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Declarations under Rule 4.17:

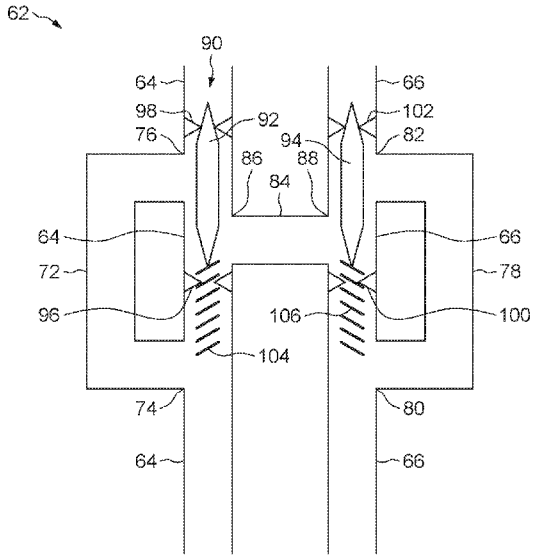
— *as to the identity of the inventor (Rule 4.17(i))*

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

(54) Title: FLUID RECIRCULATION SYSTEMS TO PROVIDE A PRINT HEAD WITH A FLUID

(57) Abstract: A fluid recirculation system is described which is to provide a print head with a fluid. It includes a first fluid path and a second fluid path. Each of the first and second fluid paths are to fluidly connect the print head with a fluid supply. The system includes a bypass fluidly connected to the first fluid path and to the second fluid path, and a shutoff to selectively allow the fluid connection via the bypass between the first and second fluid paths or to allow the fluid delivery to the print head via the first and second fluid paths.

FIG.2



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Fluid recirculation systems to provide a print head with a fluid

BACKGROUND

[0001] In some printing applications, a printer includes a print head in fluid connection with a fluid supply, for instance an ink supply, which delivers a fluid to the print head. A fluid recirculation system may be incorporated to the printer in order to implement a fluid connection between the print head and the ink supply. Such a fluid recirculation system may include several fluid paths.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] Figure 1 is a schematic view of a printer according to an example of the present disclosure.

[0003] Figure 2 is a schematic view of a fluid recirculation system of the example printer of figure 1 in a first configuration.

[0004] Figure 3 is a schematic view of the example fluid recirculation system of figure 2 in a second configuration.

[0005] Figure 4 is a schematic view of a fluid interconnecting device according to another example of the present disclosure, in a first state wherein no print head is installed on the device.

[0006] Figure 5 is a schematic view of the example fluid interconnecting device of figure 4 in a second state wherein a print head in installed on the device.

[0007] Figure 6 is a schematic view of an example fluid recirculation system in a first configuration.

[0008] Figure 7 is a schematic view of the example fluid recirculation system of Figure 6 in a second configuration.

[0009] Figure 8 is a schematic view of an example fluid recirculation system in a first configuration.

[0010] Figure 9 is a schematic view of the example fluid recirculation system of Figure 8 in a second configuration.

[0011] Figure 10 is a schematic view of an example fluid recirculation system in a first configuration.

[0012] Figure 11 is a schematic view of the example fluid recirculation system of Figure 10 in a second configuration.

DETAILED DESCRIPTION

[0013] In one example, a bypass fluidly connects two fluid paths of the fluid recirculation system. In order to avoid having the ink pigments settled inside any component of the ink delivery system, a shutoff is to selectively allow the fluid connection via the bypass between the fluid path. One may thus avoid generating pigment clusters, clogging ink delivery tubes, blocking ink pumps or affecting their performance and clogging print head firing nozzles.

[0014] In one example, the shutoff is movable between two positions wherein, respectively, it allows the fluid connection between the fluid paths and it does not allow the fluid connection between the fluid paths. In order to allow automatically the fluid connection between the fluid paths, the position of the shutoff may be controlled by the print head.

[0015] In one example, the fluid is white ink. Hence, one avoids particularly efficiently the problem of pigments settling since white ink composition is made by heavy pigment particles which will deposit by their own if they are not moved or vibrated.

[0016] In one example, an elastic return is to recall an obstructer in a state wherein the fluid communication between the fluid paths is allowed. Hence, one has the fluid recirculation between the fluid paths allowed automatically when the print head is disconnected from the system.

[0017] In one example, which is depicted in figure 1, a printer 10 includes a print head 12, an ink supply 14 and an ink delivery system 16.

[0018] The ink supply 14 may be a white ink supply. The ink supply 14 may include a first ink chamber 18 and a second ink chamber 20.

[0019] The ink delivery system 16 may include a first ink delivery tube 22 and a second ink delivery tube 24. The ink delivery tube 22 may be fluidly connected to the ink chamber 18. The ink delivery tube 24 may be fluidly connected to the ink chamber 20. The ink delivery tube 22 may include a first end 51 and a second end 52. The ink delivery tube 24 may include a first end 53 and a second end 54. The ends 51 and 53 may be proximate from the ink supply 14 whereas the ends 52 and 54 may be intended to be proximate to the print head 12.

[0020] The ink delivery system 16 may include a first interconnecting tube 26 and a second interconnecting tube 28. The interconnecting tube 26 may be connected to the ink delivery tube 22 at a connection point 30, and with the ink delivery tube 24 at a connection point 32. The interconnecting tube 28 may be connected to the ink delivery tube 22 at a connection point 34 and with the ink delivery tube 24 at a connection point 36. The connection point 34 may be located between the connection point 30 and the end 52. The connection point 36 may be located between the end 53 and the connection point 32.

[0021] The ink delivery tube 22 may include a valve 38 arranged between the connection points 30 and 34. The ink delivery tube 24 may include a valve 40 arranged between the connection points 36 and 32. The interconnecting tube 26 may include a valve 42. The interconnecting tube 28 may include a valve 44.

[0022] The ink delivery system 16 may include a first pump 46 arranged on the first ink delivery tube 22. The pump 46 may be located between the connection point 34 and the end 52. The ink delivery system 16 may include a second pump 48 arranged on the ink delivery tube 24.

The pump 48 may be located between the connection point 32 and the end 54.

[0023] The ink delivery system 16 may include a third interconnecting tube 50. The interconnecting tube 50 may be connected to the ink delivery tube 22 at a connection point 55, and may be connected to the ink delivery tube 24 at a connection point 56. The connection point 55 may be located between the pump 46 and the end 52. The connection point 56 may be located between the pump 48 and the end 54.

[0024] The ink delivery system 16 may include a three-way valve 58 which may be arranged on the second ink delivery tube 24. The three-way valve 58 may be located at the connection point 56.

[0025] The ink delivery system 16 may include a damper 60. The damper 60 may be arranged on the ink delivery tube 24, between the pump 48 and the connection point 56.

[0026] The printer 10 may include a fluid recirculation system 62 arranged between the fluid delivery system 16 and the print head 12. The fluid recirculation system 62 aims at providing the print head 12 with a fluid. For example, the fluid recirculation system 62 may provide the print head 12 with a fluid chosen among ink, water, air and a mixture thereof. In the described example, the fluid recirculation system 62 may provide the print head 12 with white ink from the ink supply 14.

[0027] With reference to figures 2 and 3, the fluid recirculation system 62 may include a first fluid path 64 and a second fluid path 66. The fluid path 64 may be fluidly connected to the ink delivery tube 22. The fluid path 66 may be fluidly connected to the ink delivery tube 24. The fluid recirculation system 62 may be without a print head as depicted on figure 2, or may have the print head 12 connected thereto as depicted on figure 3.

[0028] As depicted in figure 3, the fluid paths 64 and 66 may receive a respective needle 68 and 70 of the print head 12. When the needles 68

and 70 are respectively received in the fluid paths 64 and 66, a fluid communication is implemented between the print head 12 and the fluid paths 64 and 66. Hence, the fluid paths 64 and 66 may fluidly connect the print head 12 with the ink delivery system 16.

[0029] Referring to figures 2 and 3, the fluid path 64 may include a diversion 72. The diversion 72 may include a first connection point 74 with the fluid path 64 and a second connection point 76 with the fluid path 64. The fluid path 66 may include a diversion 78. The diversion 78 may include a first connection point 80 with the fluid path 66 and a second connection point 82 with the fluid path 66. The connection point 76 may be located on the fluid path 64 in such a way that it is more proximate to the print head 12 than the connection point 74. The connection point 82 may be located on the fluid path 66 in such a way that it is more proximate to the print head 12 than the connection point 80.

[0030] The fluid recirculation system 62 may include a bypass 84. The bypass 84 may include a connection point 86 with the fluid path 64 and a connection point 88 with the fluid path 66. The connection point 86 may be located, along the fluid path 64, between the connection points 74 and 76. The connection point 88 may be located, along the fluid path 66, between the connection points 80 and 82. By virtue of this arrangement, the bypass 84 may fluidly connect the fluid paths 64 and 66, the connection points 76 and 82 may be more proximate to the print head 12 than the connection points 86 and 88, and the connection points 74 and 80 may be more remote from the print head 12 than the connection points 86 and 88.

[0031] The fluid recirculation system 62 may include a shutoff 90. The shutoff 90 may include two dual cones 92 and 94 respectively inserted in the fluid paths 64 and 66. Each dual cone 92 and 94 may include a cylindrical portion forming a cylinder of revolution and two conical portions extending from each respective end of the cylindrical portion. Hence, the axial cross-section of the dual cones 92 and 94 may, when the

cross-section plane is moved along the axial direction of the dual cones 92 and 94.

[0032] The shutoff 90 may include a seal ring 96 arranged on the fluid path 64 between the connection points 74 and 86, and a seal ring 98 arranged on the fluid path 64 and remote from the connection point 86 with respect to the connection point 76. The shutoff 90 may also include a seal ring 100 arranged on the fluid path 66 between the connection points 80 and 88, and a seal ring 102 arranged on the fluid path 66 and remote from the connection point 88 with respect to the connection point 82.

[0033] Hence, the dual cones 92 and 94 may move between a first position, depicted on figure 2, wherein they are in contact with the respective seal rings 98 and 102, and a second position, depicted on figure 3, wherein the dual cones 92 and 94 are respectively in contact with the respective seal rings 96 and 100. In the first position, the dual cones 92 and 94 may prevent fluid flow through the respective seal rings 98 and 102. In the second position, the dual cones 92 and 94 may prevent fluid flow through the respective seal rings 96 and 100.

[0034] The shutoff 90 may include a spring 104 arranged inside the fluid path 64 in such a way that it pushes the dual cone 92 towards its first position. The shutoff 90 may include a spring 106 arranged inside the fluid path 66 in such a way that it pushes the dual cone 94 towards its first position.

[0035] As depicted in figure 3, when the print head 12 is connected to the fluid recirculation system 62, the needles 68 and 70 push the respective dual cones 92 and 94 towards the second position and compress the springs 104 and 106. In this position, the fluid flow through the seal rings 96 and 100 is prevented. Fluid delivered by the ink delivery system 16 arrives at the connection points 74 and 80 of the respective fluid paths 64 and 66, and flows into the diversions 72 and 78. At the respective

connection points 76 and 82, the fluid reverts into the fluid paths 64 and 66 and is then delivered to the print head 12.

[0036] One may remove the print head 12, as depicted on figure 2. In this configuration, the needles 68 and 70 stop pushing the respective dual cones 92 and 94 towards their second position. Hence, the springs 104 and 106 may push the respective dual cones 92 and 94 towards their first position by elastic return. In this position, fluid flow through the seal rings 98 and 102 may be prevented. Meanwhile, fluid may flow between the fluid paths 64 and 66 via the bypass 84. Hence, disconnection of the print head 12 moves automatically the shutoff 90 in such a position that it may allow the fluid connection via the bypass 84 between the fluid paths 64 and 66.

[0037] In another example, which is depicted in figures 4 and 5, a fluid interconnecting device 108 may be incorporated to the printer 10.

[0038] The fluid interconnecting device 108 may include a first channel 110 having a port 112 and a port 114. The fluid interconnecting device 108 may include a second channel 116 including a port 118 and a port 120. The channel 110 may be in fluid communication, via the port 112, with the ink delivery tube 22 of the ink delivery system 16. The channel 116 may be in fluid communication, via the port 118, with the ink delivery tube 24.

[0039] As depicted in figure 5, the ports 114 and 120 may respectively receive needles 68 and 70 of the print head 12, in order to provide the print head 12 with fluid circulating through the channels 110 and 116.

[0040] The channel 110 may include a main duct 122 and an auxiliary duct 124. The channel 110 may include two junctions 126 and 128 between the ducts 122 and 124. The junction 126 may be located between the junction 128 and the port 114. The channel 116 may include a main duct 130 and an auxiliary duct 132. The channel 116 may include two junctions

134 and 136 between the ducts 130 and 132. The junction 134 may be located between the junction 136 and the port 120.

[0041] The fluid interconnecting device 108 may include a recirculation loop 138. The recirculation loop 138 may include a junction 140 with the main duct 122 and a junction 142 with the main duct 130. Hence, the recirculation loop 138 may be fluidly linked to the main ducts 122 and 130 of the respective channels 110 and 116. Besides, the auxiliary ducts 124 and 132 are fluidly linked to the respective main ducts 122 and 130 at either sides of the recirculation loop 138.

[0042] The fluid interconnecting device 108 may include a stopper 144. The stopper 144 may include an obstructer 146 which may be received in the channel 110 and an obstructer 148 which may be received inside the channel 116. The obstructers 146 and 148 may comprise a ball.

[0043] The stopper 144 may include an elastic return 150. In the example of figures 4 and 5, the elastic return 150 may include a pair of springs 152 and 154. The spring 152 may be received inside the channel 110 and may push the ball 146 towards the port 114. The spring 154 may be received inside the channel 116 and may push the ball 148 towards the port 120.

[0044] Hence, when no print head is installed on the fluid interconnecting device 108, as depicted on figure 4, the elastic return 150 may recall the obstructers 146 and 148 in a first state wherein the obstructers 146 and 148 are respectively located at the connection points 126 and 134. In this first state, fluid flow towards the ports 114 and 120 may be prevented and fluid communication between the channels 110 and 116 via the recirculation loop 138 may be allowed. Furthermore, the fluid recirculation between the channels 110 and 116 via the recirculation loop 138 may be allowed in a passive manner, that is without requiring any active action from a user and/or an actuator.

[0045] When a print head 12 is installed on the fluid interconnecting device 108, as depicted on figure 5, the needles 68 and 70 may compress the springs 152 and 154 and push the obstructers 146 and 148 towards the ports 112 and 118, respectively. Hence, the obstructers 146 and 148 may be positioned at the respective junctions 140 and 142. In this state, the obstructers 146 and 148 may prevent fluid communication between the channels 110 and 116 via the recirculation loop 138. On the other hand, fluid may flow from the ports 112 and 128, reach the respective junctions 128 and 136, follow the auxiliary ducts 124 and 132, and resume flowing towards the ports 114 and 120 at the respective junctions 126 and 134. In this configuration, fluid may be delivered to the print head 12 by the fluid interconnecting device 108.

[0046] In a variant example, one may replace the compression wire springs with another mechanical elastic element and/or with another element to recall the stopper towards its first position.

[0047] The example fluid recirculation system of figures 6 and 7 may be similar to that of figures 2 and 3. The example fluid recirculation system of figures 6 and 7 may differ from that of figures 2 and 3 in that the compression springs 104 and 106 may be replaced with tension wire springs 156 and 158. When the print head 12 is connected to the fluid recirculation system, as depicted on figure 7, the needles 68 and 70 push the respective dual cones 92 and 94 towards the second position and extend the springs 156 and 158. When one removes the print head 12, as depicted on figure 6, the needles 68 and 70 stop pushing the respective dual cones 92 and 94 towards their second position. Hence, the springs 156 and 158 may elastically recall the respective dual cones 92 and 94 towards their first position.

[0048] The example fluid recirculation system of figures 8 and 9 may be similar to that of figures 2 and 3. The example fluid recirculation system of figures 8 and 9 may differ from that of figures 2 and 3 in that the springs

104 and 106 may be removed and replaced, respectively, with magnets 160 and 162. The magnets 160 and 162 may cooperate with respective ferromagnetic material 164 and 166. Hence, the magnets 160 and 162 may recall the respective dual cones 92 and 94 into their first position, that is the position depicted on figure 8. When the print head 12 is connected to the fluid recirculation system, as depicted on figure 9, the needles 68 and 70 may push the respective dual cones 92 and 94 towards the second position and tend to increase the distance between the magnets 160 and 162, and the respective elements 164 and 166. When the print head 12 is removed, as depicted on figure 6, the needles 68 and 70 stop pushing the respective dual cones 92 and 94 towards their second position. Hence, the magnets 164 and 166 may attract the respective dual cones 92 and 94 towards their first position.

[0049] The example fluid recirculation system of figures 10 and 11 may be similar to that of figures 2 and 3. The example fluid recirculation system of figures 10 and 11 may differ from that of figures 2 and 3 in that the compression springs 104 and 106 may be removed. The example fluid recirculation system of figures 10 and 11 may include fixed elements 168 and 170. The fixed elements 168 and 170 may be fixedly attached to the bypass 84 or to any part attached thereto. The fixed elements 168 and 170 may be pivotably attached to respective pivoting elements 172 and 174. The pivoting elements 172 and 174 may act as a spring, and may include a torsion spring, a metal strip or a plastic strip.

CLAIMS

1. Fluid recirculation system to provide a print head with a fluid, including a first fluid path and a second fluid path, each of the first and second fluid paths being to fluidly connect the print head with a fluid supply, the system including a bypass fluidly connected to the first fluid path and to the second fluid path, and a shutoff to selectively allow the fluid connection via the bypass between the first and second fluid paths or to allow the fluid delivery to the print head via the first and second fluid paths.

2. The system according to claim 1, wherein the shutoff is to activate the fluid connection via the bypass between the first and second fluid paths when the print head is disconnected from the system.

3. The system according to claim 1, wherein the shutoff is moveable between a first position wherein it allows the fluid connection via the bypass between the first and second fluid paths, and a second position wherein it does not allow the fluid connection via the bypass between the first and second fluid paths, the position of the shutoff being to be controlled by the print head.

4. The system according to claim 1, wherein the first fluid path includes a first diversion and the second fluid path includes a second diversion, each first diversion and second diversion having a first connection point to be more proximate to the print head than the bypass and a second connection point to be further from the print head than the bypass.

5. Fluid interconnecting device to be incorporated to a printer, including a first channel and a second channel, the first channel including a first port and the second channel including a second port, the first and second ports being to receive a respective part of a print

head of the printer in order to provide the print head with a fluid, the fluid interconnecting device including a recirculation loop in fluid communication with the first channel and the second channel, and a stopper to selectively allow a fluid communication between the first channel and the second channel via the recirculation loop or to allow the fluid delivery to the print head via the first and second channels.

6. The device according to claim 5, wherein the stopper is to passively switch between a first state wherein a fluid communication between the first channel and the second channel via the recirculation loop is allowed and a second state wherein a fluid communication between the first channel and the second channel via the recirculation loop is not allowed.

7. The device according to claim 5, wherein the first channel comprises a main duct and an auxiliary duct, the second channel comprising a main duct and an auxiliary duct, the recirculation loop being fluidly linked to the main ducts of the first and second channels, the auxiliary ducts being fluidly linked at either sides of the recirculation loop.

8. The device according to claim 7, wherein the stopper includes a first obstructer located inside the first channel and a second obstructer located inside the second channel.

9. The device according to claim 8, wherein the first and second channels include a first junction between the main duct and the auxiliary duct, and a second junction between the main duct and the recirculation loop, the first junctions being between the second junction and the respective first and second ports, the first and second obstructers being to be located at the first junctions when they are to allow the fluid communication between the first channel and the second channel via the recirculation loop, the first and second obstructers being to be located at the second junctions when they are to prevent the fluid

communication between the first channel and the second channel via the recirculation loop.

10. The device according to claim 7, wherein the stopper includes an elastic return to recall the first obstructer and/or the second obstructer in a state wherein the fluid communication between the first channel and the second channel via the recirculation loop is allowed.

11. The device according to claim 10, wherein the elastic return includes a spring to implement a pressure pushing the first obstructer and/or the second obstructer towards the corresponding port.

12. The device according to claim 10, wherein the elastic return includes a spring to implement a traction recalling the first obstructer and/or the second obstructer towards the corresponding port.

13. The device according to claim 10, wherein the elastic return includes a torsion spring to recall the first obstructer and/or the second obstructer towards the corresponding port.

14. The device according to claim 7, wherein the stopper includes a magnet to recall the first obstructer and/or the second obstructer in a state wherein the fluid communication between the first channel and the second channel via the recirculation loop is allowed.

15. Print head to be installed on a printer, including a fluid interconnecting device according to claim 5.

FIG.1

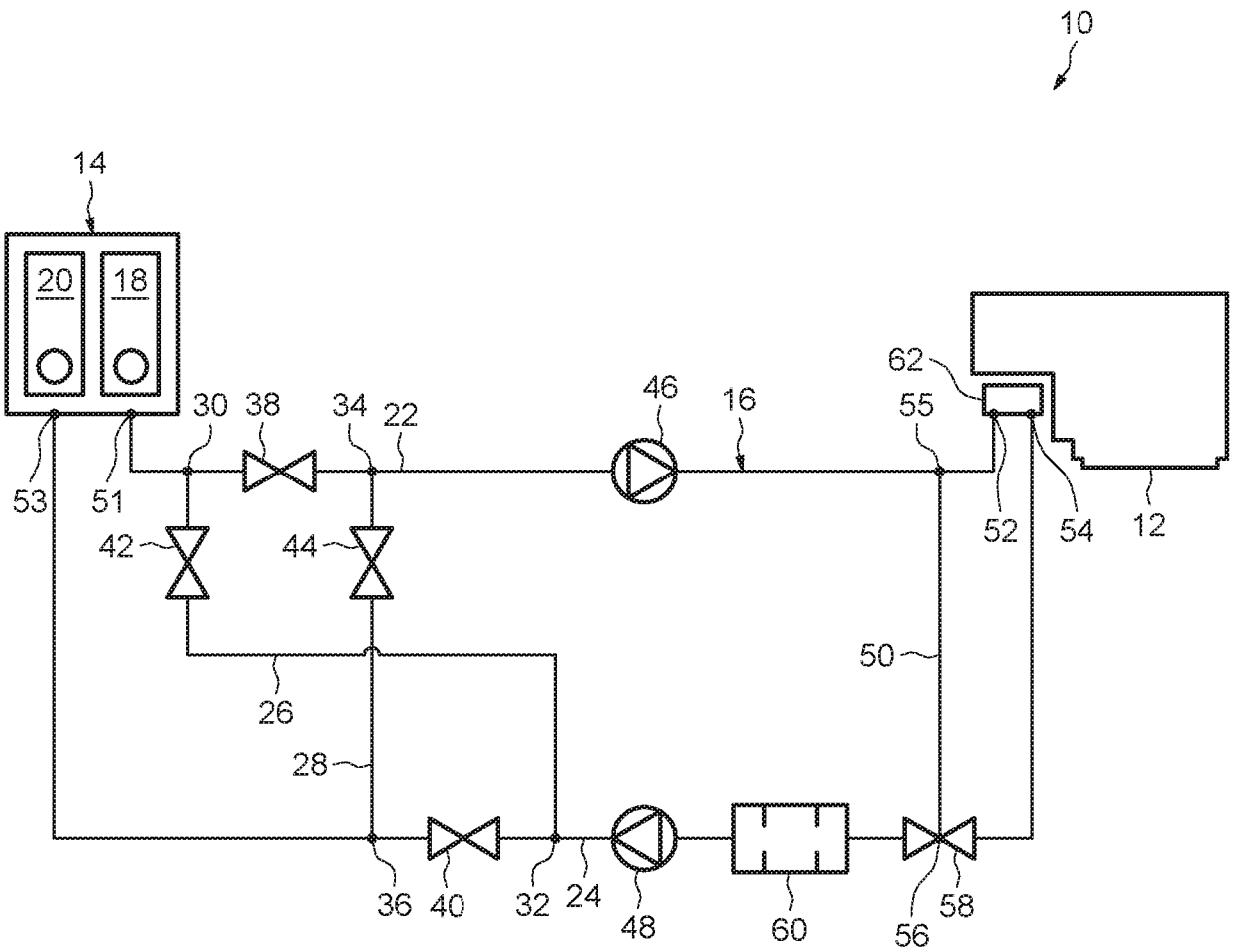
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FIG.3

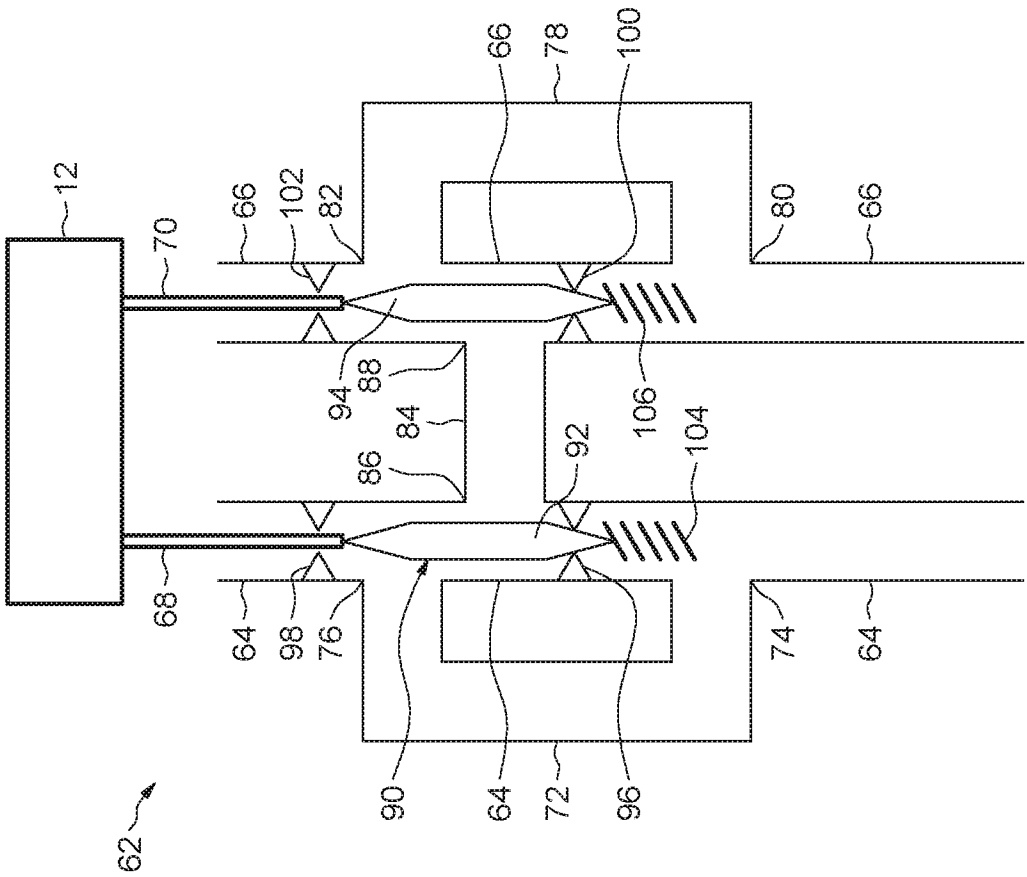
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FIG.2

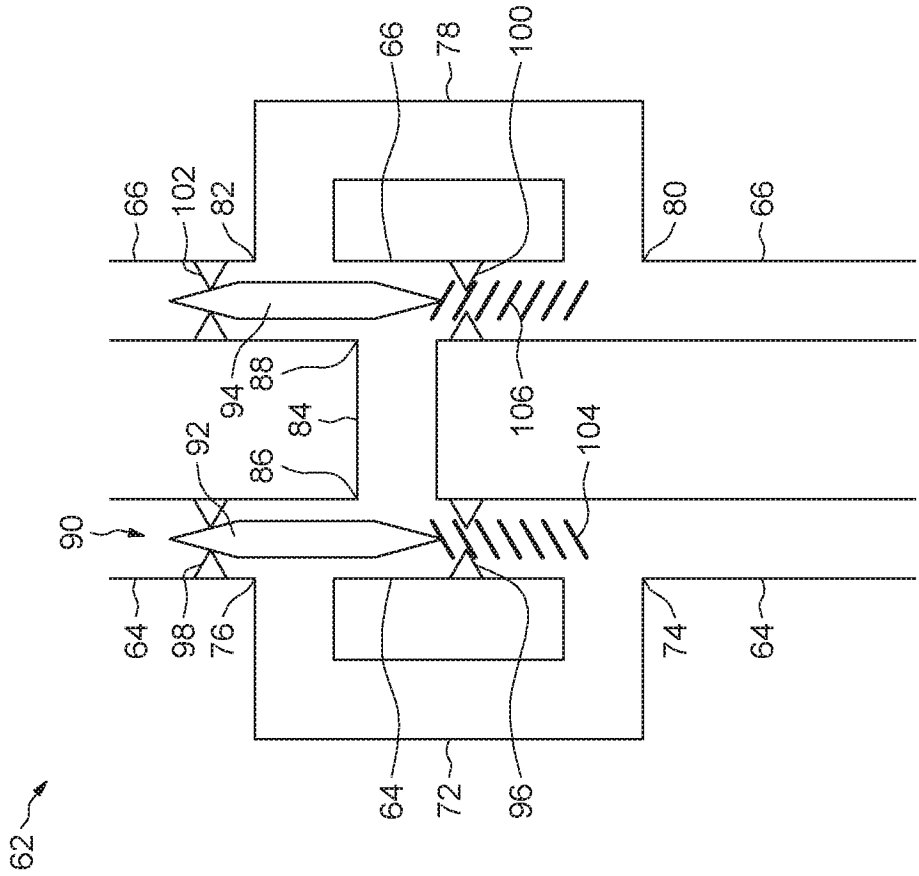
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FIG.5

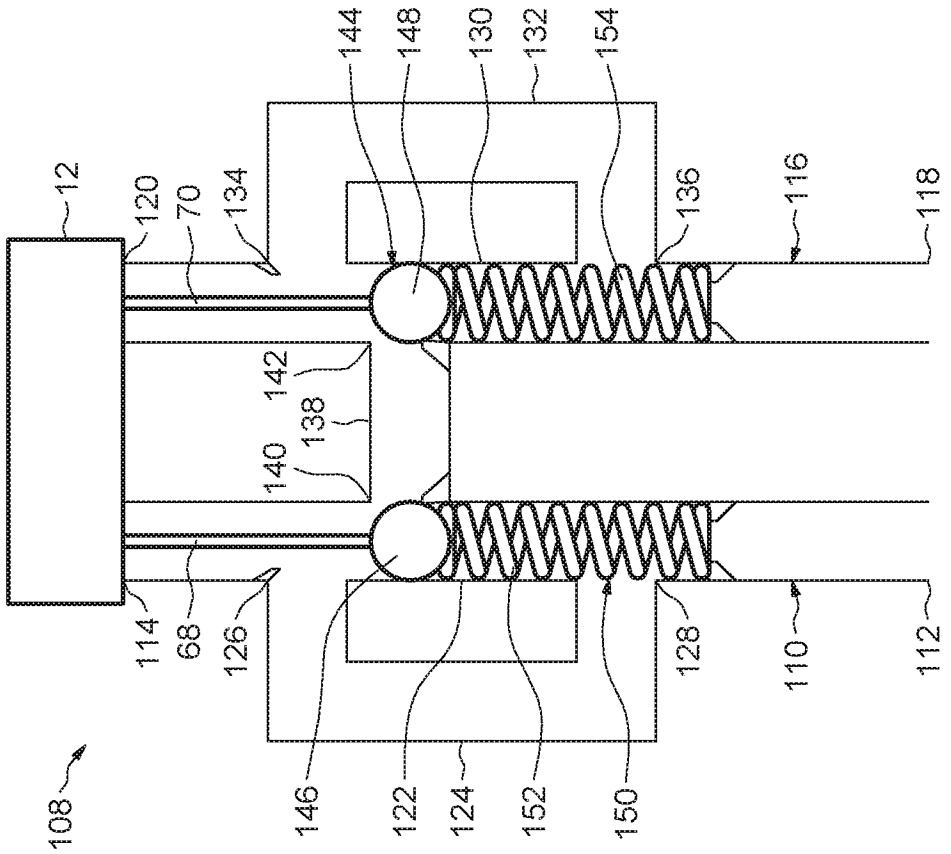
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FIG.4

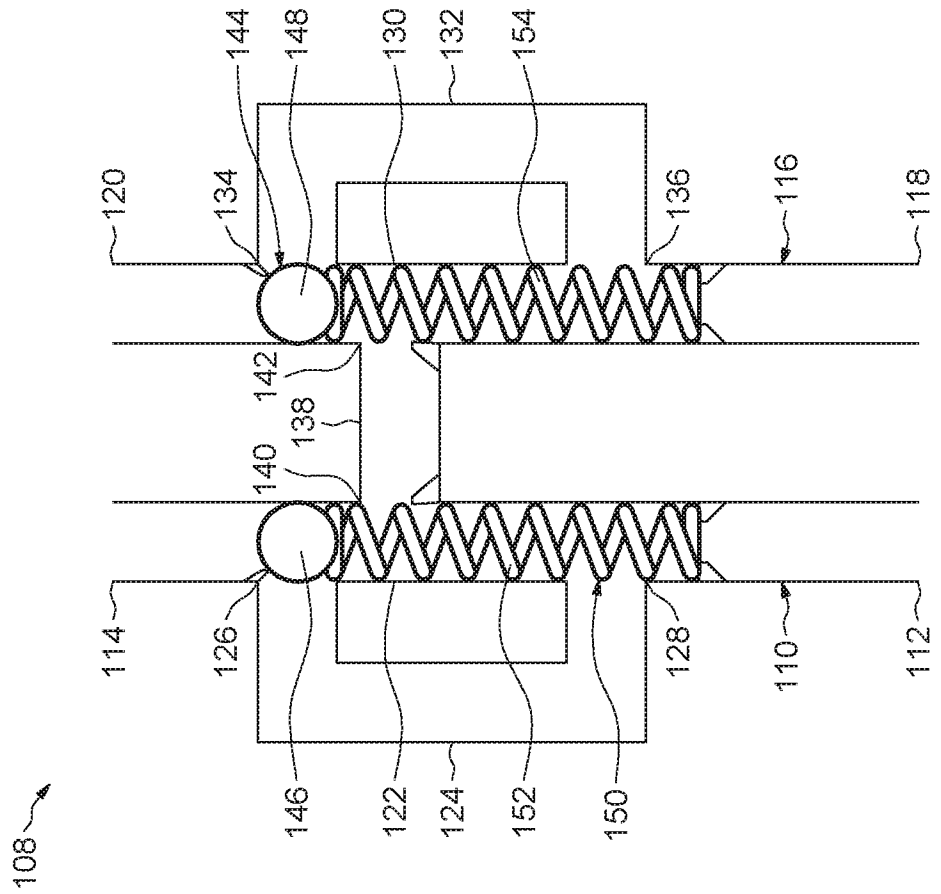
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FIG.7

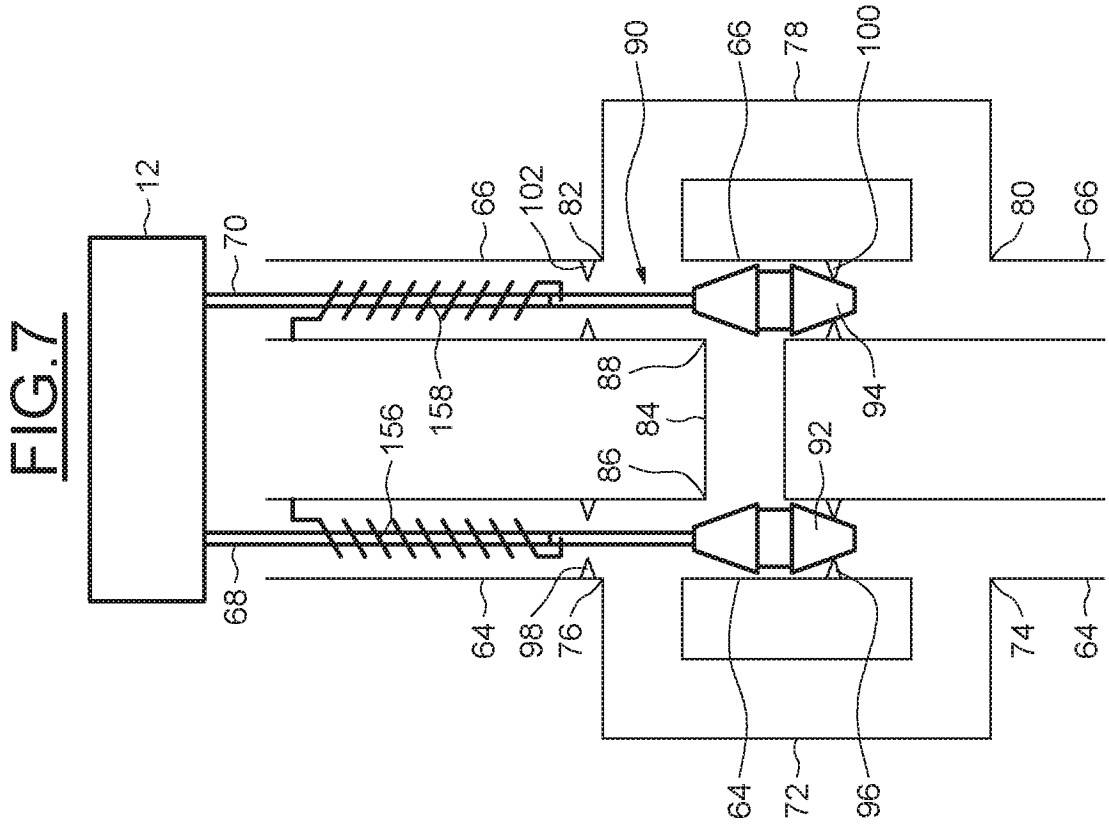
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FIG.6

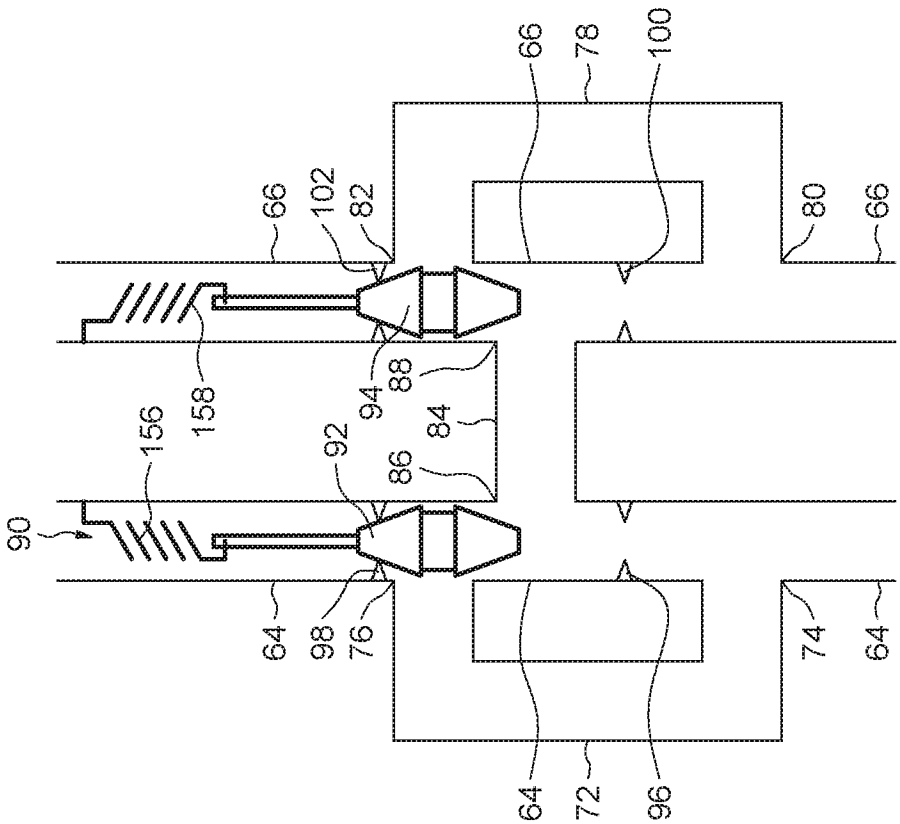
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FIG.9

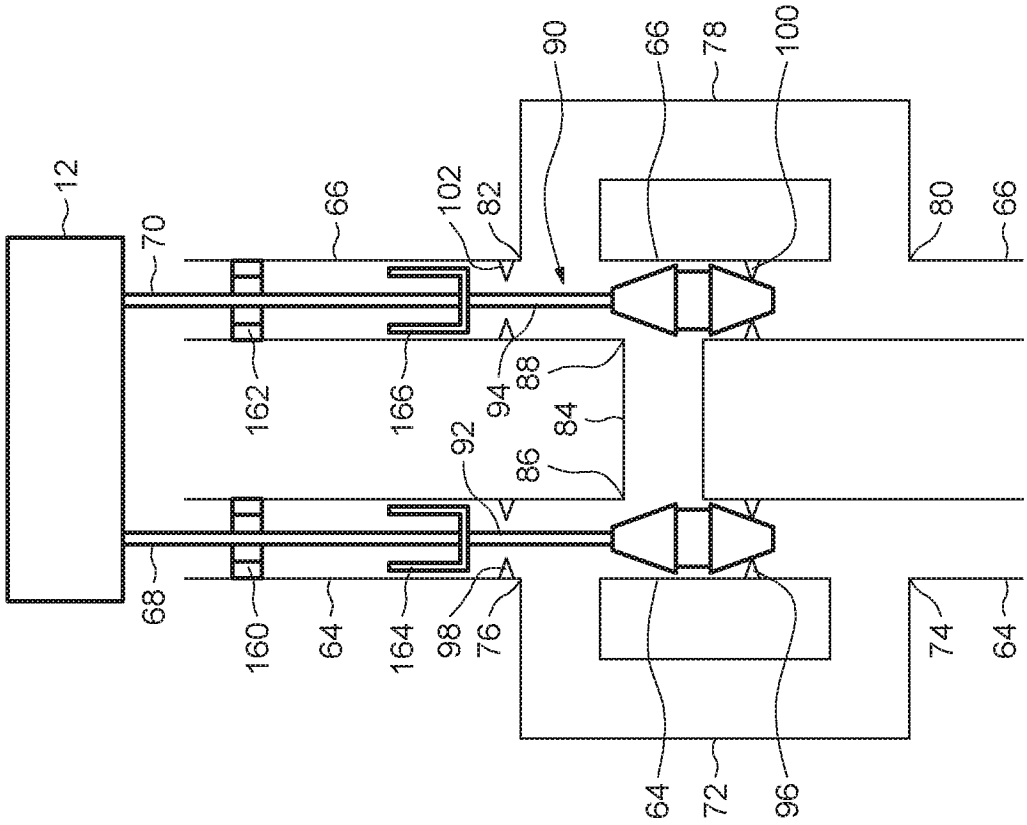
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FIG.8

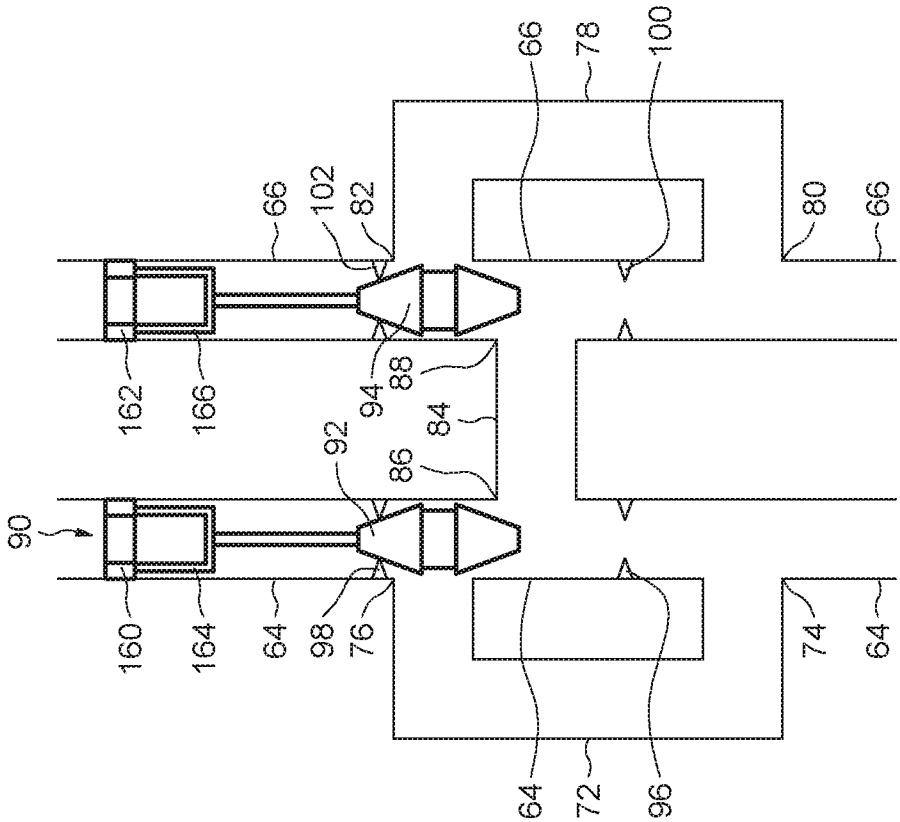
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FIG.11

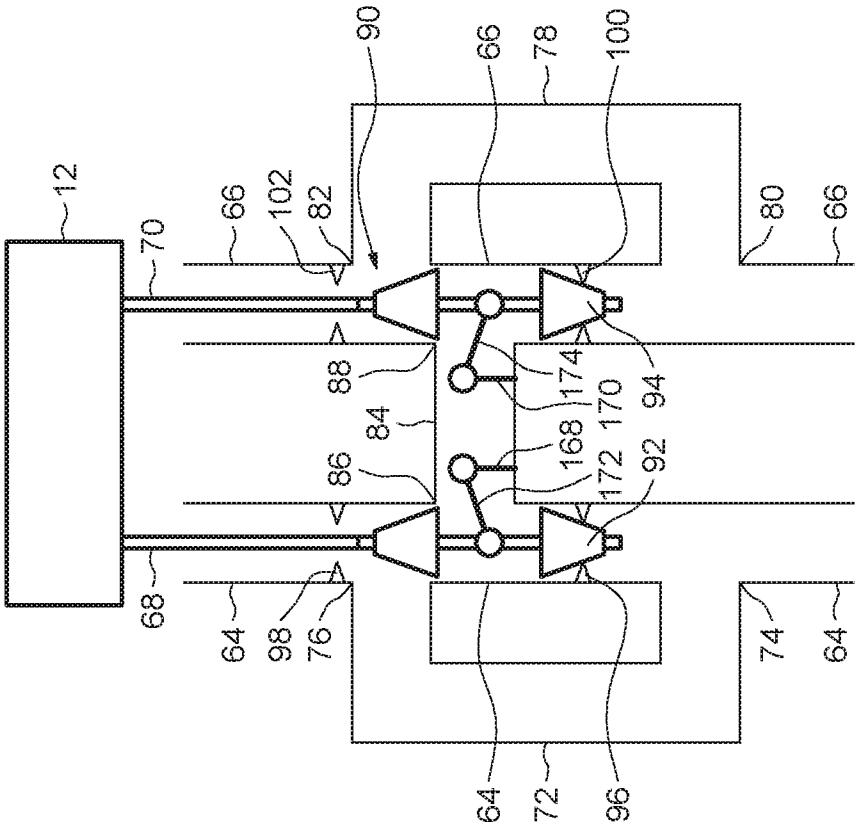
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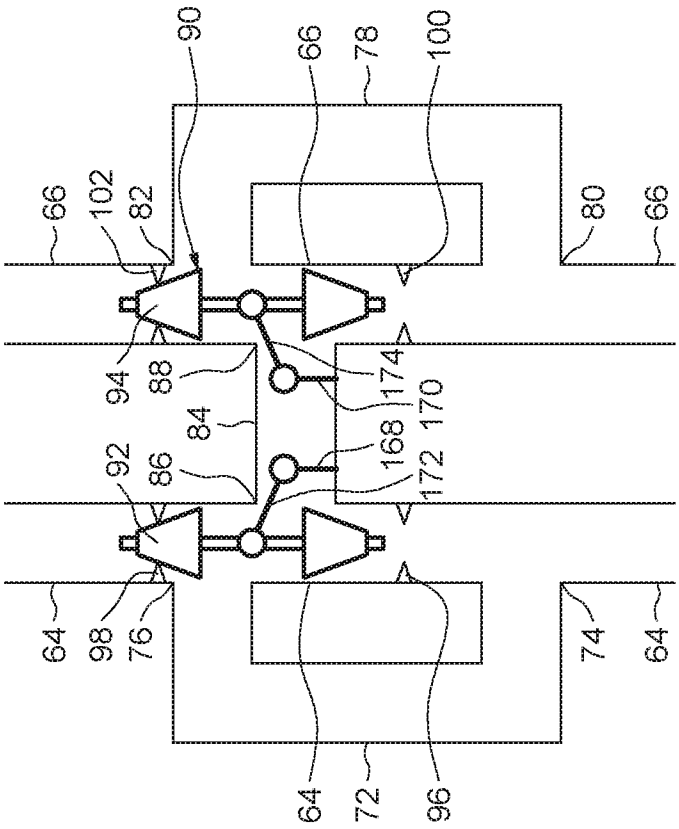
FIG.10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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 2020/042960

A. CLASSIFICATION OF SUBJECT MATTER

B41J 2/175 *(2006.01)*
B41J 2/18 *(2006.01)*

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B41J 2/00, 2/175, 2/18-2/19

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatSearch (RUPTO internal), USPTO, PAJ, K-PION, Esp@cenet, Information Retrieval System of FIPS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2019/0275804 A1 (ROLAND DG CORPORATION) 12.09.2019, [0008]-[0011], [0032]-[0034], [0036], [0042], [0047]-[0052], fig. 3	1-15
A	US 2014/0043404 A1 (FUJIFILM CORPORATION) 13.02.2014	1-15
A	US 2013/0293641 A1 (FUJIFILM CORPORATION) 07.11.2013	1-15
A	EP 2305475 A1 (MASTERMIND CO., LTD.) 06.04.2011	1-15

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 March 2021 (11.03.2021)	25 March 2021 (25.03.2021)

Name and mailing address of the ISA/RU:	Authorized officer
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