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(54) FLUID STORAGE ASSEMBLY WITH MECHANICAL ENERGY HARVESTING

(57) The present invention relates to a generator for an electronic valve for a storage vessel containing a compressible fluid (e.g., a gas cylinder). The generator is configured to generate electricity from the vibration of the storage vessel. The vibration of the storage vessel causes a mechanical motion that is converted into electricity. A fluid storage assembly for storing fluid comprises: a fluid storage vessel (10, 110); an electronic valve assembly (20, 120) for controlling the flow of fluid from the fluid storage vessel (10, 110); and a generator (50, 60, 150) for generating electricity, the generator arranged to provide electrical power to the electronic valve assembly (20, 120), wherein the generator (50, 60, 150) is arranged to generate electricity from reciprocal motion of the fluid storage assembly.

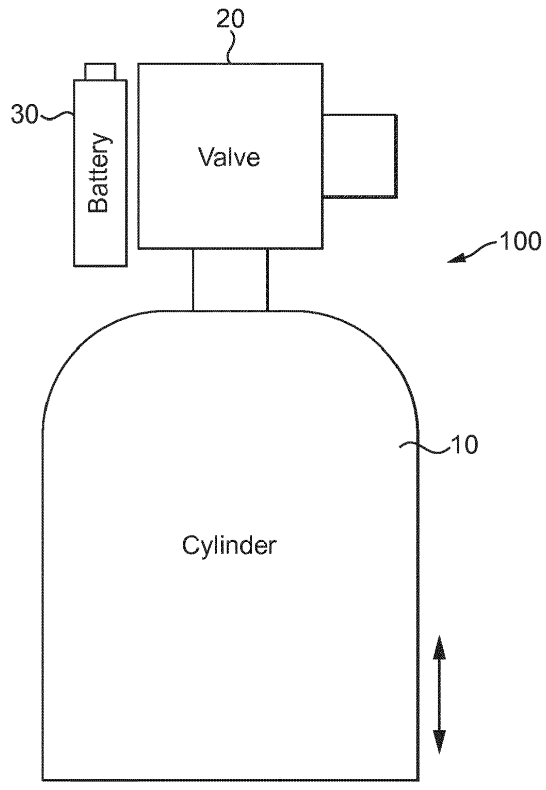

FIG. 1

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a generator for an electronic valve for a storage vessel containing a compressible fluid (e.g., a gas cylinder). The generator is configured to generate electricity from the vibration of the storage vessel. The vibration of the storage vessel causes a mechanical motion that is converted into electricity.

BACKGROUND ART

[0002] The use of storage vessels, typically referred to as cylinders, for storing and dispensing pressurised fluid is ubiquitous. Some notable examples include their use to store and dispense gases for medical purposes, for scientific research or for industrial applications. The cylinders may further be used to transport pressurised fluid between locations, either to be transferred to local storage for later use or to be extracted on demand from the cylinder at the point of use. Although reference is made to a "cylinder", it will be understood that the invention is applicable broadly to all portable pressurised gas containers whether they are strictly in the form of a cylinder or not.

[0003] Such cylinders are used to supply gas or liquid for a range of applications including welding and cutting hoses and torches, gas packaging machines and laboratory equipment.

[0004] Such cylinders may implement electronic devices or components for the purposes of display or operation. For example, the pressure can be monitored by a pressure gauge utilising an electronic display or electronic sensing elements, or electronic actuators may be incorporated in the valve mechanism. Other examples can be electronic communication devices (e.g. wireless devices) or location sensors (e.g. GPS). Thus, a power source must be provided to the cylinders to allow such electronic components to operate. Given that cylinders are normally portable and employed at locations remote from a power sources, the conventional means to supply power is to provide a battery connected to the cylinder. However, the use of batteries in this manner has disadvantages; conventional batteries are limited in their capacity, meaning that larger batteries are often required for higher power densities. Further, conventional batteries have a limited lifespan and are typically very expensive. These problems are compounded by the nature of their use, where cylinders are often deployed at remote locations for extended periods of time, meaning the power that can be supplied by the battery will not be sufficient to provide a full range of operation over the time period required.

[0005] A solution to this problem would be to simply provide a connection to a local power source, such as an attachment to the mains. However, sometimes the location at which the cylinder may be used would not include a local power source. Furthermore, there are instances where use of a local power source would not be desirable, such as when combustible material is stored in the cylinder- if safety provisions are not adequate, a short-circuit and subsequent power surge could be dangerous.

[0006] There is thus a need to provide an alternative to simply replacing the batteries of such a device, and the inventors have developed a means to generate electrical power on the cylinder assembly so as to provide a power source without relying on connection to a local power source, which can be unavailable or dangerous, or relying on power stored in a battery, which can be expensive, impractical and/or unsuitable for purpose.

[0007] The present invention seeks to provide such a means for generation of electrical power, which provides various advantages over the prior art.

SUMMARY OF THE INVENTION

[0008] According to a first aspect of the invention, there is provided a fluid storage assembly for storing fluid defined by claim 1.

LIST OF FIGURES

[0009] For a better understanding of the invention, and to show how the same may be put into effect, reference is now made, by way of example only, to the accompanying drawings in which:

Figure 1 shows schematic representation of a fluid storage assembly of a first embodiment of the invention;

Figure 2 shows a schematic representation of a generator for use in the storage assembly of Figure 1;

Figure 3 shows a schematic representation of an alternative generator for use in the storage assembly of Figure 1; and

Figure 4 shows schematic representation of a storage vessel of a second embodiment of the invention.

DETAILED DESCRIPTION

[0010] As can be seen in Figure 1, a fluid storage assembly 100 for storing fluid comprises a fluid storage vessel 10 and an electronic valve assembly 20 for controlling the flow of fluid from the fluid storage vessel 10.

[0011] The fluid storage vessel 10 may be a conventional gas cylinder or pressurised liquid containing cylinder.

[0012] The electronic valve assembly 20 may comprise an electronic valve, electrical storage (a capacitor or a battery 30), and a housing. The electrical storage may be mounted on the electronic valve, or may be mounted on or enclosed within the housing.

[0013] The electronic valve may control flow of fluid into and out of the fluid storage vessel 10.

[0014] The electronic valve assembly 20 may include a variety of sensors, including one or more of: sensors for sensing a parameter of the stored fluid, such as pressure, temperature, mass or volume; sensors for sensing a parameter of the surroundings, such as temperature; and/or sensors for sensing the flow rate of a fluid leaving the fluid storage assembly 100.

[0015] The electronic valve assembly 20 may include a variety of other components, including one or more of: an electromagnetic valve and/or regulator for controlling the rate of flow of fluid from the fluid storage vessel 10; a communications device for transmitting sensed data and/or receiving instructions for actuating an electromagnetic valve; and a display for displaying data, such as sensed data.

[0016] Electronic valve assemblies 20 benefit from a safe source of power for recharging. The inventors have realised that fluid storage assemblies are subjected to vibrations from which energy may be drawn. The inventors have established that significant vibrational energy can be obtained, in particular, during transportation on a road vehicle to the location where they will be used. The oscillations of the road vehicle are large and generally most powerful in the vertical direction.

[0017] In accordance with the invention, the fluid storage assembly also comprises a generator 50. The generator 50 is arranged for generating electricity from vibration. The generator 50 may be arranged to generate electricity from reciprocal motion of the fluid storage assembly 10 in the vertical direction. The generator 50 may be mounted on the fluid storage vessel 10 directly, or via the electronic valve assembly 20, since this will typically be rigidly attached to the cylinder. The generator 50 is arranged for generating electricity from vibration whether or not the fluid storage vessel 10 is in use dispensing fluid at that time.

[0018] The generator 50 is arranged to supply the generated electrical power to the electronic valve assembly 20 (e.g. for powering components thereof as the energy is being generated) and/or the battery 30 (e.g. for charging the battery 30 when the electronic valve 20 is not in use).

[0019] A preferred form of generator 50 is shown in Figure 2. The generator 50 comprises a magnet 56 supported by one or more resilient members 58. For example, a resilient member 58 may be provided either side of the magnet 56 or one resilient member 58 may support the magnet 56.

[0020] The mass of the magnet 56, along with the resilience of the resilient members 58 preferably provide a tuneable generator 50 that will resonate at a desired frequency. Preferably, the magnet 56 will resonate at a frequency in the range 5 Hz to 50 Hz.

[0021] Such a system has been found through extensive testing to be preferable for harvesting energy from the vertical motion of a vehicle such as a lorry for carrying the fluid storage assembly.

[0022] It is expected that much energy may be derived from the prolonged journeys made during delivery along roads and motorways (as opposed to storage yards). For such cases a resonant frequency in the range 8 Hz to 20 Hz is preferred.

[0023] If a fluid storage assembly is to be carried by vehicle around storage yards, then a resonant frequency in the range 5 Hz to 15 Hz is preferred.

[0024] The/each resilient member 58 is preferably a spring. This could be a leaf spring or coil spring, etc. However, it is most preferable that it is a coil spring, since the vibrations to be harvested will be predominantly in the vertical direction. As shown in Figure 2, the coil spring 58 may be oriented in parallel with the vertical direction, which would coincide with a longitudinal dimension of the fluid storage vessel 10 and/or be perpendicular to a floor contacting surface of the base of the fluid storage vessel 10.

[0025] The magnet 56 is located within a coil 52 such that movement of the magnetic field of the magnet 56 cuts the coil 52 thereby generating electricity by induction as is known in the art. Suitable circuitry may be provided for rectification of the generated electrical current, either as part of the generator 50 or the electrical valve assembly 20.

[0026] In an alternative arrangement, the magnet 56 may be static and the coil 52 may reciprocate relative to the magnet 56. In either case, the generator 50 will comprise a guide 54 along which a shuttle (a magnet 56 or a coil 52) is arranged to reciprocate, where motion of the shuttle relative to the guide 54 provides relative motion between a coil 52 and a magnet 56 thereby generating electricity.

[0027] The guide 54 can be one or more rails along which the shuttle reciprocates, as shown in Figure 2, or a tube surrounding the shuttle.

[0028] An alternative is shown in Figure 3, in which the guide 64B may comprise a shaft through a hole in the shuttle in addition to (as shown), or instead of (not shown), guides 64A (one or more rails or a tube) around the shuttle. The resilient member (58) is not shown in Figure 3, but is preferably be provided.

[0029] Low friction bearings, such as roller bearings, ball bearings, or bushes may be provided between the shuttle and guides 64, 64A, 64B.

[0030] Owing to the amplitude of the oscillations likely to be experienced by the fluid storage assembly 100 during vehicular transportation, the shuttle is arranged to move over a range 2mm to 20mm. For example, this may be achieved by the length of the guides 64, 64A, 64B may be 2mm to 20mm.

[0031] A second embodiment of a fluid storage assembly 200 for harvesting energy from vibrations in accordance with the invention is shown in Figure 4.

[0032] Again, the fluid storage assembly 200 for storing fluid comprises a fluid storage vessel 110 and an electronic valve assembly 120 for controlling the flow of fluid from the fluid storage vessel 110. In the same manner as in the first embodiment, a battery 130 may be provided.

In the same manner as in the first embodiment, the electronic valve assembly 20 may comprise a variety of components that require a supply of electricity.

[0033] In this embodiment, the fluid storage assembly 200 further comprises a base 115. The base 115 may define a support surface 118 for supporting the fluid storage vessel 110 in a stable orientation. Typically, this will involve a longitudinal direction of the fluid storage vessel 110 (which may be a cylinder) extending perpendicular to the ground on which the base 115 rests. On flat, level ground, the longitudinal direction will correspond to the vertical direction.

[0034] The generator 150 in this embodiment comprises a piezoelectric material 150, located between the support surface 118 and the fluid storage vessel 110. In this way, the piezoelectric material 150 will support the weight of the fluid storage vessel 110. The piezoelectric material 150 is arranged to generate electricity by its deformation under varying loads, so as the fluid storage vessel 110 oscillates, electricity will be generated. Again, suitable circuitry may be provided for rectification of the generated electrical current, either as part of the generator 150 or the electrical valve assembly 120.

[0035] The generator 150 is arranged to generate electricity from reciprocal motion of the fluid storage assembly 110 in a direction perpendicular to the support surface 118.

[0036] The electronic valve assembly 200 may be arranged to measure the electricity (power voltage and/or current) generated by the piezoelectric material 150 to thereby estimate the mass of the fluid storage assembly 200 from which may be determined an estimate of the amount of fluid stored in fluid storage vessel 110. The estimate may be provided to the electronic valve assembly 120.

[0037] The electronic valve assembly 200 of this embodiment is particularly beneficial for use with liquid carrying fluid storage vessels 110.

[0038] Whereas in the second embodiment, the piezoelectric material 150 is advantageously placed between the support surface 118 and the fluid storage vessel 110, this is not essential. In an alternative arrangement, the piezoelectric material 150 may be located within the electronic valve assembly 120. For example, the piezoelectric material 150 may form a cantilever mounted to the electronic valve assembly 120 at one end with a mass attached to its free end. The mass may be arranged to vibrate in the vertical direction relative to the fluid storage vessel 110. The length of the cantilever and the mass may be chosen to resonate at the same frequencies as the device of the first embodiment.

[0039] Whereas in the description above, there has been presented a sprung-mass-type vibration energy harvesting generator 50, 60 and a piezoelectric-type vibration energy harvesting generator 150, further alternative generators may be provided.

[0040] One alternative generator may comprise a self-winding mechanism that can drive a device such as a dynamo to generate electricity. The self-winding mechanism may be embodied in the manner known in the field of watches. Such a device could be small enough to be housed within the electric valve assembly 20, 120.

[0041] It is also envisaged that the generator may comprise both the sprung-mass-type vibration energy harvesting generator 50, 60 and the piezoelectric-type vibration energy harvesting generator 150. Moreover, there may also additionally be provided a self-winding mechanism that can drive a device such as a dynamo to generate electricity.

[0042] In preferred embodiments, the generator 50, 60, 150 is housed within the electronic valve assembly 20, 120. Even more preferably, the electronic valve assembly 20, 120 also includes the electrical storage 30 which may also be housed within the electronic valve assembly 20, 120. Therefore, the electronic valve assembly 20, 120 forms an integrated unit encapsulating both energy harvesting and energy storage functionality.

Claims

1. A fluid storage assembly for storing fluid comprising:

    a fluid storage vessel (10, 110);
    an electronic valve assembly (20, 120) for controlling the flow of fluid from the fluid storage vessel (10, 110); and
    a generator (50, 60, 150) for generating electricity, the generator arranged to provide electrical power to the electronic valve assembly (20, 120),

    wherein the generator (50, 60, 150) is arranged to generate electricity from reciprocal motion of the fluid storage assembly.

2. The fluid storage assembly of claim 1, further comprising a base (115) defining a support surface (118) for supporting the fluid storage vessel (110) in a stable orientation, wherein the generator (150) is arranged to generate electricity from reciprocal motion of the fluid storage assembly (110) in a direction perpendicular to the support surface (118).

3. The fluid storage assembly of claim 2, wherein the generator (150) comprises a piezoelectric material between the support surface (118) and the fluid storage vessel (110).

4. The fluid storage assembly of claim 3, wherein the electronic valve assembly (20, 120) is arranged to monitor the electricity generated by the piezoelectric material to thereby generate an estimate of the amount of fluid stored in the fluid storage vessel (110).

5. The fluid storage assembly of any preceding claim, wherein the generator (50, 60) comprises a guide (54, 64A, 64B) and a shuttle (56, 66) arranged to reciprocate relative to the guide (54, 64A, 64B), wherein the generator (50, 60) is arranged such that motion of the shuttle (56, 66) relative to the guide (54, 64A, 64B) provides relative motion between a coil (52) and a magnet (56, 66) thereby generating electricity.

6. The fluid storage assembly of claim 5, wherein:

the shuttle is mounted on a resilient member (58); and
the stiffness of the resilient member (58) and the mass of the shuttle (56, 66) are predetermined such that the shuttle (56, 66) resonates at a frequency of 5 Hz to 50 Hz.

7. The fluid storage assembly of any one of claims 5 to 6, wherein the shuttle (56, 66) is arranged to reciprocate over a distance in the range 2mm to 20mm.

8. The fluid storage assembly of any one of claims 5 to 7, wherein the generator (60) comprises a pillar (64B) which extends through the shuttle (66) and along which the shuttle (66) reciprocates.

9. The fluid storage assembly of any preceding claim, wherein the generator comprises a self-winding mechanism.

10. The fluid storage assembly of any preceding claim, wherein the electronic valve assembly (20, 120) comprises electrical storage (30, 130) and the generator (50, 60, 150) charges the electrical storage (30, 130).

11. The fluid storage assembly of any preceding claim, wherein the generator (50, 60, 150) is housed within the electronic valve assembly (20, 120).

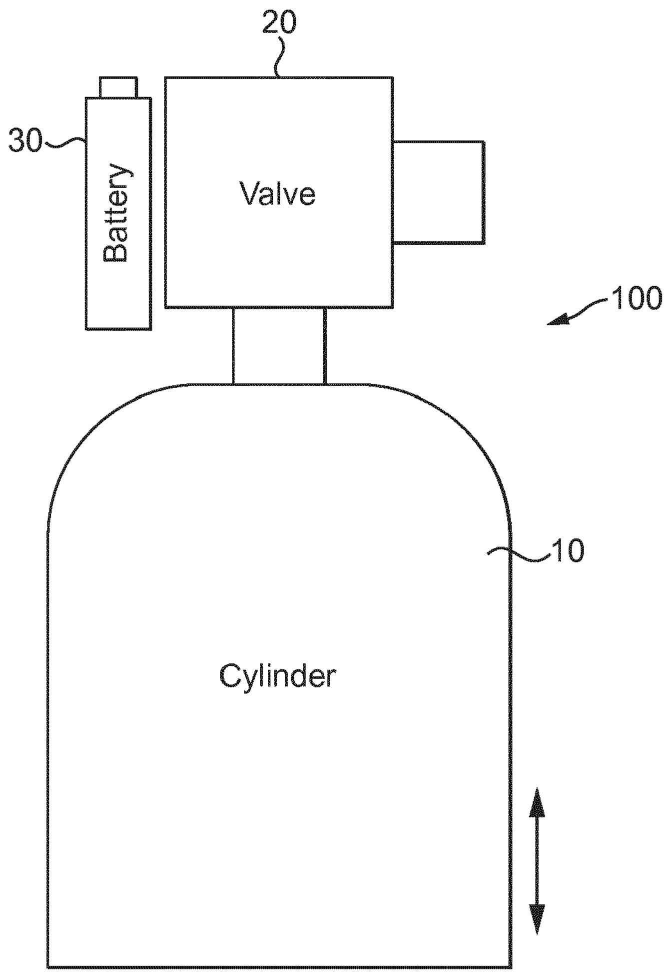

FIG. 1

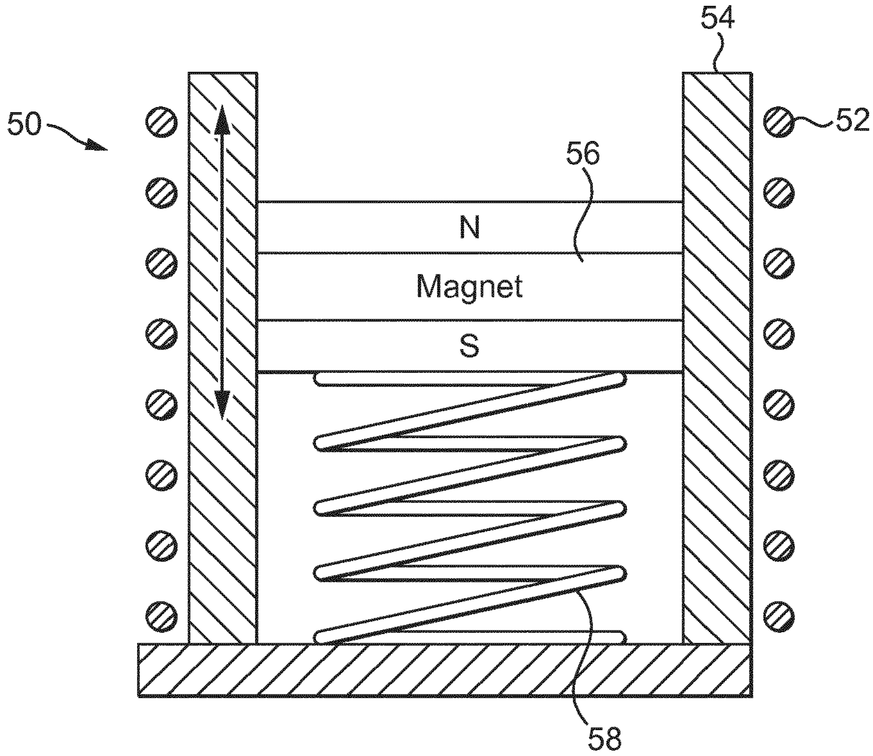

FIG. 2

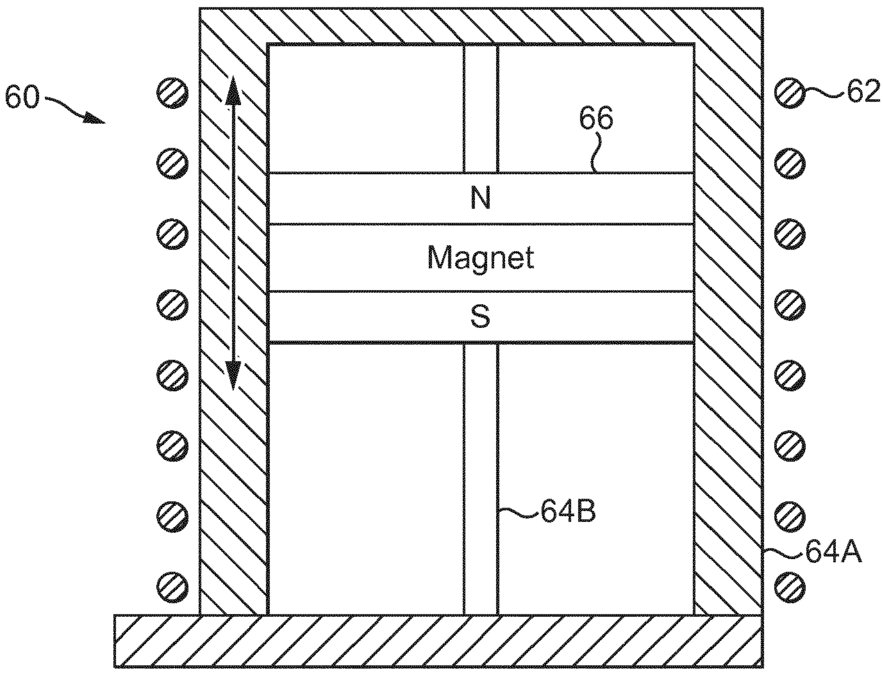

FIG. 3

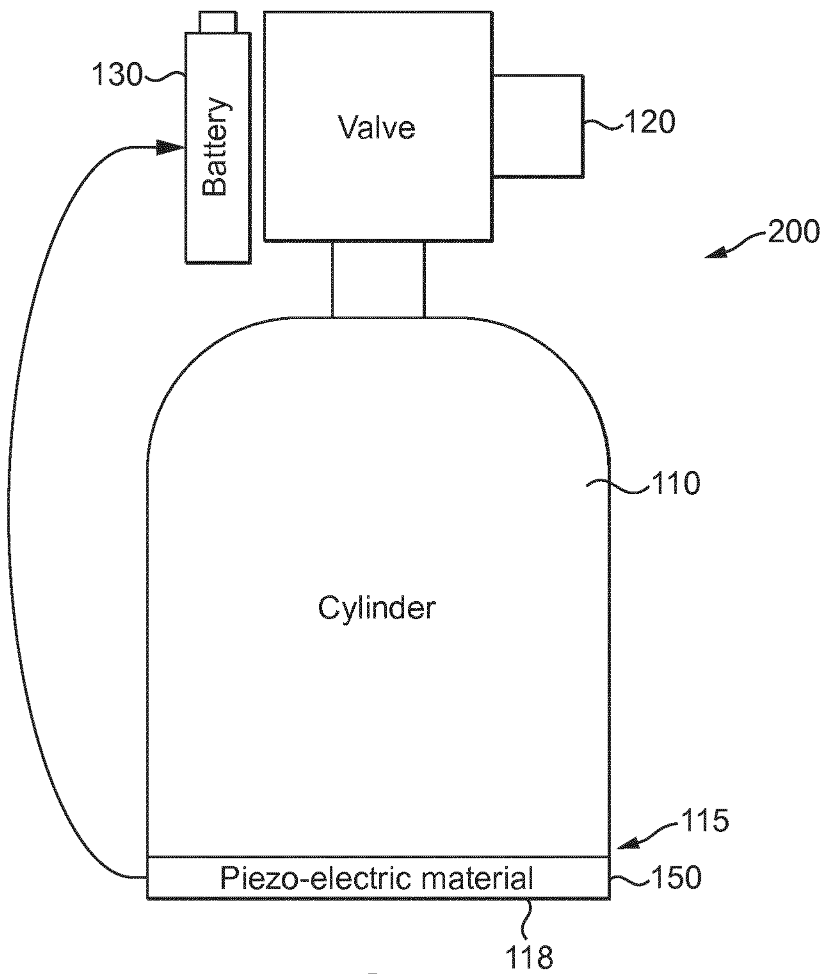
130
Battery
Valve
120
200
110
Cylinder
115
Piezo-electric material
150
118

FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 17 15 5378

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)
F17C

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	11 July 2017	Ott, Thomas

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 17 15 5378

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82