in cavity 104, plug 80 has been modified to provide for continuous flushing of cavity 104 during operation of valve 50. See FIG. 9C. In one embodiment depicted in FIGS. 8-8c, openings or gaps 106 between plug 80 and valve body 50 have been provided. Gaps 106 at each end of continuous flow path 102 are depicted in FIGS. 8a and 8b. FIG. 8c depicts a top view of the gap depicted in FIG. 8a; however, the top view of FIG. 8b would appear identical to that of FIG. 8a. Gaps 106 allow a portion of the fluid flowing through central passage 90 to enter into cavity 104 during operation of valve 50. As shown in FIG. 5, gaps 106 permit the continuous flow of fluid through a second continuous flow path 102 beneath plug 80. During fluid flow through valve 50, the continuous flow of fluid through second continuous flow path 102 carries debris out of cavity 104 and transports the debris out of valve 50 through valve outlet 64.

[0011] Figure 4 depicts a further improvement to plug 80. To improve fluid flow through second continuous flow path 102, first opening 86 of plug 80 may further carry a first upwardly projecting lip 94 associated with gap 106 at the lowest portion 96 of central passage 90, i.e. at bottom portion 84 of plug 80 adjacent to inlet 86. Additionally, second opening 88 of plug 80 carries a second upwardly projecting lip 98 associated with gap 106 at the lowest portion 96 of central passage 90, i.e. at bottom portion 84 of plug 80 adjacent to outlet 88. Upwardly projecting lips 94, 98 may be in the form of a flange or protrusion or other extension from the lowest portion 96 of central passage 90. Thus, gaps 106 and projecting lips 94, 98 cooperate to provide second continuous fluid path 102 when plug 80 is in alignment with valve body 60 to provide fluid flow through central passageway 90. In general, lips 94 and 98 will extend above lower portion 96 of central passageway 90 by about 3.8mm (0.15 inch) to about 76mm (3.0 inch). More preferably, lips 94 and 98 will extend above lower portion 96 of central passageway 90 by about 6.1mm (0.24 inch) to about 64mm (2.5 inch). The distance lips 94 and 98 extend above lower portion 96 will vary with valve size. Typically, lips 94 and 98 extend into path 92 a distance sufficient to divert approximately 2% to about 5% of the fluid passing through path 92 into and through fluid path 102.

[0012] As depicted in FIG. 6, gap 106 is defined by valve body 60 and a recess in the lowest portion 96 of central passage of plug 80. The cooperation of gaps 106 in conjunction with lips 94, 98 must provide for sufficient fluid flow through second continuous fluid path 102 to clear cavity 104 of debris, sediment or sludge. Thus, lips 94 and 98 cooperate with gaps 106 to ensure adequate fluid flow along second continuous fluid path 102 and through cavity 104 to dislodge and remove debris, sediment or sludge. For purposes of this discussion, fluid flow passes through valve 50 from right to left. Under these conditions, lip 94 acts as the entrance lip and lip 98 the exit lip. Lip 94 captures a sufficient amount of fluid to create the second continuous fluid path 102 through cavity 104. Lip 98, acting as the exit lip, aid in mixing of the second continuous fluid path 102 back into first fluid path 92 thereby carrying debris, sediment or sludge out of cavity 104 into first fluid path 92. Although described herein with regard to flow from right to left, valve 50 will also provide the desired self-cleaning function under conditions of fluid flow from left to right. Under left to right flow conditions, lip 98 acts as the inlet lip and lip 94 as the exit lip.

[0013] In general, gaps 106 will have a depth of about 4.8mm (0.19 inch) to about 76mm (3 inches) (dimension X) from the edge of plug 80 and a width of about 13mm (0.5 inches) to about 130mm (5 inches) (dimension Y) depending on the size of the valve. Thus, larger valves will have larger dimensions for gap 106 to ensure adequate flow through path 102 to maintain cavity 104 substantially free of sediment.

[0014] Typically, each lip 94 and 98 will define a canopy or scoop, i.e. an upwardly and forwardly projecting curved flange having a back-wall and sidewalls that connect to the lowest portion 96 of plug 80 and at least overlap or extend above gap 106. As depicted in FIG. 5, lip 94 will direct a consistent volume of fluid into second continuous flow path 102 and optional lip 98 in cooperation with gap 106 defines the exit port for fluid exiting second continuous path 102.

[0015] FIGS. 10-22 demonstrate the improvement provided by the embodiments of the present invention over the prior art. FIG. 9A depicts a prior art plug. FIG. 9B depicts a plug 80 with gaps 106. FIG. 9C depicts plug 80 with lips 94 and 98 adjacent to gaps 106. The dashed line in FIG. 10 represents the level of sediment prior to each flushing test.

[0016] Each plug depicted in FIGS. 9A-9C was tested to determine its ability to clear sediment at a level as depicted in FIG. 10. Testing of each plug was carried out by placing the indicated level of sediment in cavity 104 and flowing diesel (density of about 0.812kg/m^3) through the open valve at a flow velocity of 2 m/s and a pressure of 2.0MPa (290 psi) as measured at the entrance of the valve. Downstream pressures and velocities were determined using computational fluid dynamics as depicted in FIGS. 11-21. Additionally, fluid velocity, as determined by computational fluid dynamics, through continuous path 102 was measured and depicted. Thus, in addition to testing the ability to clear sediment, pressure and the resulting flow rate testing data provides an understanding of the ability of each plug to clear sediment from cavity 104.

[0017] As demonstrated by FIGS. 11-14, under normal operational conditions, the prior art plug precludes fluid access to cavity 104. In particular, FIGS. 11 and 12 reflect very low pressure and an indicated zero velocity value along path 102. Additionally, the vector velocity values depicted in FIG 13 demonstrates the lack of flow through cavity 104 within the prior art valve. Thus, buildup of debris in cavity 104 will continue during operation, i.e. opening and closing, of the prior art valve using the plug of FIG. 9A.

[0018] Similarly, as indicated in FIGS. 15 and 16, under the operational conditions, merely removing a section of central passage from plug 80 to provide an opening or gap 106 did not significantly increase fluid flow through cavity 104. As depicted in FIG. 15, cavity 104 experienced very little increase in fluid pressure during operation of valve 50. Further, FIG. 16 demonstrates that fluid flow through the valve body of FIG. 9B did not experience significant increase fluid velocity along flow path 102. The results of FIG. 16 correspond to the vector analysis results depicted in FIGS. 17, 17A and 17B. As reflected in FIGS. 17-17B, fluid flow does not reach the valve base and does not adequately flow through cavity 104. Thus, the described operating conditions removed very little debris from cavity 104 when the valve operated with the plug depicted in FIG. 9B.

[0019] As reflected by FIGS. 18-21, the embodiment of FIG. 9C provided the best results. Embodiment 9C includes the further modification of upwardly projecting lips 94, 98 in combination with gap 106. Lip 94, associated within the inlet side of plug 80, is configured as a scoop. Thus, lip 94 effectively captures and provides continuous flow of fluid through path 102.

[0020] As reflected in FIG. 18, second continuous flow path 102 experienced the greatest increase in fluid pressure when using the embodiment of FIG. 9C. Additionally, flow path 102 experienced the greatest increase in flow rate. Further, FIG. 18 demonstrates the increased fluid velocity along path 102 through cavity 104. Finally, FIGS. 20 and 20A depict the improved vector velocities of fluid passing along path 102 through cavity 104. Thus, the fluid stream provided by lips 94 and 98 will better entrain and remove sediment from cavity 104. As depicted in FIG. 21, substantially all sediment was removed from cavity 104 when valve 50 was operated using plug 80 of FIG. 9C.

[0021] FIGS. 22A, 22B and 22C provide a side-by-side comparison of the capabilities of plugs 80 depicted in FIGS. 9A, 9B and 9C respectively. As shown in FIG. 22, prior art plug 80 depicted in FIG. 9A failed to clear any sediment from cavity 104. Modified plug 80 of FIG. 9B removed a small portion of sediment but failed to provide adequate clearing. Finally, plug 80 of FIG. 9C modified with gap 106 and upwardly projecting lip 94 cleared substantially all sediment from cavity 104.

[0022] Other embodiments of the present invention will be apparent to one skilled in the art. As such, the foregoing description merely enables and describes the general uses and methods of the present invention. Accordingly, the following claims define the true scope of the present invention.

REFERENCES CITED IN THE DESCRIPTION

compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US1473210A [0003]
- CN2806913Y [0003]
- US5181539A [0003]

PATENTKRAV

1. Prop (80), der er konfigureret til anvendelse i en dobbelt blokerings- og udluftningsventil (50), hvilken prop (80) omfatter:

en første åbning (86) og en anden åbning (88), der definerer en central passage, hvilken central passage (90) tilvejebringer en kontinuerlig fluidbane (92) gennem proppen (80);

hvor den første propåbning (86) har et første mellemrum (106) ved den laveste del (84) af den første åbning (86);

hvor den anden propåbning (88) har et andet mellemrum (106) ved den laveste del (84) af den centrale passage (90);

kendetegnet ved, at den første propåbning (86) bærer en første opadvendende læbe stødende op til det første mellemrum; og

ved, at den anden propåbning (88) bærer en anden opadvende læbe (94) stødende op til det andet mellemrum (106).

2. Prop (80) ifølge krav 1, hvor den første og den anden opadvendende læbe (94) strækker sig fra ca. 3,8 mm (0,15) tomme til ca. 76 mm (3,0 tommer) ind i den kontinuerlige fluidbane (92).

3. Prop (80) ifølge krav 1, hvor den første opadvendende læbe (94) strækker sig fra ca. 6,4 mm (0,25 tomme) til ca. 64 mm (2,5 tomme) over den laveste del (84) af den første åbning (86).

4. Prop (80) ifølge krav 1, hvor den første opadvendende læbe (94) strækker sig en tilstrækkelig afstand ind i den første fluidbane (92) til at omlede ca. 2 % til ca. 5 % af et fluid, der passerer gennem den første fluidbane (92).

5. Prop (80) ifølge krav 1, hvor det første og det andet mellemrum (106) vil have en dybde på ca. 4,8 mm (0,19 tomme) til ca. 76 mm (3 tommer) og en bredde på ca. 13 mm (0,5 tomme) til ca. 130 mm (5 tommer).

6. Prop (80) ifølge krav 1, hvor den første og den anden opadvendende læbe (94) er i form af en øse.

7. Ventil (50), der omfatter:

et ventillegeme (60), hvilket ventillegeme (60) definerer en indløbsåbning (62), og en udløbsåbning (64);

en nedre kappe (66) fastgjort til bunden af ventillegemet (60), hvilken nedre kappe (66) har en indre overflade;

en øvre kappe (72) fastgjort til toppen af ventillegemet (60), hvilken øvre kappe (72) har en central åbning (74);

den øvre kappe (72), nedre kappe (66) og ventillegemet (60) definerer en kavitet, en prop (80) ifølge et hvilket som helst af de foregående krav placeret inde i kaviteten,

hvilken prop (80) endvidere omfatter en øvre stamme (82), der passerer gennem åbningen (74) i den øvre kappe (72);

hvilken prop (80) endvidere omfatter en bunddel (84);

hvor den centrale passage (90) af proppen (80), når den flugter med ventillegemeindløbsåbningen (62) og ventillegemeudløbsåbningen (64), tilvejebringer en første kontinuerlig fluidbane (92) gennem ventilen (50);

når den første propåbning (86) og den anden propåbning (88) åbninger flugter med ventillegemeindløbsåbningen (62) og ventillegemeudløbsåbningen (64), det første og det andet mellemrum (106) tilvejebringer fluidforbindelse med en anden kontinuerlig fluidbane (102), den anden kontinuerlige fluidbane (102) defineret af bunddelen (84) af proppen (80) og den indvendige overflade af den nedre kappe (66).

8. Ventil (50) ifølge krav 7, hvor, når den roterbare prop (80) er i den lukkede position, den roterbare prop (80) og den nedre kappe (66) definerer en kavitet (104), og hvor, når den roterbare prop (80) er i en åben position, den anden kontinuerlige fluidbane (102) passerer gennem kavitetens (104) område.

DRAWINGS

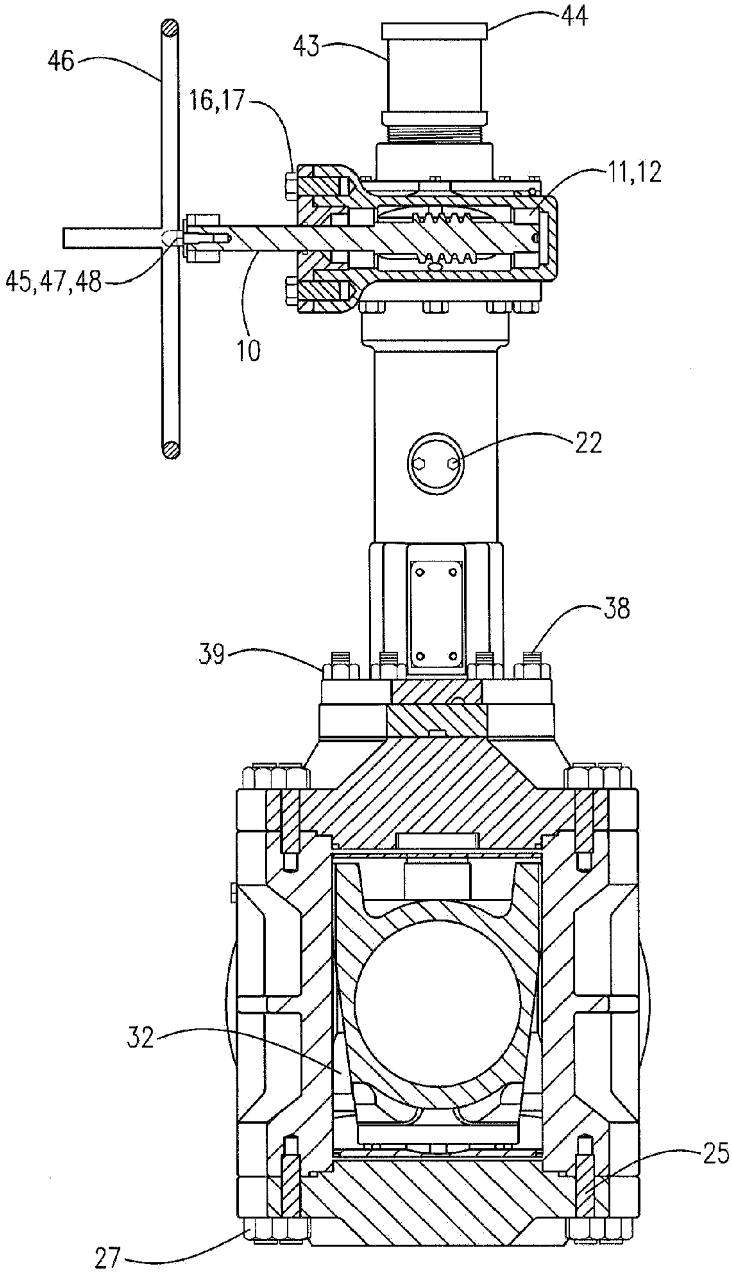

FIG. 1
PRIOR ART

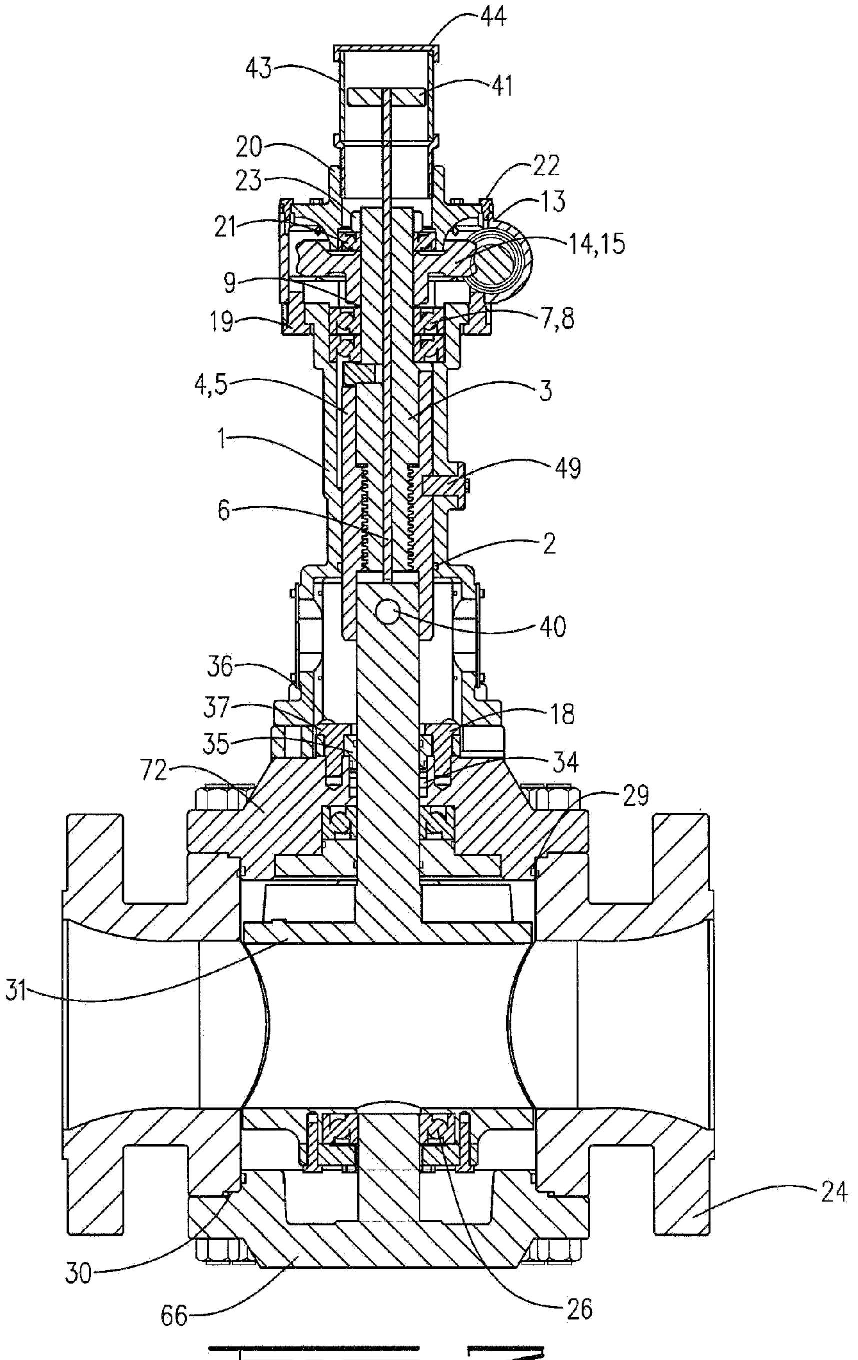

FIG. 2
PRIOR ART

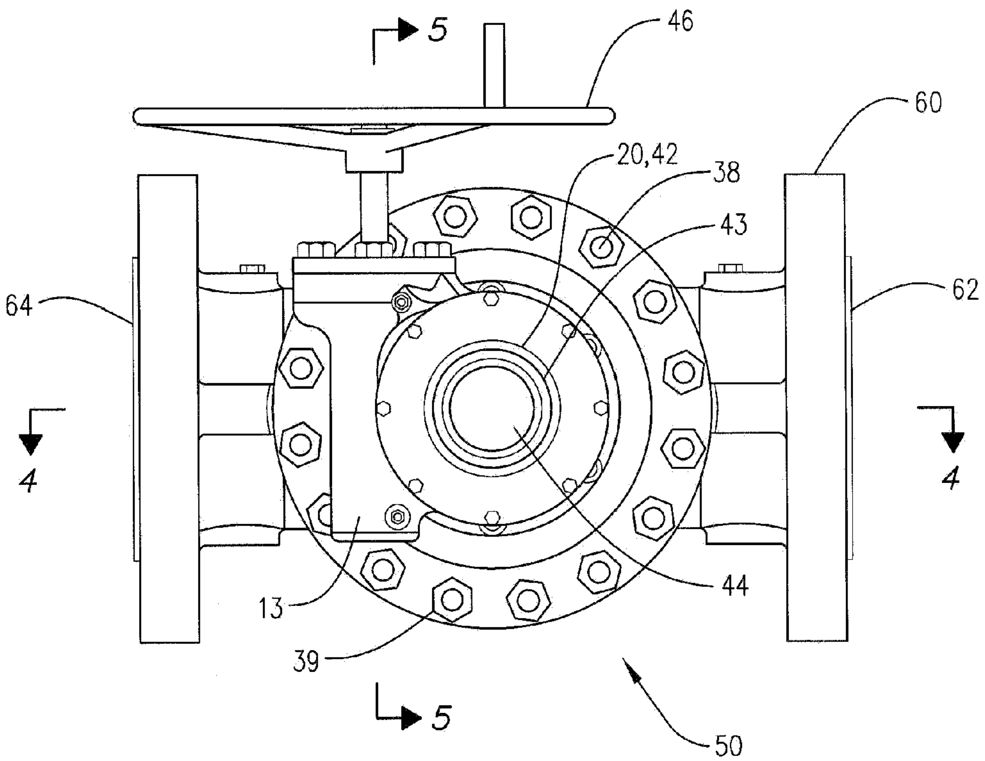

FIG-3

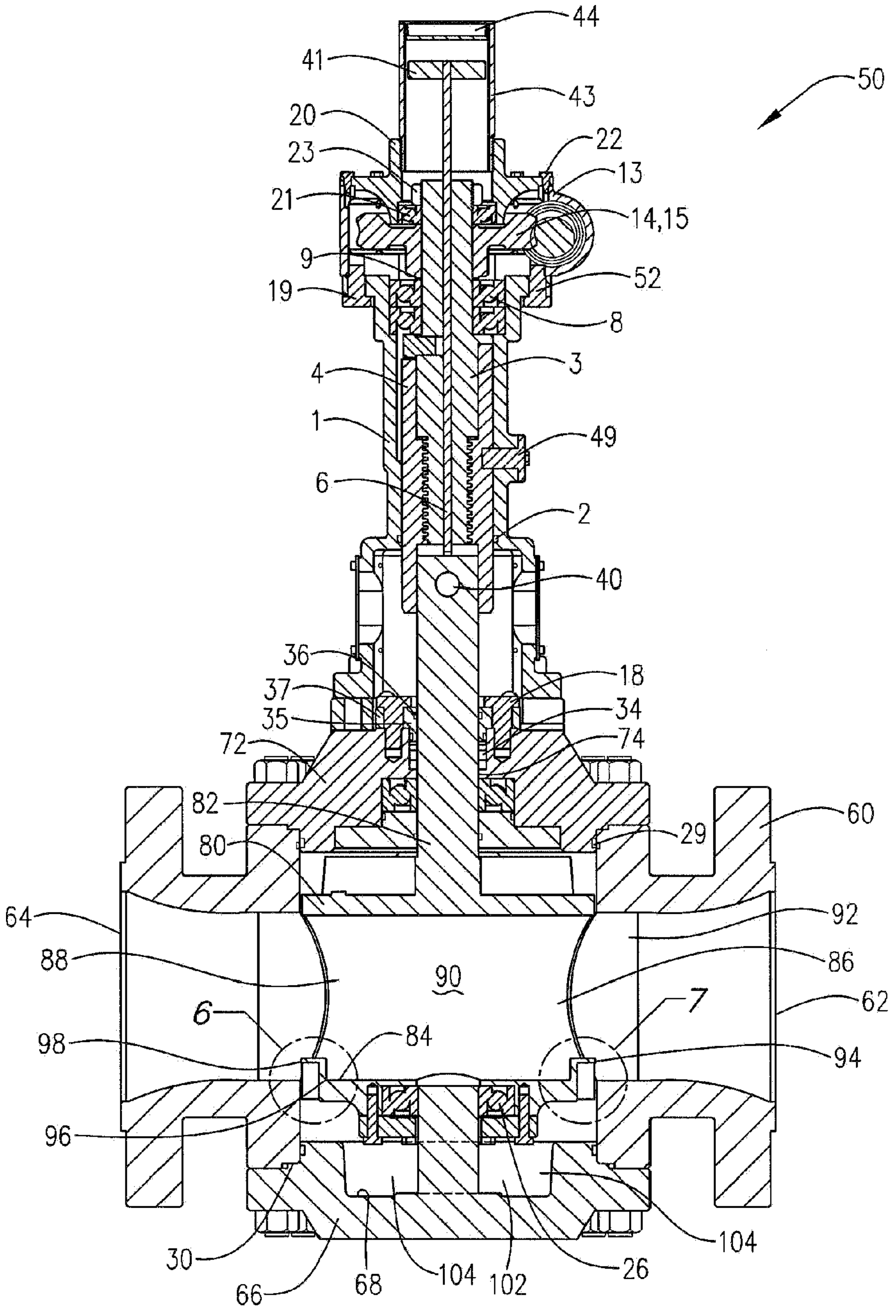
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FIG. 4

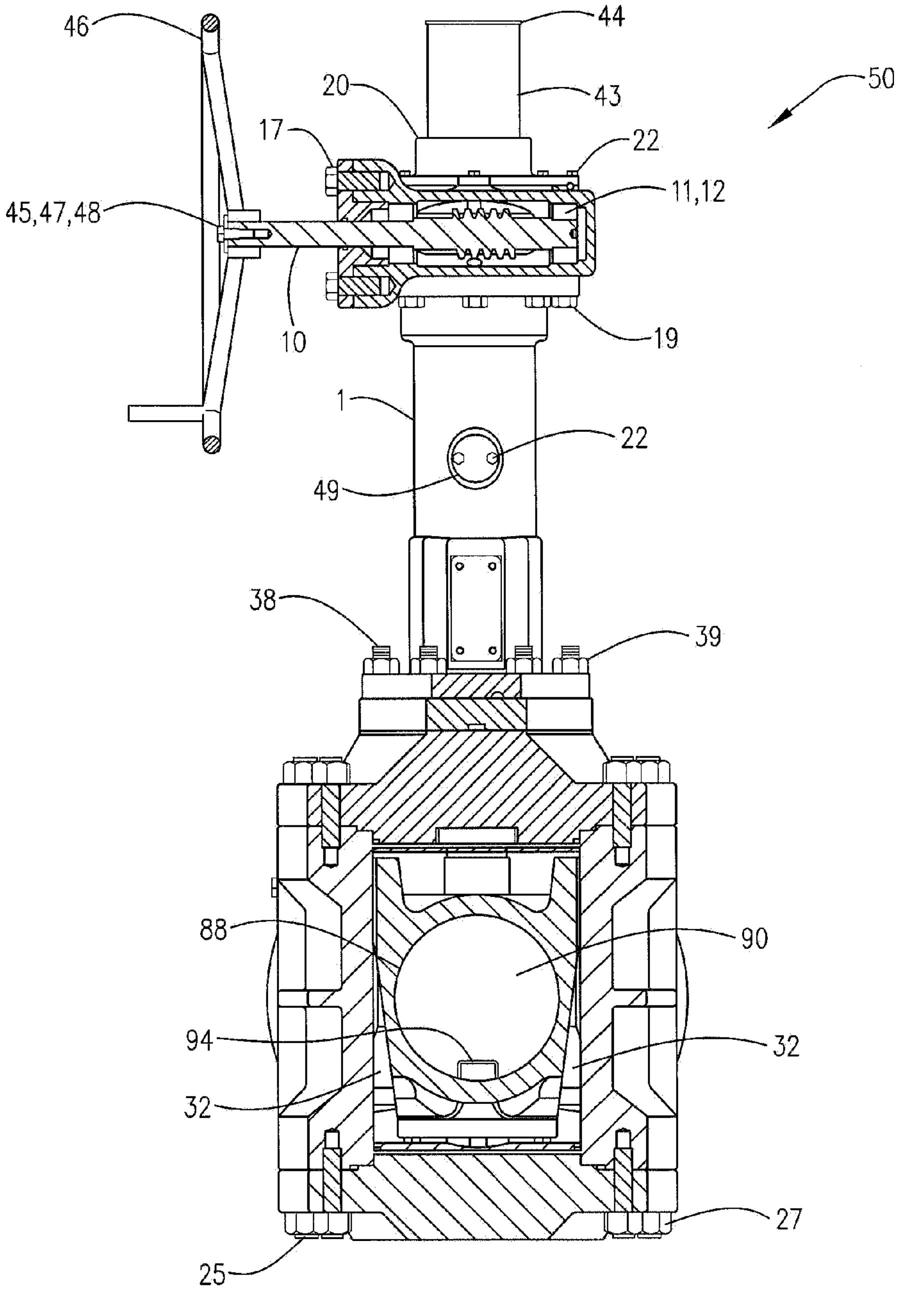
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FIG. 5

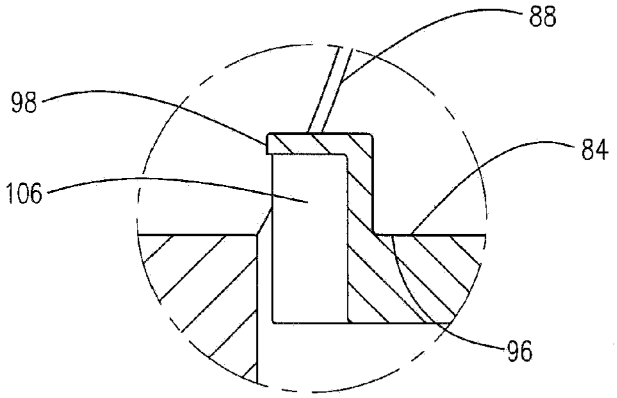


FIG. 6

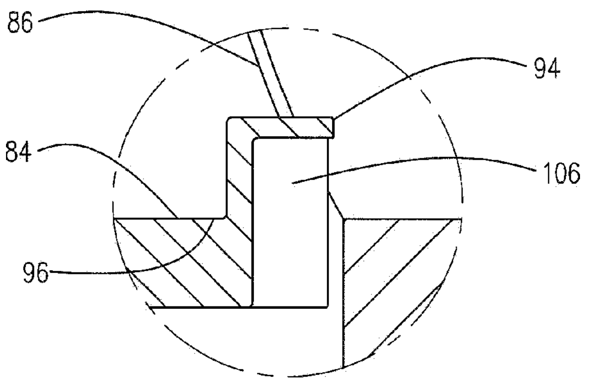
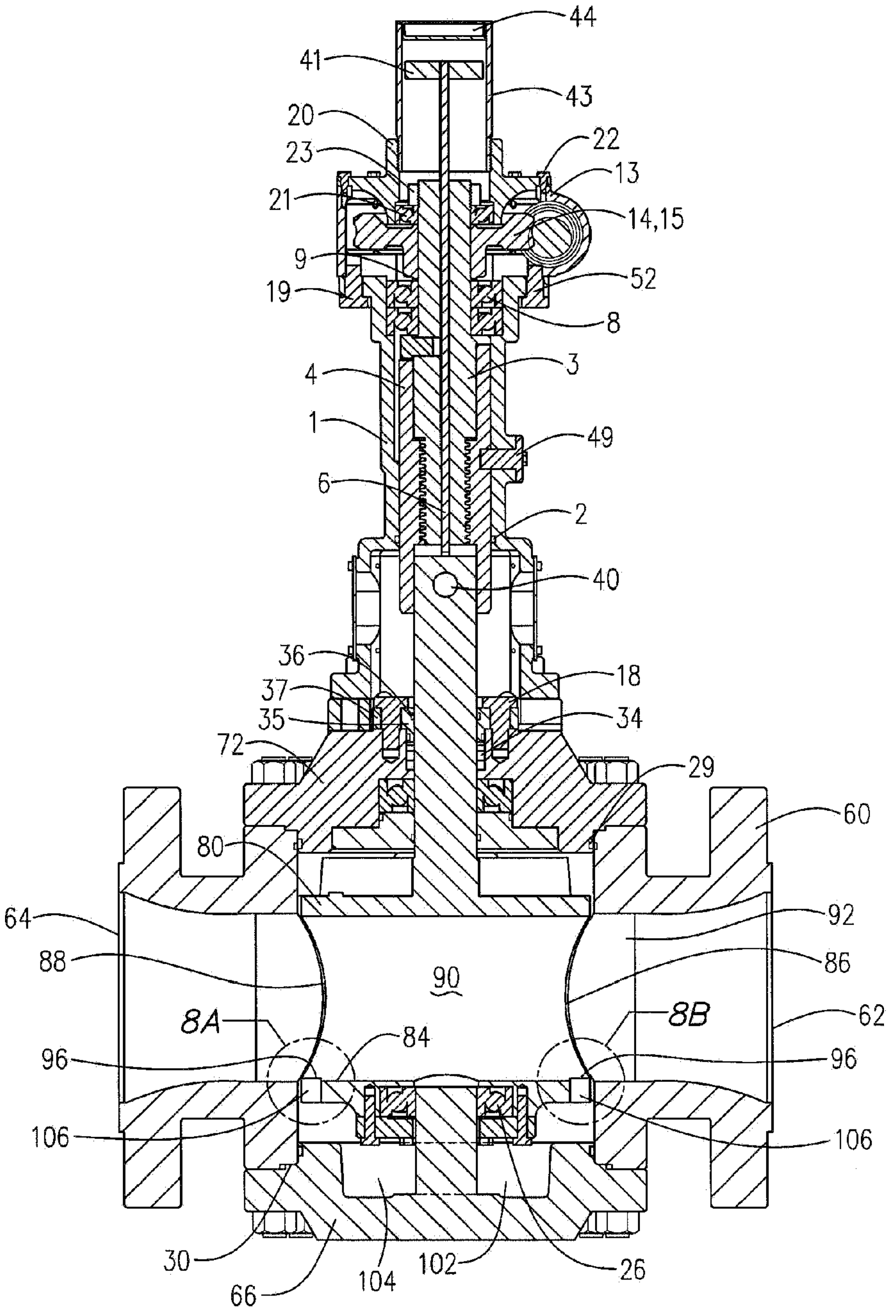


FIG. 7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29
60
80
64
92
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8A
8B
62
96
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106
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102
26

FIG. 8

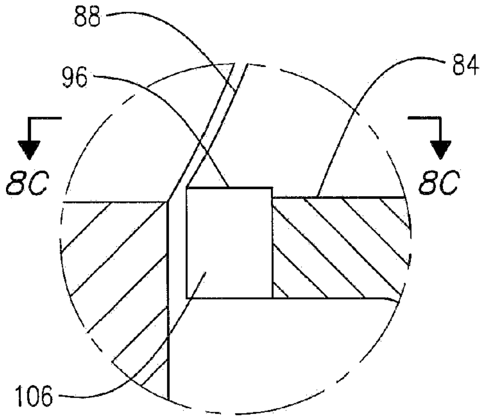


FIG- 8A

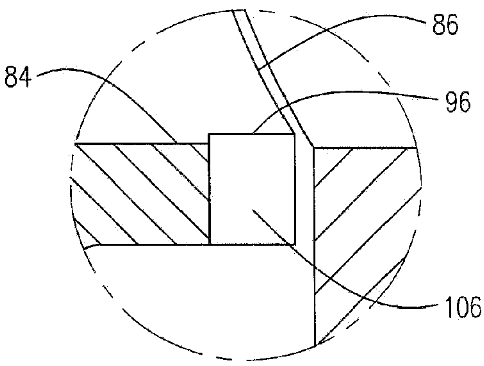


FIG- 8B

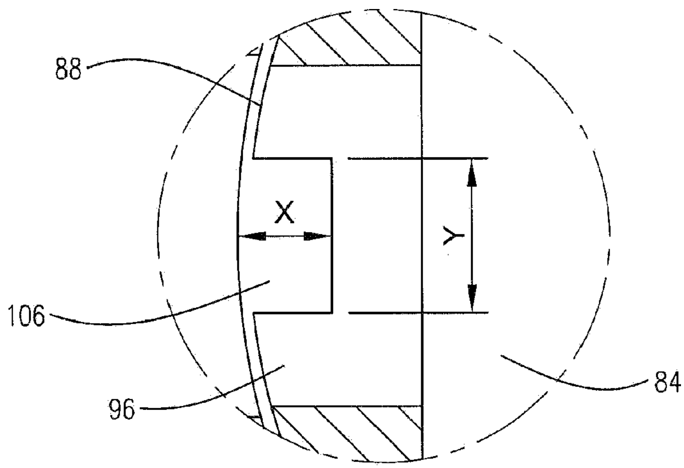


FIG- 8C

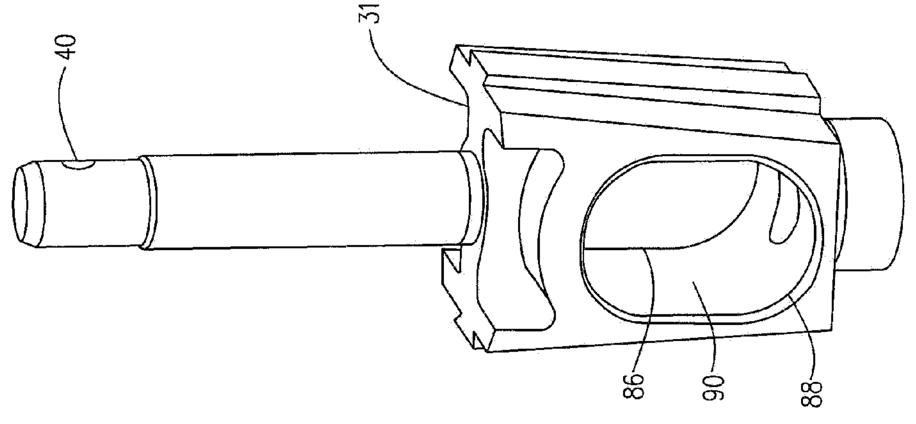


FIG. 3A
PRIOR ART

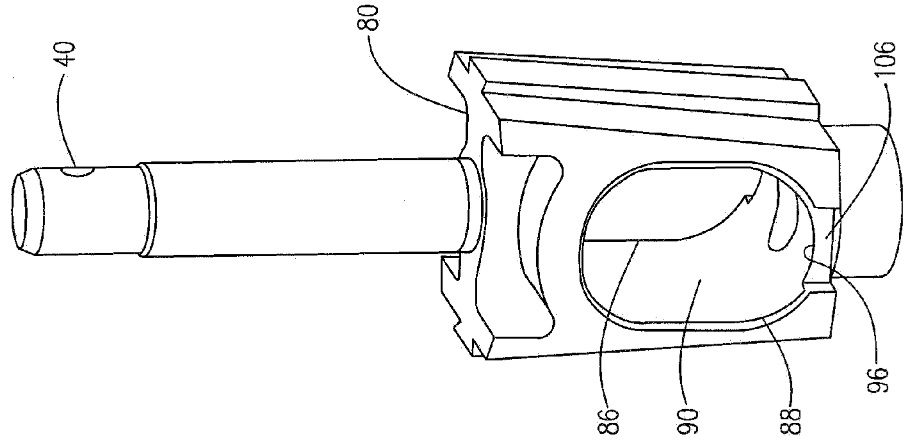


FIG. 3B

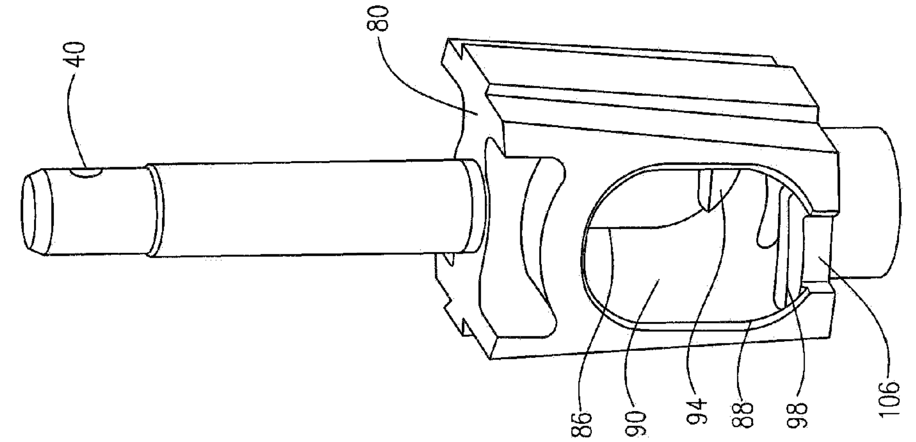
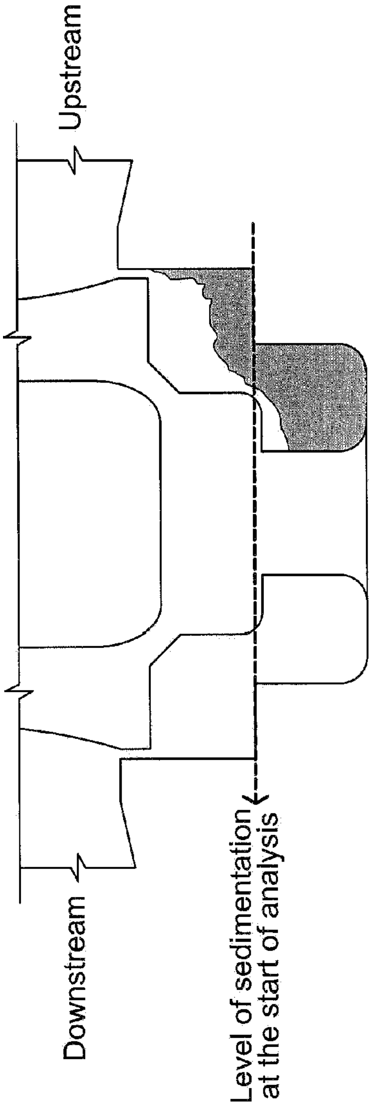


FIG. 3C


Upstream
Downstream
Level of sedimentation
at the start of analysis

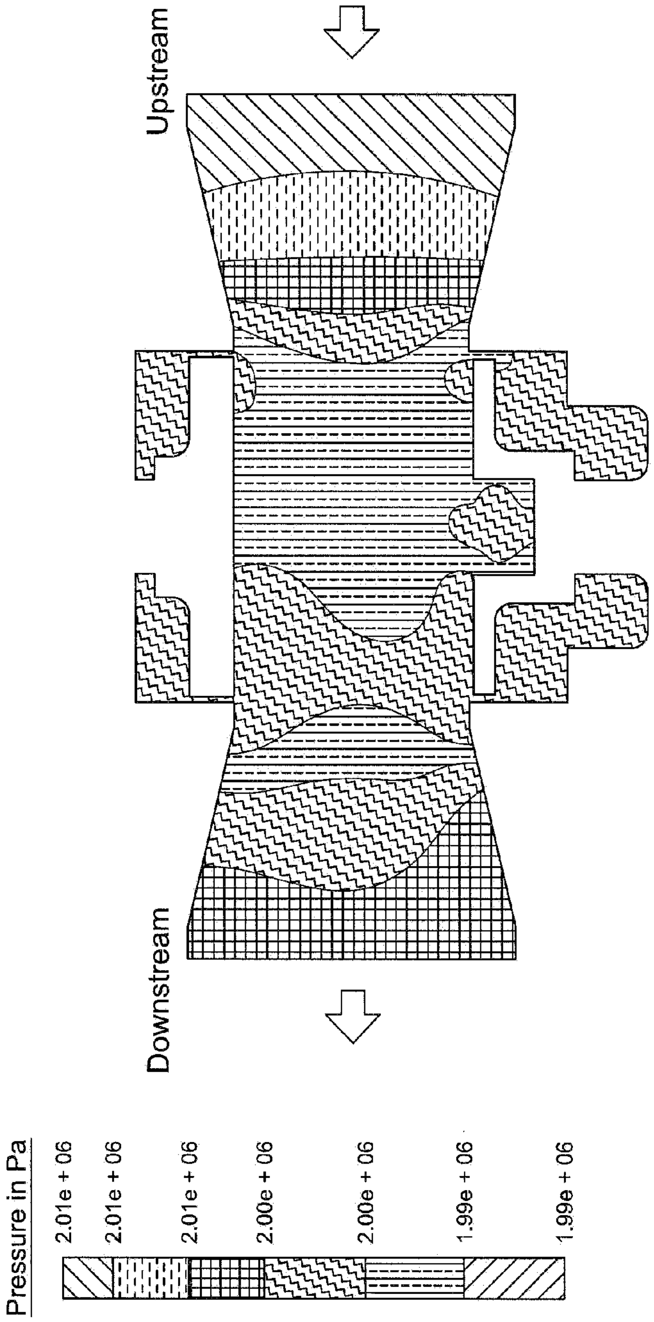


FIG. 1
PRIOR ART

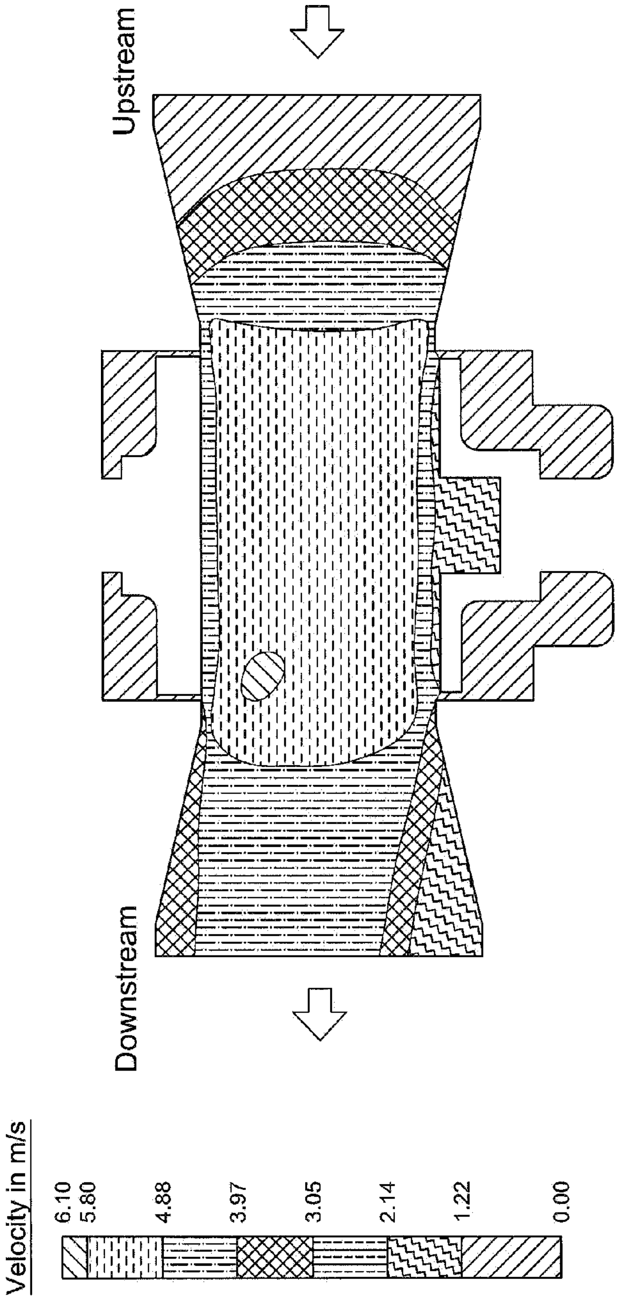


Fig. 12
PRIOR ART

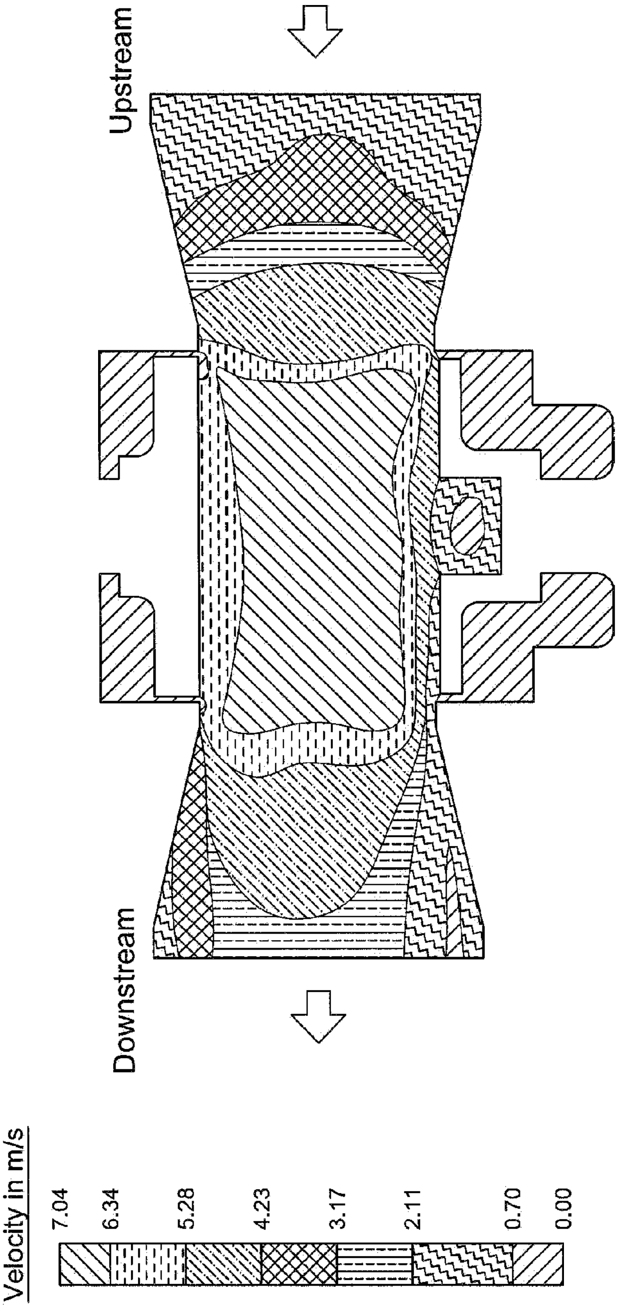

Upstream
Downstream
Velocity in m/s
7.04
6.34
5.28
4.23
3.17
2.11
0.70
0.00

FIG. 13

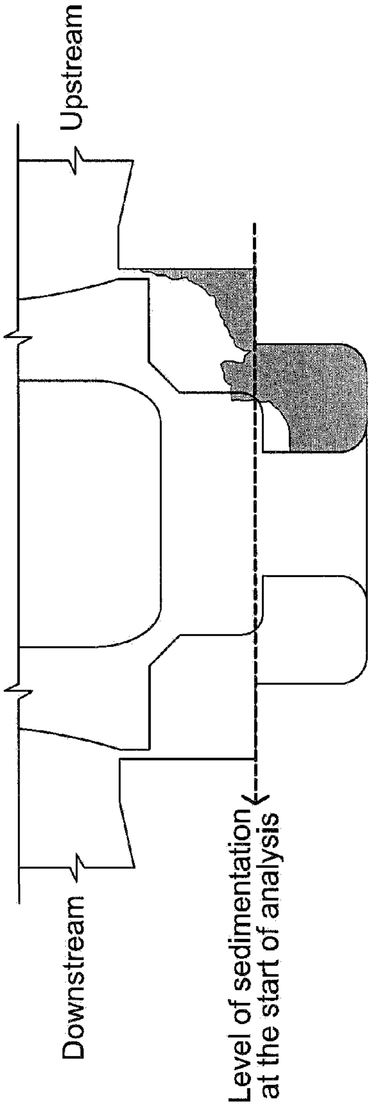

Upstream
Downstream
Level of sedimentation
at the start of analysis

FIG. 14

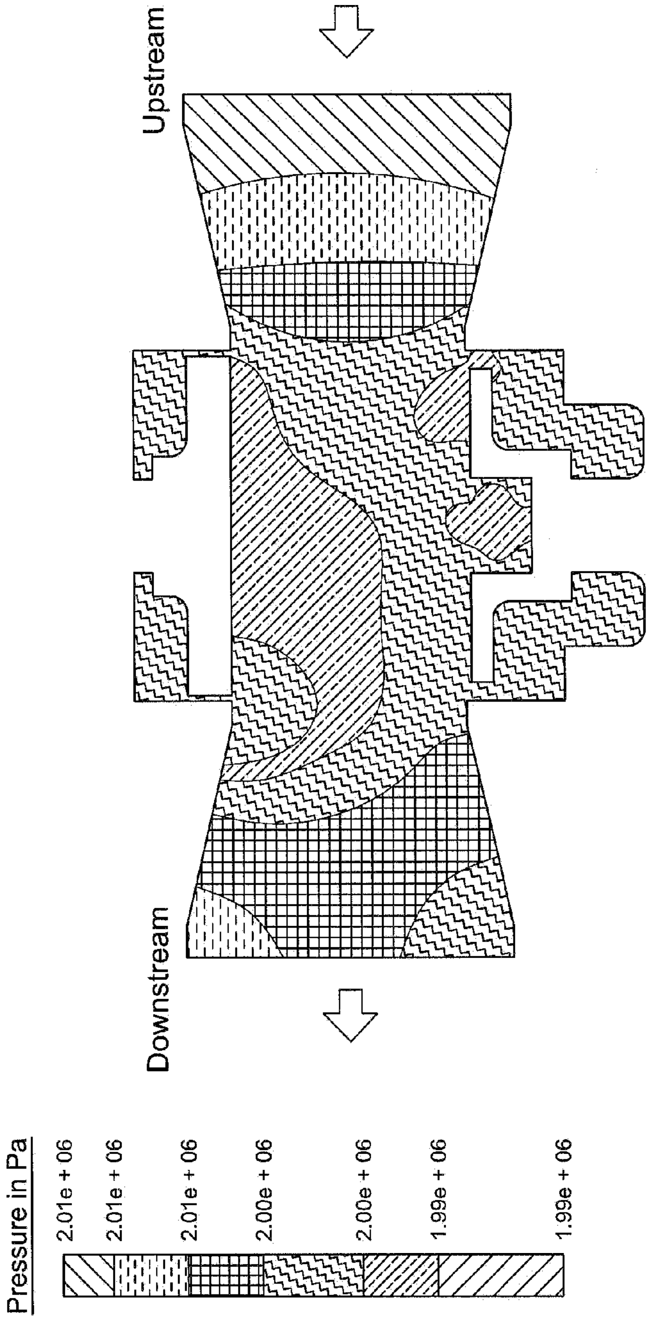
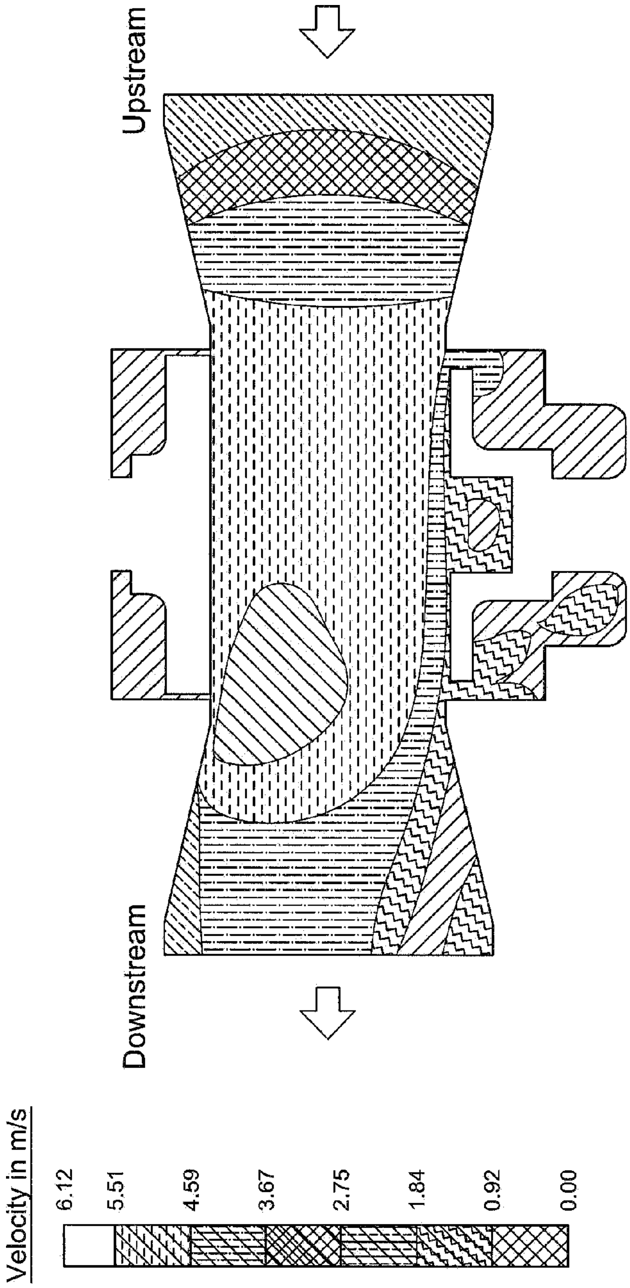

Upstream
Downstream
Pressure in Pa
2.01e + 06
2.01e + 06
2.01e + 06
2.00e + 06
2.00e + 06
1.99e + 06
1.99e + 06

FIG. 13



Upstream
Downstream
Velocity in m/s
6.12
5.51
4.59
3.67
2.75
1.84
0.92
0.00

FIG-13

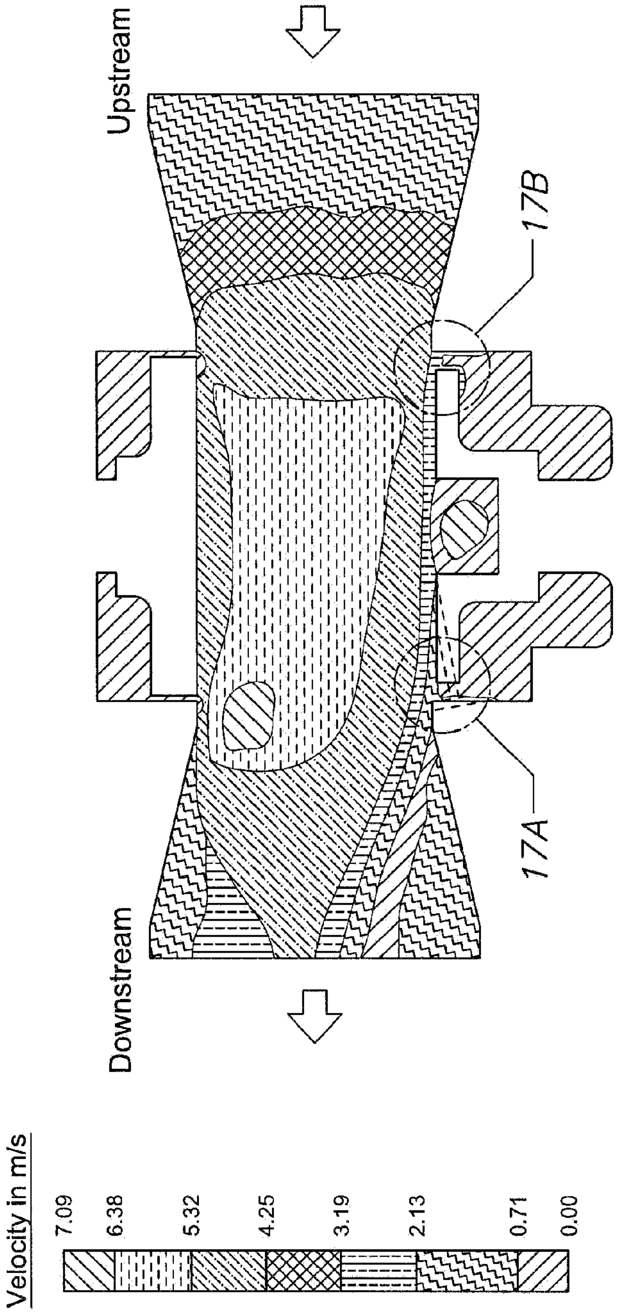

Upstream
Downstream
17B
17A
Velocity in m/s
7.09
6.38
5.32
4.25
3.19
2.13
0.71
0.00

FIG. 17

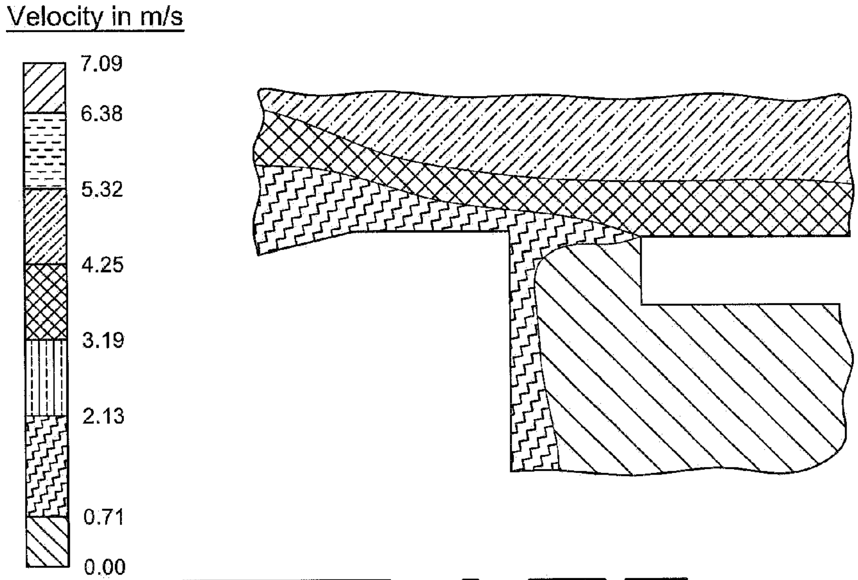


FIG. 17A

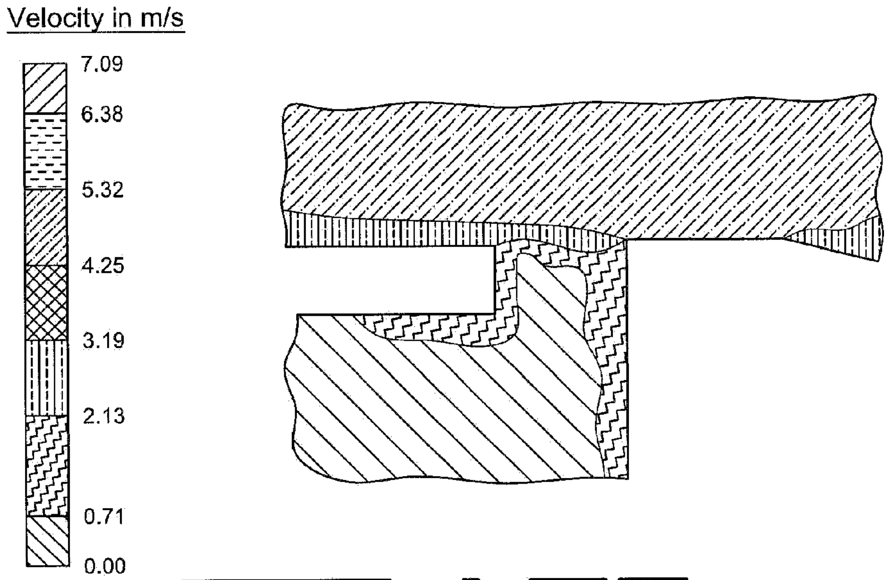
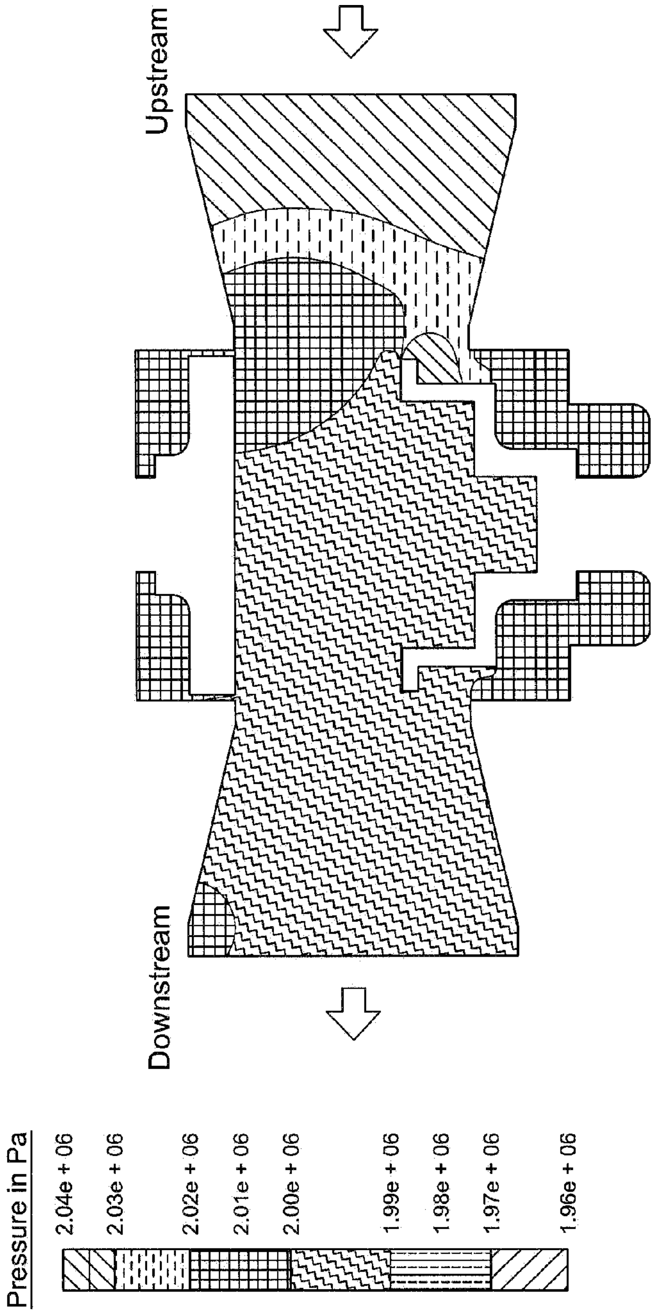


FIG. 17B


Upstream
Downstream
Pressure in Pa
2.04e + 06
2.03e + 06
2.02e + 06
2.01e + 06
2.00e + 06
1.99e + 06
1.98e + 06
1.97e + 06
1.96e + 06

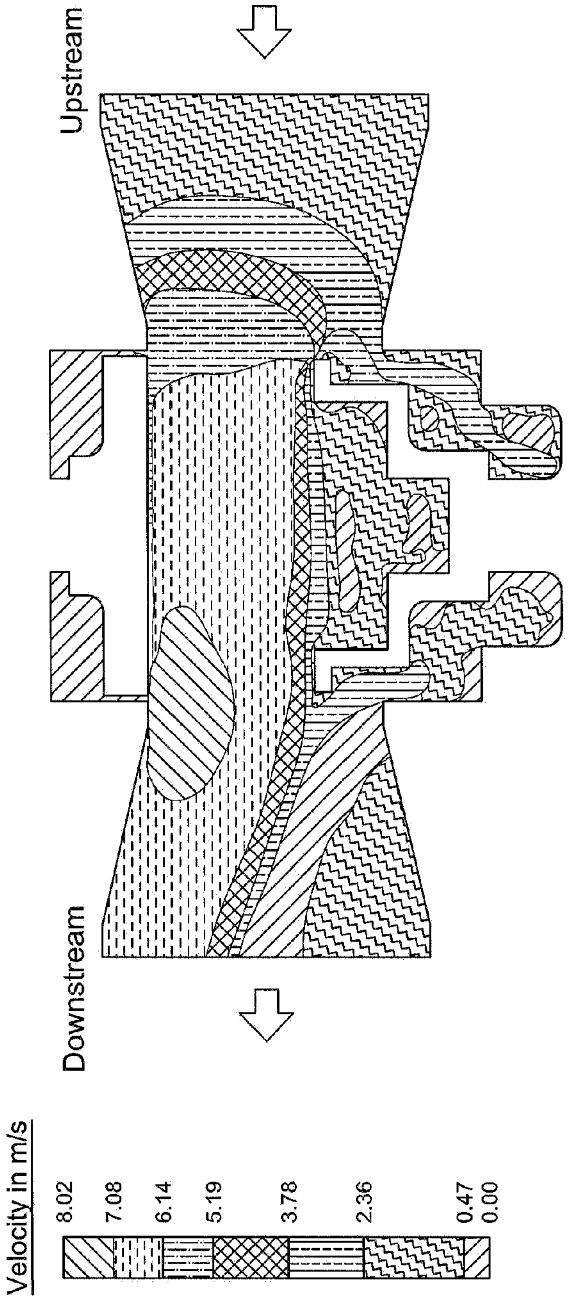

Upstream
Downstream
Velocity in m/s
8.02
7.08
6.14
5.19
3.78
2.36
0.47
0.00

FIG. 13

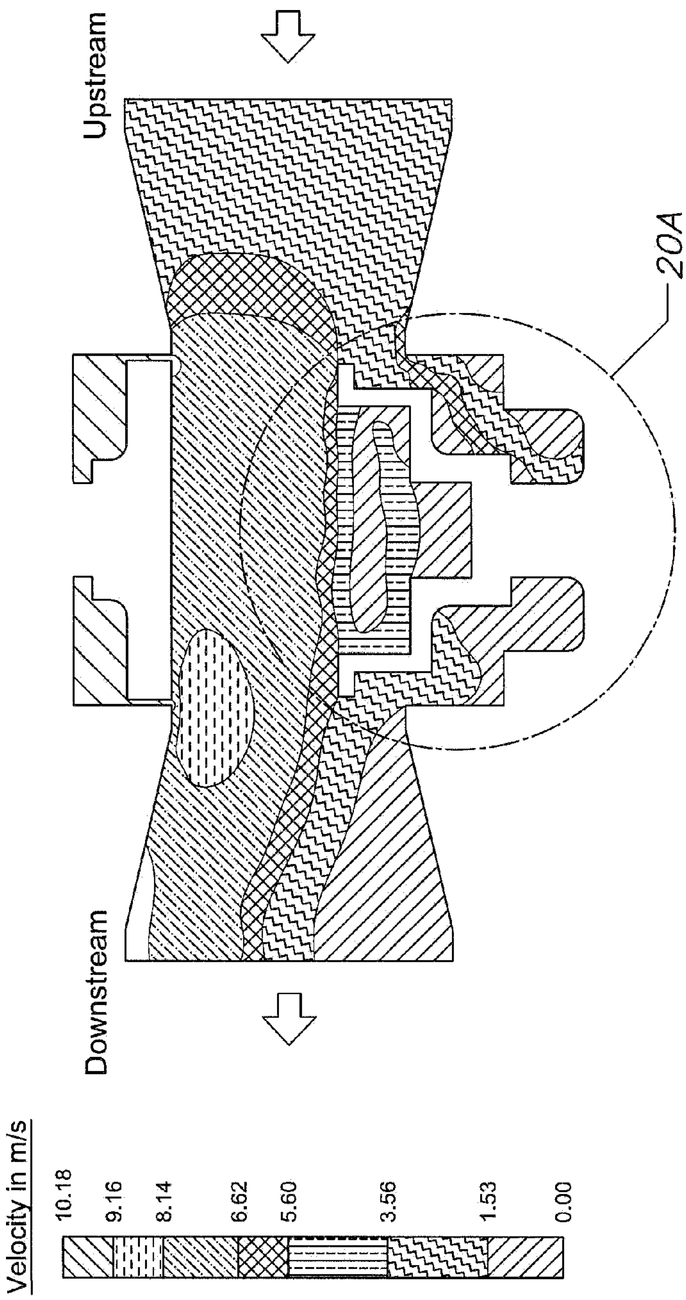

Upstream
Downstream
20A
Velocity in m/s
10.18
9.16
8.14
6.62
5.60
3.56
1.53
0.00

FIG. 20

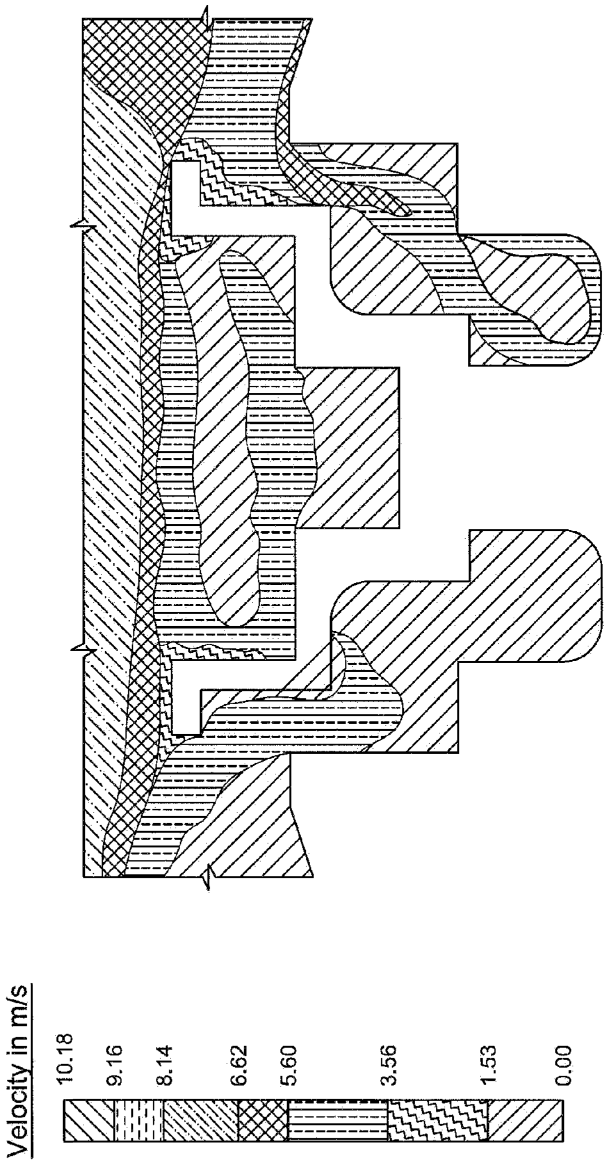


FIG. 20A

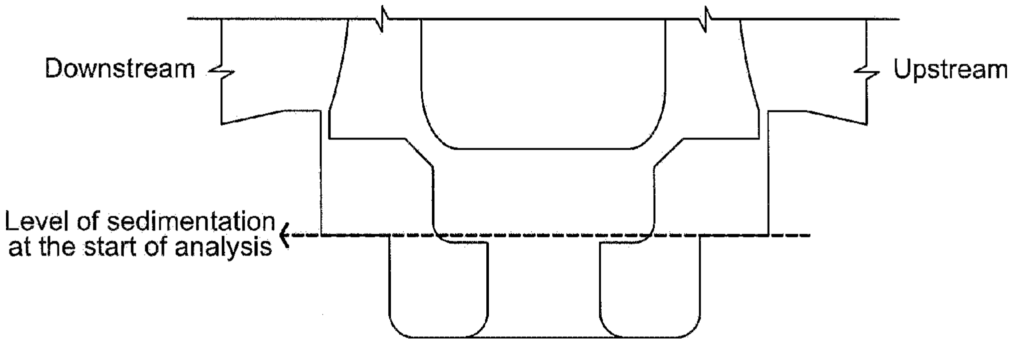


FIG. 21

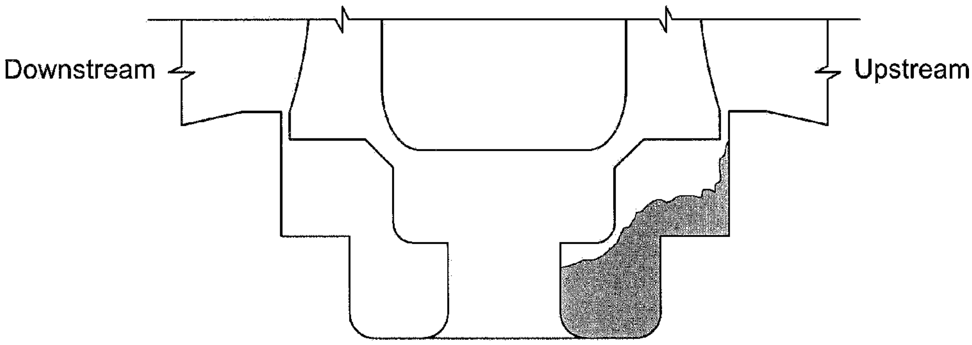


FIG. 22A

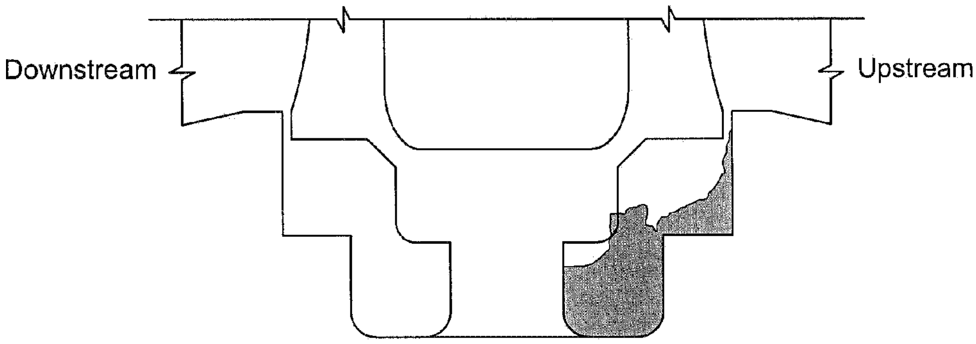


FIG. 22B

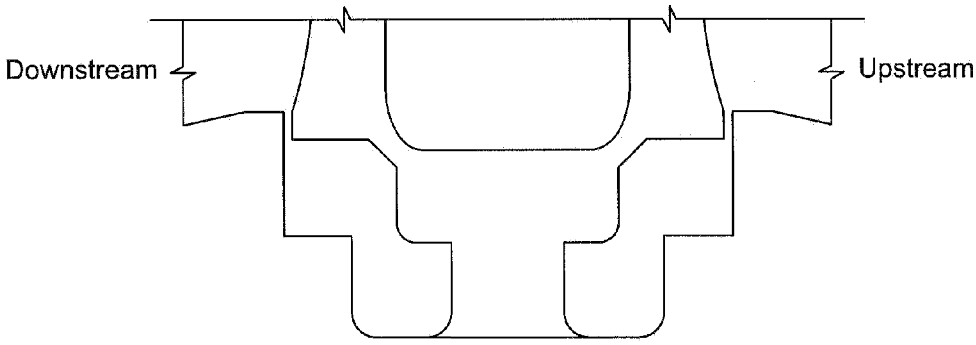


FIG. 22C