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(54) **SPRAY SYSTEM AND METHOD OF SPRAYING**

(57) A liquid spray system (1a) and method of using a liquid spray system is shown. The spray system (1a) comprises a receptacle (100) for holding liquid to be sprayed, a support structure (200) for supporting the receptacle, a spray applicator (300) and an air pressurising

device (400a) for driving the liquid out of the receptacle (100) and for mixing with the liquid at an outlet of the spray applicator (300). Preferably, the spray system is wearable on a user. Advantageously, the spray system is compact and versatile.

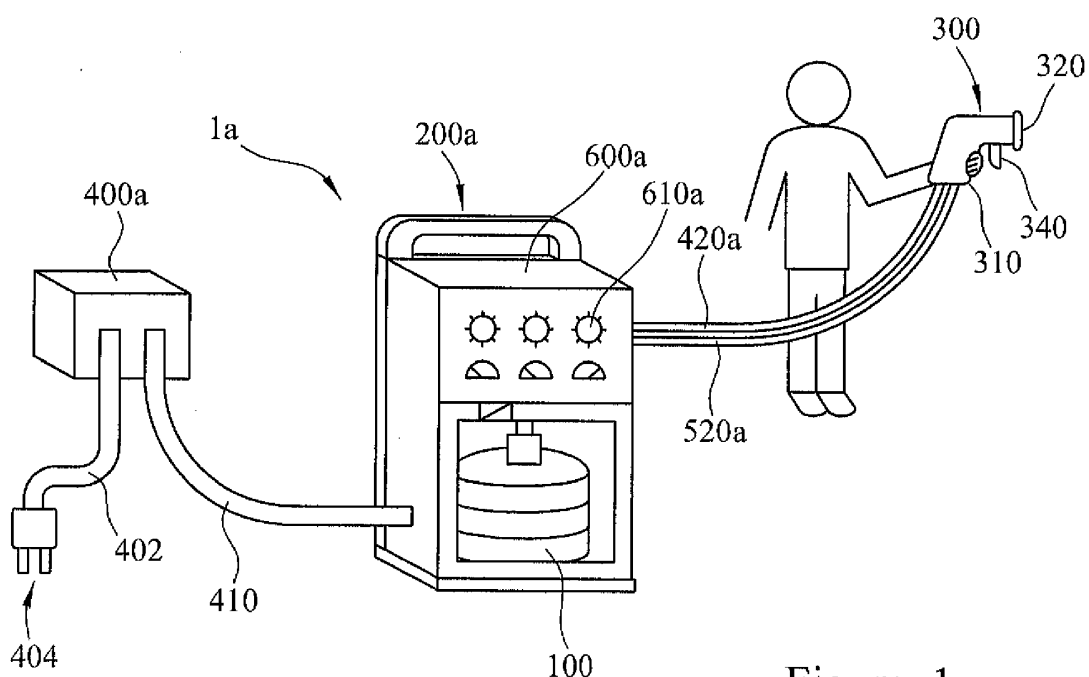


Figure 1

Description**FIELD**

[0001] The present disclosure relates in general to liquid spray systems and methods of using liquid spray systems, particularly, although not exclusively for spraying paint.

BACKGROUND

[0002] Conventionally, a surface to be painted is painted by hand using a brush, pad or roller (conventional applicators). Although painting by brush, in particular, can be accurate, the application of paint onto a surface in this manner is slow. The use of a pad or roller helps to speed-up the painting process compared to the use of a brush (albeit at the cost of some accuracy). Nevertheless, all of the aforementioned approaches require paint to be frequently absorbed onto the specific conventional applicator before the paint can be transferred to the surface to be painted.

[0003] Another conventional paint application approach is to spray the paint toward a surface. Spraying is more efficient than direct contact of the applicator to the surface because the sprayed paint is typically applied in a continuous or semi-continuous manner from a reservoir. Furthermore, the coverage of paint onto a surface is generally more consistent than a brush, pad or roller application and possible accumulation of paint (i.e. unwanted lumps) are avoided. However, as the spraying technique relies on the adhesion properties of the paint to the surface, some spray systems lead to splashback (also known as bounce back) of the paint. This is because not all of the sprayed paint is capable of adhering to the surface and is consequently repelled away from the surface.

[0004] Another disadvantage of conventional spray systems is that it is often difficult to control the quality of an edge finish. In particular, problems such as drift of the paint can lead to overspray, i.e. application of the paint onto an unintended location. To overcome this problem, high-pressure spray systems may be used to ensure effective application of the paint. However, high-pressure spray systems may increase the risk of splashback.

[0005] Both splashback and overspray are problematic because nearby surfaces (including those on the user) may become inadvertently coated. Nearby surfaces are often therefore cleaned after the spray application or covered beforehand. If splashback and overspray can be minimised, the need to extensively mask surfaces, which is time and cost inefficient, can be significantly reduced.

[0006] It is desirable to provide a spray system and method of using a spray system that is more convenient than known systems. A spray system that is also more accurate is desirable. Furthermore, it is desirable that the system is easy to use and/or easy to transport. It is an object of aspects of the present invention to address one

or more of the above mentioned or other problems.

SUMMARY

[0007] According to a first aspect of the present invention there is provided a liquid spray system comprising:

a receptacle for holding liquid, the receptacle comprising:

a main body;

a reservoir having a liquid outlet;

a displacement member moveable within the main body for varying a capacity of the reservoir and having a liquid contacting side and an air contacting side;

an air inlet in fluid communication with the air contacting side of the displacement

member;

a support structure for supporting the receptacle;

a spray applicator comprising:

a liquid inlet for receiving liquid from the liquid outlet of the reservoir;

a liquid outlet;

a liquid outlet valve for controlling the release of liquid via the liquid outlet;

a trigger for controlling the outlet valve; and

an air pressurising device in fluid communication with the air contacting side of the displacement member and arranged to be operable to move the displacement member, in use; the air pressurising device also being in fluid communication with the liquid outlet valve of the spray applicator and being arranged to be operable to propel liquid out of the liquid outlet valve of the spray applicator, in use.

[0008] The displacement member suitably comprises a flexible membrane.

[0009] The flexible membrane is suitably coupled to the main body of the receptacle at a portion of the air inlet and a portion of the liquid outlet.

[0010] The liquid outlet portion of the reservoir and air inlet portion of the receptacle are suitably arranged at or towards opposite ends of the receptacle.

[0011] The main body suitably comprises a coating arranged on an air contacting side for preventing adhesion of the flexible membrane with the main body.

[0012] The support structure suitably comprises an accommodating part for receiving the receptacle. The receptacle may be a cartridge. The cartridge suitably comprises a one-way valve for restricting liquid flow into the cartridge.

[0013] Suitably, the air inlet of the liquid spray system comprises the one-way valve.

[0014] The receptacle suitably comprises a pressure relief valve operable to equalise pressure on the air side of the displacement member with ambient air.

[0015] The support structure suitably comprises a connecting member interposed between the liquid outlet portion of the reservoir and the liquid inlet of the spray applicator. Suitably, the connecting member is connectable to a first transmission line for transmitting liquid from the liquid outlet portion of the reservoir to the connecting member and a second transmission line for transmitting liquid away from the connecting member and to the liquid inlet of the spray applicator.

[0016] The support structure suitably comprises a receptacle holding part and a ground contacting part wherein the ground contacting part is moveable relative to the receptacle holding part for guiding the receptacle holding part over ground.

[0017] Suitably, the support structure is arranged for supporting the air pressurising device. The support structure may be wearable on a user.

[0018] The liquid spray system may further comprise a control valve for restricting propellant air supplied by the air pressurising device in fluid communication with the outlet valve of the spray applicator to a pressure of less than 1.1 bar.

[0019] The support structure is suitably arranged to encase the receptacle.

[0020] The air pressurising device may comprise a compressor.

[0021] The liquid of the liquid spray system suitably comprises paint or varnish. The paint or varnish may be any suitable paint or varnish. For example, the paint may be a solvent or water based lacquer. Suitable lacquers may include oxidatively drying solvent or water based alkyd or acrylic lacquers.

[0022] The liquid spray system may be used in conjunction with an unmanned aerial vehicle (UAV), such as a drone. The liquid spray system may be at least partially or wholly mounted on or in an unmanned aerial vehicle (UAV). The entire liquid spray system may be mounted on or in an unmanned aerial vehicle (UAV).

[0023] The spray applicator may be mounted on or in an unmanned aerial vehicle (UAV). The spray applicator may be mounted on or in an unmanned aerial vehicle (UAV), while the receptacle for holding liquid may be mounted not on the unmanned aerial vehicle (UAV). The receptacle for holding liquid may be connected to the UAV mounted spray applicator by one or more delivery conduits. The delivery conduits suitably being operable to deliver the liquid spray and pressured air from the air pressurising device. Suitably, such an arrangement al-

lows for the UAV to administer the liquid spray at a position remote from the receptacle for holding liquid.

[0024] The unmanned aerial vehicle (UAV) may operate under remote control by a human operator or autonomously by onboard sensors/computers.

[0025] According to a second aspect of the present invention there is provided a method of using a liquid spray system comprising the steps of:

10 filling a reservoir of a receptacle with liquid;

loading the receptacle into a support structure;

15 supplying gas to a displacement member of the receptacle from a gas pressurising device;

moving the displacement member relative to a main body of the receptacle with gas supplied by the gas pressurising device;

20 guiding liquid from the reservoir towards a spray applicator;

activating a trigger of the spray applicator; and

25 propelling liquid from an outlet valve of the spray applicator using gas from the gas pressurising device as propellant.

30 **[0026]** The method may comprise filling the reservoir with liquid during manufacture and providing the receptacle as a cartridge.

[0027] The method may comprise disturbing a tamper-proofing means comprised by the cartridge. The method may comprise disturb the tamper-proofing means during loading the cartridge into the support structure.

[0028] The method may comprise releasing gas from a gas side of the displacement member using a pressure relief valve for equalising pressure with ambient air.

40 **[0029]** The method may comprise wearing the support structure.

[0030] The gas used in the method suitably comprises air.

[0031] The liquid of the method is suitably a coating composition, such as a paint composition or a varnish composition. The paint or varnish may be any suitable paint or varnish. For example, the paint or varnish may be a solvent or water based lacquer. Suitable lacquers may include oxidatively drying solvent or water based alkyd or acrylic lacquers.

50 **[0032]** According to a third aspect of the present invention there is provided a kit of parts for a liquid spray system comprising:

55 a cartridge filled with liquid for spraying;

a support structure for supporting the cartridge;

a spray applicator; and

an air pressurising device.

[0033] Further suitable features of the invention may become apparent from the further description, hereunder. The liquid spray system comprises a receptacle for holding liquid. The receptacle is suitably a container for storing liquid. The receptacle includes a main body and a displacement member movable within the main body. The displacement member is therefore suitably a moveable member. The main body is suitably an outer part of the receptacle and encloses the displacement member.

[0034] The receptacle comprises a reservoir having a reservoir outlet, suitably adapted to allow release of the liquid from the reservoir. The displacement member is suitably configured to move relative to the main body in order to vary the capacity of the reservoir. The displacement member comprises a liquid contacting side and an air contacting side. The liquid contacting side and the air contacting side may be permanent in that, when liquid is present in the receptacle, the liquid is always present on the liquid contacting side. The receptacle further comprises an air inlet. The air inlet is communicable with the air contacting side of the displacement member. That is, the air inlet is in fluid communication with air contacting side of the displacement member. The spray system further comprises a support structure for supporting the receptacle. That is, the support structure suitably restricts movement of the receptacle relative to the support structure. Therefore, when the receptacle is coupled to the support structure, the receptacle and support structure are suitably provided as one body.

[0035] The spray system comprises a spray applicator. The spray applicator is suitably configured to release liquid from the spray system in the form of spray. The spray applicator comprises a liquid inlet for receiving liquid from the liquid outlet of the reservoir, a liquid outlet, a liquid outlet valve for controlling the release of liquid via the liquid outlet and a trigger for controlling the outlet valve. That is, the outlet valve is suitably a trigger-operated valve, wherein activation of the trigger (which may comprise movement) may produce movement in the outlet valve.

[0036] The spray system further comprises an air pressurising device. The air pressurising device is in fluid communication with the air contacting side of the displacement member and is arranged to be operable to move the displacement member, in use. The air pressurising device is also arranged to be in fluid communication with the liquid outlet valve of the spray applicator and is arranged to be operable to propel liquid out of the liquid outlet valve of the spray applicator, in use. The air pressurising device may be operable to provide a driving force to move the displacement member so that liquid is expelled from the reservoir and out of the spray applicator. The air from the air pressurising device suitably atomises the liquid.

[0037] The receptacle may be provided as a cartridge. Advantageously, the receptacle is easy to install and the risk of liquid loss is reduced. The cartridge may be a refillable cartridge rather than a one-time use cartridge.

Refilling the cartridge may only be possible by allowing air to be released from inside the receptacle to allow the displacement member to move.

[0038] The receptacle or cartridge may comprise a tamper-proofing means such as a tamperproof seal. The cartridge may comprise a one-way valve for restricting liquid flow into the cartridge. The air inlet of the receptacle may be the one-way valve. The one-way valve may be overridden to release air from the air contacting side of the displacement member. The receptacle may comprise a pressure relief valve for equalising pressure on the air side of the displacement member with ambient air. That is, the effect of a one-way valve may be overcome by the pressure relief valve.

[0039] The spray system may comprise a plurality of receptacles. Alternatively, the spray system may comprise a single receptacle that is in use at any one time and space for accommodating another receptacle that is not in use (i.e. liquid is not transportable to the spray applicator). The reservoir of each receptacle may have a different volumetric capacity. A plurality of receptacles may be in fluid communication with the spray applicator or only one receptacle at any one time may be in fluid communication with the spray applicator.

[0040] An inner wall of the main body that is configured to contact air rather than liquid may comprise a non-stick coating to allow the displacement member to contact the inner wall without sticking thereto. The non-stick coating may be a sprayable non-stick coating. The term non-stick refers to a reduction in tackiness such that abutting parts are prevented from being bonded to each other. The non-stick coating applied to the inner wall may have the effect of reducing the adherence of the displacement member to the main body such that the displacement member can move freely. When the displacement member comprises a flexible membrane, the main body may comprise a coating arranged on an air contacting side for preventing adhesion of the flexible membrane with the main body. The coating is therefore suitably a non-stick coating.

[0041] The main body may be cylindrical. The main body may comprise a neck within which the liquid outlet of the reservoir is arranged. The main body may be a pressure vessel to allow the reservoir to be under pressure. That is, the main body may resist deformation under liquid and/or air pressure.

[0042] The main body may define part of the reservoir. The portion of the main body forming part of the reservoir may be variable depending on the varying capacity of the reservoir. The displacement member alone may define the reservoir such that when the reservoir contains liquid the liquid is not configured to come into contact with the main body. The reservoir outlet may also function as an inlet but may only be operable when air is released.

able from the air contacting side because air between the displacement member and the main body may prevent the reservoir from filling and/or refilling.

[0043] The displacement member may be slidably arranged relative to the main body. That is, the movement of the displacement member is suitably a sliding movement. The displacement member may be generally rigid or generally flexible.

[0044] The displacement member may comprise a flexible membrane that is operable as a bladder. The bladder may contract and expand. Expansion of the bladder may cause a reversible thinning of the membrane. The main body may determine a limit of expansion of the bladder, particularly an inner wall of the main body. The flexible membrane may be coupled to the main body of the receptacle at a portion of the air inlet and a portion of the liquid outlet. This ensures that the flexible membrane is held relative to the main body.

[0045] The liquid outlet portion of the reservoir and air inlet portion of the receptacle are arranged at or towards opposite ends of the receptacle. The liquid outlet portion may be arranged in a neck of the main body.

[0046] The support structure may comprise an accommodating part for receiving the receptacle. A first liquid transmission line may interlink the receptacle and the spray applicator. A first air transmission line may interlink the air pressurising device and the receptacle. A second air transmission line may interlink the receptacle and the spray applicator.

[0047] A first liquid transmission line may interlink the receptacle and a control unit and a second liquid transmission line may interlink the control unit and the spray applicator. Additionally, a first air transmission line may interlink the air pressurising device and the control unit, a second air transmission line may interlink the control unit and the receptacle and a third air transmission line may interlink the control unit and the spray applicator.

[0048] The support structure may comprise a connecting member interposed between the liquid outlet portion of the reservoir and the liquid inlet of the spray applicator. The connecting member may be connectable to a first transmission line for transmitting liquid from the liquid outlet portion of the reservoir to the connecting member and a second transmission line for transmitting liquid away from the connecting member and to the liquid inlet of the spray applicator. The connecting member may comprise a control valve. That is, the connecting member may be a control unit for controlling the flow of liquid from the receptacle to the spray applicator. A first air transmission line and second air transmission line may be similarly connected either side of the connecting member, wherein the connecting member may comprise an air control valve. The control unit may control either or both of the air and liquid flows. The control unit may be wearable on a user, for example as a belt. The control unit may be attachable to the support structure.

[0049] The transmission lines may be elongate members having a passageway for the transportation of liquid

or air. The elongate members may be flexible so that their orientation can be changed. A transmission line may be a hose.

[0050] The support structure may be arranged to support the air pressurising device. The air pressurising device may be enclosed by the support structure. The support structure may be wearable on a user. That is, the support structure may be provided in the form of a backpack.

[0051] The support structure may be arranged to encase the receptacle. The support structure may comprise a hatch for accessing the receptacle. The hatch may be pivotable. The hatch may comprise a transparent portion for visual inspection of an inside of the support structure.

[0052] The support structure may comprise a receptacle holding part and a ground contacting part. The ground contacting part may be moveable relative to the receptacle holding part for guiding the receptacle holding part over ground. The ground contacting part may comprise at least one wheel. Preferably, the ground contacting part comprises a plurality of wheels for stability. Therefore, the support structure may be provided in the form of a trolley.

[0053] The support structure may comprise a handle for manually gripping the support structure. The handle may be telescopic. The support structure may have a resting position that is configured to maintain a base of the receptacle parallel to a ground surface.

[0054] The spray applicator may be a spray gun. That is, the spray applicator may be holdable in a user's hand and the trigger may be operable by one or more of the user's fingers, such as a user's forefinger (index finger). The spray applicator may comprise a primary air outlet in fluid communication with the air pressurising device and the liquid outlet valve of the spray applicator.

[0055] The spray system may comprise a control valve for restricting propellant air supplied by the air pressurising device in fluid communication with the outlet valve of the spray applicator to a pressure of less than 1.1bar. Suitably, the pressure is between 0.5bar and 1bar. For example, the pressure may be between 0.6bar and 0.7bar, such as about 0.62bar. Such pressure may help to reduce turbulence and therefore improves control.

[0056] The spray applicator may comprise a secondary air outlet that is in fluid communication with the air pressurising device and is configured for varying a spray pattern (i.e. fan shape) of liquid spray from the liquid outlet. The secondary air outlet may control the fan shape to be round or flat. That is, a round spray pattern results in a coated area that is round and the flat spray pattern results in a coated area that is linear. The secondary air outlet may therefore be provided downstream of the primary air outlet. The liquid outlet may be provided upstream of the primary air outlet.

[0057] The spray applicator may comprise the control valve. The control valve may be a primary regulator to control the flow rate of air towards the primary air outlet. The spray applicator may comprise a secondary regula-

tor to control the flow rate of air towards the secondary air outlet. The primary and secondary regulators may be independently controlled. The primary and secondary regulators may be concentric.

[0058] The regulator may be operable to control a pressure of air at the secondary air outlet to be at least 10% greater than a pressure of air at the primary outlet. Suitably, the pressure at the secondary air outlet is at least 25% greater than a pressure of air at the primary outlet. For example, the pressure at the secondary air outlet may be from 20% to 40% greater than a pressure of air at the primary outlet. The pressure at the secondary air outlet may be from 25% to 33% greater than a pressure of air at the primary outlet. When the pressure at the primary air outlet is about 0.62bar, the pressure at the secondary air outlet is suitably between 0.75bar and 0.85bar.

[0059] The trigger may be depressible. The trigger may be depressible towards a handle of the spray applicator. The trigger may be biased away from a main body of the spray applicator by a biasing means. The biasing means may be a resilient member. The resilient member may be a spring, for example a compression spring. The main body may have a gripping portion for being gripped by a user's hand. The trigger may be moved from a resting position to a pre-loading position before the outlet valve is activated. This may allow for unwanted movement of the trigger to be absorbed without the release of liquid from the spray applicator. Therefore, the movement between the resting position and pre-loading position is suitably a non-activation event.

[0060] The air pressurising device may be a compressor. The compressor may be electronically operated. The air pressurising device may be connected to an energy store for providing energy to operate the compressor, for example a battery. Alternatively, or additionally, the air pressurising device may be operable by mains electricity. A first air transmission line may be connected between the compressor and the air inlet of the receptacle. A second air transmission line may be connected between the compressor and the spray applicator. A control unit may be interposed between the compressor and the air inlet of the receptacle. At least one of the transmission lines may be a hose, which may be flexible.

[0061] The liquid may be a coating, such as a paint or varnish. The liquid may be a lacquer. The paint may be an acrylic paint or an alkyd paint. For example, the paint or varnish may be a solvent or water based lacquer. Suitable lacquers may include oxidatively drying solvent or water based acrylic or alkyd lacquers.

[0062] It is a further aim to provide a method of using a liquid spray system. The method comprises the step of filling a reservoir of a receptacle with liquid. The method further comprises loading the receptacle into a support structure. The method further comprises supplying gas to a displacement member of the receptacle from a gas pressurising device. The method further comprises moving the displacement member relative to a main body of

the receptacle with gas supplied by the gas pressurising device. That is, the gas pressurising device provides the motive force for moving the displacement member. The method further comprises guiding liquid from the reservoir towards a spray applicator, activating a trigger of the spray applicator and propelling liquid from an outlet valve of the spray applicator using gas from the gas pressurising device as propellant.

[0063] Suitably, the step of filling the reservoir with liquid is performed during manufacture of the receptacle and the receptacle is provided as a cartridge. That is, suitably a receptacle cannot easily be filled by an end-user. The step of filling the reservoir may comprise expanding the reservoir in proportion to the increase in received liquid volume. That is, the reservoir may have a smaller first (or pre-filled) volume compared to a second (or filled) volume. Suitably, the step of filling the reservoir comprises opening a one-way valve. Suitably an air inlet of the receptacle comprises the one-way valve. Suitably, the one-way valve is kept open while the reservoir is filled.

[0064] The step of loading the receptacle into the support structure may comprise loading the receptacle along guiding means. The guiding means may be guiding rails. The guiding means may conform to a shape of an outer wall of the receptacle. The step of loading the receptacle into the support structure may comprise loading the receptacle until a gripping means is engaged. The gripping means may be biased toward a central space in which the receptacle is loaded. The gripping means may be moved under pressure. The pressure may be overcome by hand when pushing the receptacle into the support structure by hand.

[0065] The gas pressurising device may be a compressor. The compressor may be powered by mains electricity or by a battery. The gas may be supplied to a gas inlet of the receptacle. The gas inlet may be in fluid communication with a gas side of the displacement member.

[0066] The method may comprise disturbing a tamper-proofing means comprised by the cartridge. Advantageously, a cartridge can remain closed until used by an end-user. The method may comprise disturbing the tamper-proofing means during loading the cartridge into the support structure. Advantageously, a separate step of removing the tamper-proofing means is not required which is more convenient for an end-user. A single action of loading the cartridge results in the tamper-proofing means being overcome.

[0067] Suitably, the method comprises the step of releasing gas from a gas side of the displacement member using a pressure relief valve for equalising pressure with ambient air. The gas may comprise air.

[0068] The method may comprise wearing the support structure. Alternatively or additionally, the support structure may comprise a ground contacting part and a receptacle holding part and the method may comprise moving the ground contacting part relative to the receptacle holding part so that the receptacle holding part is guided over ground. The ground contacting part may comprise at

least one wheel. Suitably, the ground contacting part may comprise a plurality of wheels for stability. Therefore, the support structure may be provided in the form of a trolley.

[0069] The method may comprise using the liquid spray system in conjunction with an unmanned aerial vehicle (UAV), such as a drone. The liquid spray system may be at least partially or wholly mounted on or in an unmanned aerial vehicle (UAV). The entire liquid spray system may be mounted on or in an unmanned aerial vehicle (UAV).

[0070] The spray applicator may be mounted on or in an unmanned aerial vehicle (UAV). The spray applicator may be mounted on or in an unmanned aerial vehicle (UAV), while the receptacle for holding liquid may be mounted not on the unmanned aerial vehicle (UAV). The receptacle for holding liquid may be connected to the UAV mounted spray applicator by one or more delivery conduits. The delivery conduits suitably being operable to deliver the liquid spray and pressurized air from the air pressurizing device. Suitably, such an arrangement allows for the UAV to administer the liquid spray at a position remote from the receptacle for holding liquid.

[0071] The method may further comprise operating the unmanned aerial vehicle (UAV) under remote control by a human operator or autonomously by onboard sensors/computers.

[0072] The liquid may be a coating composition, such as a paint or varnish. The liquid may be a lacquer. The paint may be an acrylic paint or an alkyd paint. For example, the paint or varnish may be a solvent or water based lacquer. Suitable lacquers may include oxidatively drying solvent or water based acrylic or alkyd lacquers.

[0073] A kit of parts for a liquid spray system may be provided. The kit of parts may comprise a cartridge filled with liquid for spraying, a spray applicator, an air pressurising device and a support structure for supporting the cartridge. Each of the parts may correspond to the corresponding component part as previously described.

[0074] All of the features disclosed herein may be combined with any of the above aspects and in any combination.

BRIEF DESCRIPTION OF DRAWINGS

[0075] For a better understanding of the invention, and to show how example embodiments may be carried into effect, reference will now be made to the accompanying drawings in which:

Fig. 1 shows a perspective view of a user spraying a surface with a first embodiment of a spray system, wherein a support structure of the spray system is floor-standing and not wearable on the user;

Fig. 2 shows a cross-sectional view of the receptacle of Fig. 1;

Fig. 3 shows a perspective view of the support struc-

ture of Fig. 1 wherein a hatch of the support structure is in an open position for accessing a receptacle shown as a cartridge housed by the support structure;

Fig. 4 shows the support structure of Fig. 3 alternatively housing a second cartridge of relatively smaller volume than the cartridge shown in Fig. 3 wherein the hatch is in a closed position;

Fig. 5 shows the main unit of Fig. 3 wherein the support structure comprises a control unit which is attachable to a receptacle holding part of the support structure;

Fig. 6 shows a second embodiment of the spray system, wherein a support structure of the second embodiment comprises a floor contacting part comprising wheels;

Fig. 7 shows a receptacle holding part of the support structure of the second embodiment for housing a plurality of cartridges;

Fig. 8 shows a control unit of the second embodiment attached to a user;

Fig. 9 shows a third embodiment of the spray system, wherein a support structure and a control unit are wearable on a user, wherein an air pressuring device is floor-standing and not wearable on the user;

Fig. 10 shows a fourth embodiment of the spray system, wherein a support structure and an air pressurising device powered by an energy storage unit are wearable on a user;

Fig. 11 shows the support structure and air pressurising device of Fig. 10;

Fig. 12 shows alternative embodiments of the support structure; and

Fig. 13 shows a control unit of the fourth embodiment.

Fig. 14 shows a flow chart of a method of using a liquid spray system.

DESCRIPTION OF EMBODIMENTS

[0076] At least some of the following example embodiments provide an improved liquid spray system, method of using a liquid spray system and kit of parts for a liquid spray system. The example system is simple and convenient for the user. Additionally, the effect of splashback and overspray is reduced. Other advantages and improvements will be discussed in more detail herein.

[0077] A spray system 1a according to a first embodiment is shown in Figure 1. The spray system comprises a receptacle 100 for containing liquid to be sprayed onto a surface. The receptacle is shown as a bottle in the form of a cartridge. Using a cartridge is advantageous because the liquid can be easily changed, particularly when the liquid remaining in the receptacle is low. The cartridge may comprise a tamper-proofing means (not shown). The tamper-proofing means may be disturbed when inserting the cartridge. Alternatively, the tamper-proofing means may be removed manually by a user before inserting the cartridge. In Figure 1, a cylindrical receptacle is shown. The capacity of the receptacle is 4L, although a 2L receptacle can be equally used. Advantageously, the support structure is capable of holding cartridges of varying capacity and/or size.

[0078] The receptacle 1a shown in Figure 1 is installed in a support structure 200a. The support structure is a floor-standing support structure. That is, the support structure has a predetermined resting position. The resting position equates to a vertical orientation of the receptacle when installed in the support structure.

[0079] The spray system 1a further comprises a spray applicator 300 that is holdable by the hand of the user. The spray applicator comprises a trigger 340 for activating the release of the liquid away from a liquid outlet valve (not shown) of the spray applicator. The trigger is preferably biased towards a first position that is a non-activating position. The biasing means may be a resilient member such as a spring. The spray applicator is a spray gun. The spray applicator has a liquid outlet 320 that is arranged at an opposite end to a liquid inlet 310.

[0080] The spray system 1a comprises an air pressurising device 400a in the form of a compressor. The compressor supplies the receptacle 100 with air pressure so that the liquid can be driven out of the receptacle and towards the spray applicator 300. The compressor is shown to be powered by mains electricity and comprises an electrical connector 404 that supplies electricity through an electrical cable 402. However, the air pressurising device may be a canister of pressurised air. The canister is advantageous because it is portable and can be easily used outside without the risk of electrical shock. Furthermore, the compressor may be powered by a battery rather than mains electricity.

[0081] The spray system 1a is further shown with transmissions lines 410, 420a, 520a. The transmission lines are hoses that convey air or liquid around the spray system. For example, a first air transmission line 410 provides fluid communication between the compressor and the receptacle 100. A second air transmission line 420a and a first liquid transmission line 520a fluidly link the receptacle and the spray applicator 300. A three-way connector may separate the first and second air transmission lines so that air supplied under pressure from the compressor is diverted from the first air transmission line towards the receptacle to drive a displacement member 130 of the receptacle and force liquid out of the re-

ceptacle.

[0082] Finally, a control unit 600a with control dials 610a is shown that is attached to the support structure 200a. Although three control dials are shown, at least one control dial may be used to simplify the options for adjustment. The control unit is removable from the support structure. That is, the control unit can be coupled and decoupled to the support structure. This allows the control unit to be removed for maintenance, repair or update.

[0083] The receptacle 100 is shown in cross-section in Figure 2. The receptacle comprises a main body 110 that is an outer part of the receptacle. The main body may be made from metal. The receptacle further comprises a displacement member 130 that is provided as a bladder. The displacement member is configured to expand and contract as liquid fills and leaves (through a liquid outlet (not shown) of) a reservoir 120, respectively. In the example shown, the reservoir is provided by the displacement member alone and not the main body. However, in an alternative embodiment, the reservoir 120 may be formed by the main body and the displacement member, for example, if the displacement member is provided as a piston. The displacement member therefore has an air contacting side 134 and a liquid contacting side 132. The main body also has an air contacting side 112 that comes into contact with the displacement member. To allow the displacement member to move freely away from the air contacting side of the main body, the air contacting side comprises a coating that is a non-stick coating to avoid the adhesion of the displacement member to the main body.

[0084] Figure 2 further shows an air inlet 140. The air inlet allows air to enter the receptacle 100 from the compressor. The air contacts the air contacting side 112 of the main body 110 and the air contacting side 134 of the displacement member 130 to force the displacement to move. In the example shown, the displacement member is a bladder and comprises a flexible membrane allowing the displacement member to be manipulated so that the displacement member can expand and contract by air pressure. The air inlet comprises a one-way valve 142 for restricting air flow and preventing air flow out of the receptacle. This prevents the reservoir 120 being filled without circumventing (i.e. overcoming) the one-way valve because the displacement member is prevented from expanding when liquid enters the reservoir. Advantageously, the cartridge may not be refillable by the user without a special tool to open the one-way valve.

[0085] The support structure 200a of the first embodiment is shown in more detail in Figures 3 to 5. As previously mentioned, the support structure is shown with a removable control unit 600a that regulates the flow of air and/or liquid of the spray system 1a. Transmissions lines 420a, 520a are shown to transport the air and liquid around the system. Furthermore, a 2L cartridge 100-12 and a 4L cartridge 100-14 are shown. The support structure comprises a handle 244 for ease of transportation.

The cartridge is removed by opening a door 240, shown as a hatch. The door may comprise a window for visual inspection of the inside of the support structure. The door comprises an opening means 242. The opening means may be a handle. However, preferably the opening means is a button to release the hatch. The door is hinged to allow the door to pivot and provide an opening through which to pass the receptacle 100. The support structure 200a comprises an accommodating part 220 for receiving the receptacle (i.e. housing the receptacle) and a ground contacting part 230a for abutment against a ground surface. The accommodating part is therefore a receptacle holding part 220. A further liquid transmission line 510a is shown that is arranged to convey liquid from the receptacle to the control unit.

[0086] A spray system 1b according to a second embodiment is shown in Figure 6. The spray system of the second embodiment differs from the spray system 1a of the first embodiment in that the air pressurising device 400b is powered by liquid fuel, such as diesel or gasoline, the support structure 200b is arranged in the form of a trolley and the control unit 600b (see Figure 8) is wearable on the user.

[0087] A first air transmission line 410 connects the air pressurising device 400b and the support structure 200b. Although not shown, a first liquid transmission line 510b is connected between a liquid outlet portion of the reservoir 120 and a connecting member 210 shown in Figure 7. A second liquid transmission line 520b is configured to transmit liquid away from the connecting member and toward the liquid inlet 310 of the spray applicator 300. Similarly, a second air transmission line 420b is configured to transmit air from the connecting member and toward the spray applicator to propel liquid out of the liquid outlet valve of the spray applicator. Both the second liquid transmission line and the second air transmission line comprise a pair of transmission sub-lines. A first air transmission sub-line 420b-1 is connected upstream of the control unit 600b and a second air transmission sub-line 420b-2 is connected downstream of the control unit. Likewise, a first liquid transmission sub-line 520b-1 is connected upstream of the control unit and a second liquid transmission sub-line 520b-2 is connected downstream of the control unit. A control dial 610b is used to control the passage of liquid and/or air.

[0088] The support structure 200b comprises a telescopic handle for ease of storage. The support structure comprises a receptacle holding part 220 (i.e. an accommodating part) and a ground contacting part 230b. Unlike the support structure 220a of the first embodiment, the support structure of the second embodiment is capable of holding a plurality of receptacles 100 at once. Each receptacle may be a different size as shown in Figure 7. The receptacle holding part comprises a door that allows access to the inside of the receptacle holding part (i.e. the region accommodating the at least one receptacle). The door does not comprise a window. The ground contacting part comprises a plurality of wheels. The wheels

may be connected by a common axle. Alternatively, the wheels may rotate independently and therefore have separate axles. The ground contacting part further comprises a foot provided away from the wheels. The foot does not move relative to the receptacle holding part but is configured to rest against a ground surface when the support structure is in a standing position.

[0089] A spray system 1c according to a third embodiment is shown in Figure 9. The spray system differs from the spray system 1a of the first embodiment in that the support structure 200c and control unit 600c are both wearable on a user (the support structure comprises a ground contacting part 230c for resting the support structure on ground in a resting position). The support structure is worn by the user using shoulder straps 260c and the control unit is worn using a belt 270c. The air pressurising device 400a of the first embodiment is shown. However, the air pressurising device 400b of the second embodiment can equally be used. The air pressurising device is powered by mains electricity and comprises an electrical connector 404 that supplies electricity through an electrical cable 402.

[0090] The first air transmission line 410 of the third embodiment is connected between the air pressurising device 400a and the control unit 600c. The control unit therefore acts as a hub about which the network of transmission lines is arranged. A second air transmission line 420c comprises a first air transmission sub-line 420c-1 which transmits air towards the receptacle 100 and a second air transmission sub-line 420c-2 transmits air towards the spray applicator 300. Additionally, a first liquid transmission line 520c comprises a first liquid transmission sub-line 520c-1 which transmits liquid from the receptacle 100 to the control unit and a second liquid transmission sub-line 520c-2 transmits liquid from the control unit to the spray applicator. Therefore, the first and second liquid transmission sub-lines flow in and out of the control unit whereas the first and second air transmission sub-lines both flow out of the control unit since the first air transmission line supplies the control unit with air from the air pressurising device.

[0091] Finally, a spray system 1d according to a fourth embodiment is shown in Figure 10. The spray system of the fourth embodiment is similar to the spray system 1c of the third embodiment in that the support structure 200d and control unit 600d (including at least one control dial 610d as shown in Figure 13) are both wearable on a user. The support structure is provided as a backpack. The backpack includes shoulder straps 260d and a belt 270d. The air pressurising device 400d of the fourth embodiment is powered by a battery. This allows the spray system to be portable and the air pressurising device can be carried by the user. The support structure comprises a plurality of compartments, each for the receptacle and the air pressurising device with battery. A lower compartment is the ground contacting part 230d.

[0092] Figure 12 shows two variations of the shoulder straps 260e, 260f and belt 270e, 270f combination of

Figures 9 and 10. These variations comprise holders for further receptacles 100 or generally pockets for storing other items of use. The shoulder straps and belt are comfortable and convenient for a user.

[0093] Figure 14 shows a method 1000 of using a liquid spray system. The method includes filling the receptacle with liquid (S100), preferably a coating composition such as a paint or varnish. The filling step may be performed using a one-way valve so that an end-user cannot easily re-fill the receptacle because the one-way valve may require a special tool to overcome. Once the receptacle is filled, the receptacle can be loaded into a support structure (S200). When the receptacle comprises a tamper-proofing means, the step of loading the receptacle may disturb the tamper-proofing means and allow the liquid to be released from the receptacle. Once the receptacle is loaded, gas is supplied to a displacement member of the receptacle from a gas pressurising device (S300). The gas pressurising device may be a compressor and the gas may be air. The supply of gas under pressure results in the movement of the displacement member relative to a main body of the receptacle (S400). The displacement member therefore acts as a bladder and expands and contracts under pressure. As a result of the movement of the displacement member, liquid is guided from the reservoir towards a spray applicator (S500). To release the liquid from the spray system, a trigger on the spray applicator is activated (S600), preferably by hand. The liquid is then propelled from an outlet valve of the spray applicator using gas from the gas pressurising device as a propellant (S700). The liquid can be directed to a surface to be coated. Once a liquid level in the receptacle is sufficiently low, the receptacle can be replaced. Therefore, it is convenient if the receptacle is a cartridge so that the receptacle can be swapped with ease.

[0094] In summary, exemplary embodiments of a liquid spray system and method of using a liquid spray system have been described. It is believed that the described exemplary embodiments offer improvements over known systems and method. The spray system of the exemplary embodiments is convenient to manufacture and straightforward to use. Furthermore, the spray system of the exemplary embodiments is easy to transport and accurate to apply a liquid to a surface to be coated by the liquid.

[0095] The spray system may be manufactured industrially. An industrial application of the example embodiments will be clear from the discussion herein.

[0096] Although preferred embodiment(s) of the present invention have been shown and described, it will be appreciated by those skilled in the art that changes may be made without departing from the scope of the invention as defined in the claims.

Claims

1. A liquid spray system (1a, 1b, 1c, 1d) comprising:

a receptacle (100) for holding liquid, the receptacle comprising:

- a main body (110);
- a reservoir (120) having a liquid outlet;
- a displacement member (130) moveable within the main body for varying a capacity of the reservoir and having a liquid contacting side (132) and an air contacting side (134);
- an air inlet (140) in fluid communication with the air contacting side of the displacement member;

- a support structure (200a, 200b, 200c, 200d) for supporting the receptacle;
- a spray applicator (300) comprising:

- a liquid inlet (310) for receiving liquid from the liquid outlet of the reservoir;
- a liquid outlet (320);
- a liquid outlet valve for controlling the release of liquid via the liquid outlet;
- a trigger (340) for controlling the outlet valve; and

- an air pressurising device (400a, 400b, 400d) in fluid communication with the air contacting side of the displacement member and arranged to be operable to move the displacement member, in use; the air pressurising device also being in fluid communication with the liquid outlet valve of the spray applicator and being arranged to be operable to propel liquid out of the liquid outlet valve of the spray applicator, in use.

2. The liquid spray system (1a, 1b, 1c, 1d) according to claim 1, wherein the displacement member (130) comprises a flexible membrane.
3. The liquid spray system (1a, 1b, 1c, 1d) according to claim 2, wherein the flexible membrane is coupled to the main body (110) of the receptacle (100) at a portion of the air inlet (140) and a portion of the liquid outlet.
4. The liquid spray system (1a, 1b, 1c, 1d) according to claim 3, wherein the liquid outlet portion of the reservoir (120) and air inlet portion (140) of the receptacle (100) are arranged at or towards opposite ends of the receptacle.
5. The liquid spray system (1a, 1b, 1c, 1d) according to any one of claims 2 to 4, wherein the main body (110) comprises a coating arranged on an air contacting side (112) for preventing adhesion of the flexible membrane with the main body.

6. The liquid spray system (1a, 1b, 1c, 1d) according to any preceding claim, wherein the support structure (200a, 200b, 200c, 200d) comprises an accommodating part (220) for receiving the receptacle (100).
7. The liquid spray system (1a, 1b, 1c, 1d) according to any preceding claim, wherein the receptacle (100) is a cartridge.
8. The liquid spray system (1a, 1b, 1c, 1d) according to claim 7, wherein the cartridge comprises a one-way valve (142) for restricting liquid flow into the cartridge.
9. A method (1000) of using a liquid spray system comprising the steps of:
- filling (S100) a reservoir of a receptacle with liquid;
 - loading (S200) the receptacle into a support structure;
 - supplying (S300) gas to a displacement member of the receptacle from a gas pressurising device;
 - moving (S400) the displacement member relative to a main body of the receptacle with gas supplied by the gas pressurising device;
 - guiding (S500) liquid from the reservoir towards a spray applicator;
 - activating (S600) a trigger of the spray applicator; and
 - propelling (S700) liquid from an outlet valve of the spray applicator using gas from the gas pressurising device as propellant.
10. The method (1000) of claim 9, comprising filling (S110) the reservoir with liquid during manufacture and providing (S120) the receptacle as a cartridge.
11. The method (1000) of claim 10, comprising disturbing (S210) a tamper-proofing means comprised by the cartridge.
12. The method (1000) of claim 11, comprising disturbing (S212) the tamper-proofing means during loading the cartridge into the support structure.
13. The method (1000) of any one of claims 9-12, comprising releasing (S800) gas from a gas side of the displacement member using a pressure relief valve for equalising pressure with ambient air.
14. The method (1000) of any one of claims 9 to 13, comprising wearing (S900) the support structure.
15. A kit of parts for a liquid spray system (1a, 1b, 1c, 1d) comprising:
- a cartridge filled with liquid for spraying;
 - a support structure (200a, 200b, 200c, 200d) for supporting the cartridge;
 - a spray applicator (300); and
 - an air pressurising device (400a, 400b, 400d).
16. The liquid spray system (1a, 1b, 1c, 1d) according to claim 8, wherein the air inlet (140) comprises the one-way valve (142).
17. The liquid spray system (1a, 1b, 1c, 1d) according to any one of claims 1-8 or 16, wherein the receptacle (100) comprises a pressure relief valve for equalising pressure on the air side of the displacement member (130) with ambient air.
18. The liquid spray system (1b) according to any one of claims 1-8, 16 or 17, wherein the support structure (200b) comprises a connecting member (210) interposed between the liquid outlet portion of the reservoir (120) and the liquid inlet (310) of the spray applicator (300).
19. The liquid spray system (1b) according to claim 18, wherein the connecting member (210) is connectable to a first transmission line (510b) for transmitting liquid from the liquid outlet portion of the reservoir (120) to the connecting member and a second transmission line (520b) for transmitting liquid away from the connecting member and to the liquid inlet (310) of the spray applicator (300).
20. The liquid spray system (1b) according to any one of claims 1-8 or 16-19, wherein the support structure (200b) comprises a receptacle holding part (220) and a ground contacting part (230b) wherein the ground contacting part is moveable relative to the receptacle holding part for guiding the receptacle holding part over ground.
21. The liquid spray system (1d) according to any one of claims 1-8, 16 or 17, wherein the support structure (200d) is arranged for supporting the air pressurising device (400d).
22. The liquid spray system (1d) according to claim 21, wherein the support structure (200d) is wearable on a user.
23. The liquid spray system (1a, 1b, 1c, 1d) according to any one of claims 1-8 or 16-22, comprising a control valve (212) for restricting propellant air supplied by the air pressurising device (400a, 400b, 400d) in fluid communication with the outlet valve of the spray applicator (300) to a pressure of less than 1.1bar.
24. The liquid spray system (1a, 1b, 1c, 1d) according to any one of claims 1-8 or 16-23, wherein the support structure (200a, 200b, 200c, 200d) is arranged

to encase the receptacle (100).

- 25.** The liquid spray system (1a, 1b, 1d) according to any one of claims 1-8 or 16-24, wherein the air pressurising device (400a, 400b) is a compressor. 5
- 26.** The liquid spray system (1a, 1b, 1c, 1d) according to any one of claims 1-8 or 16-25, wherein the liquid is a coating, such as a paint or varnish. 10
- 27.** The method (1000) of any one of claims 9-14, wherein the gas comprises air.
- 28.** The method (1000) of any of claims 9-14 or 27, wherein the liquid is a coating composition, such as a paint or varnish. 15

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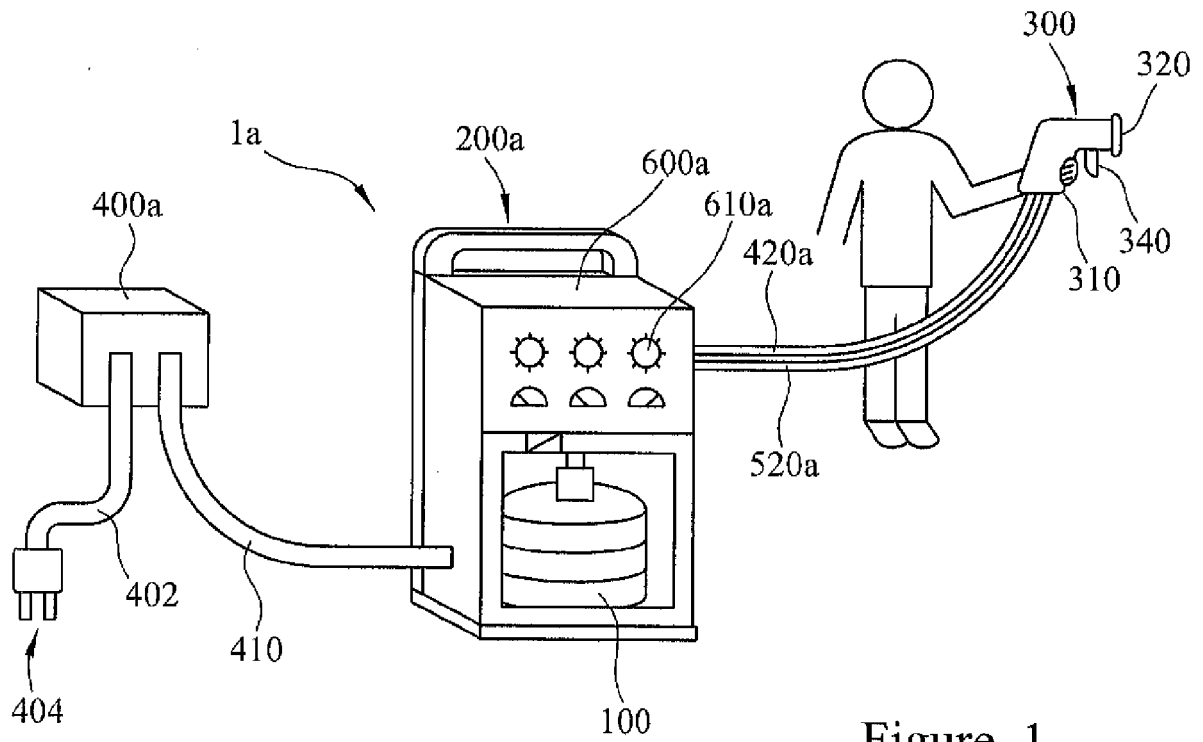


Figure 1

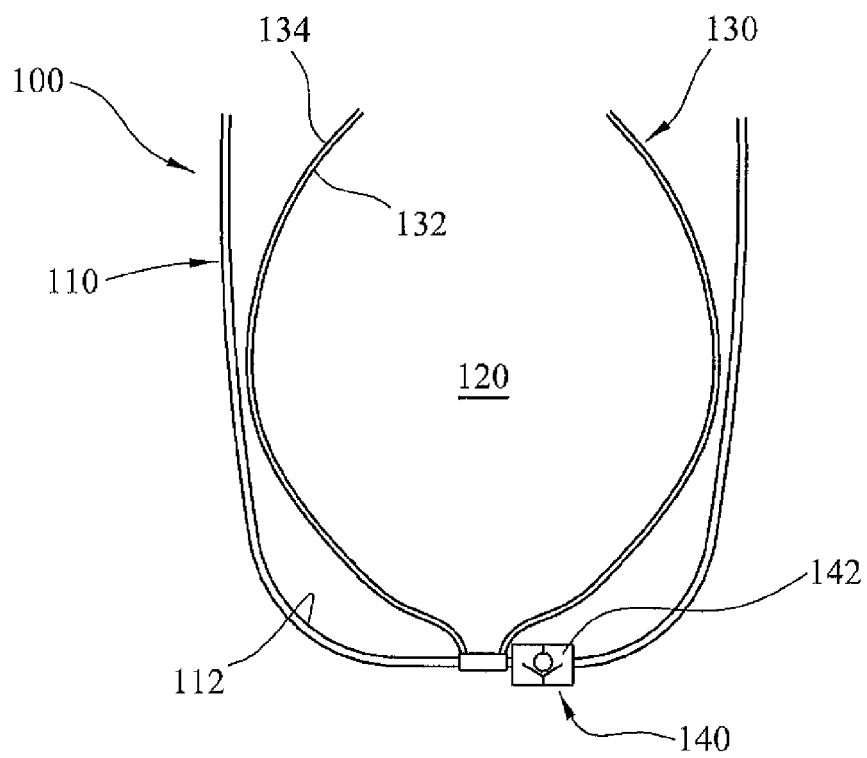


Figure 2

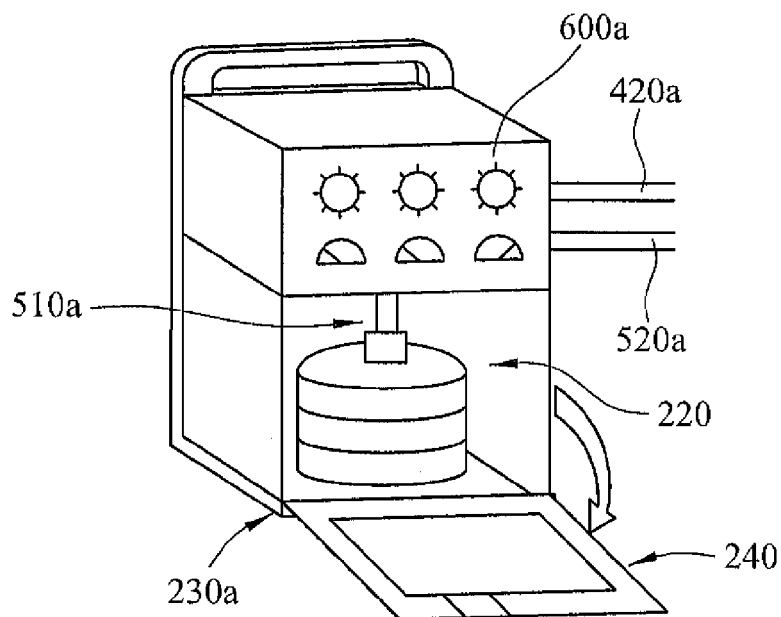


Figure 3

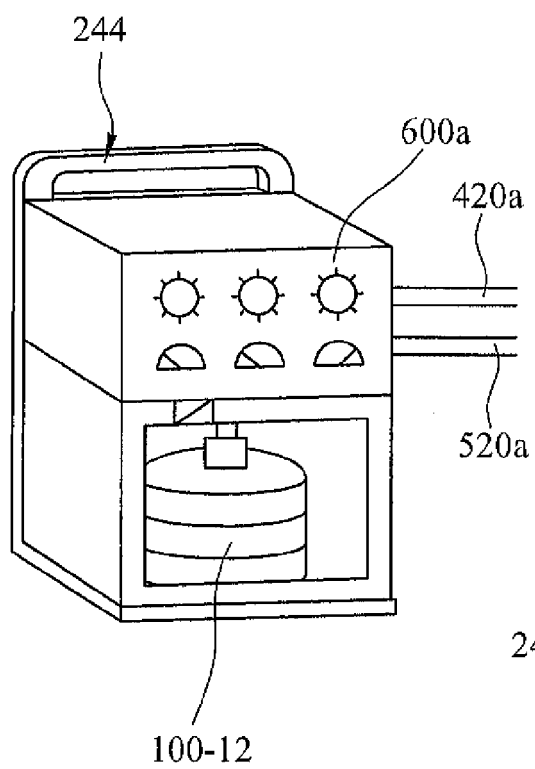


Figure 4

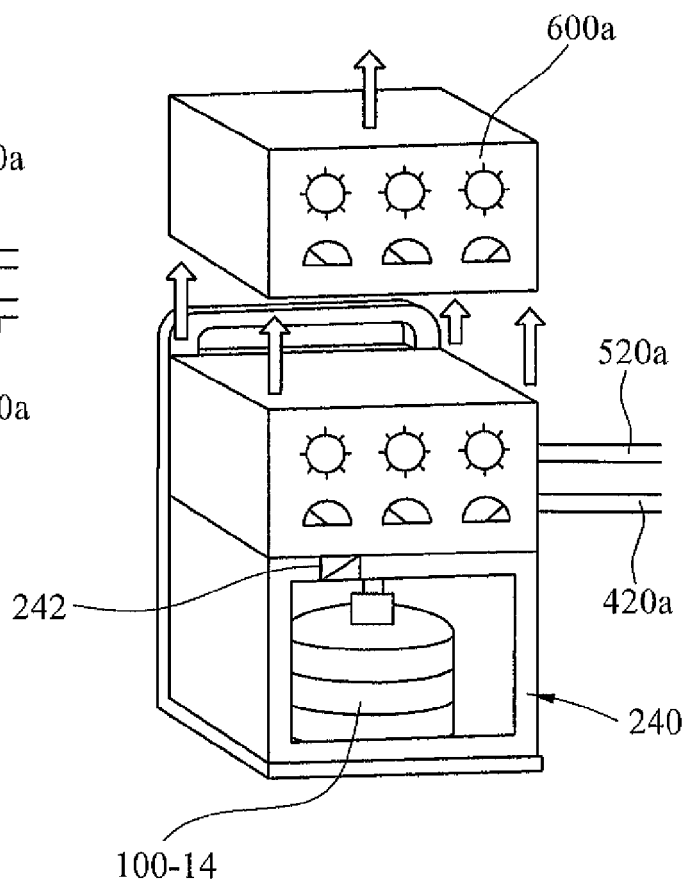


Figure 5

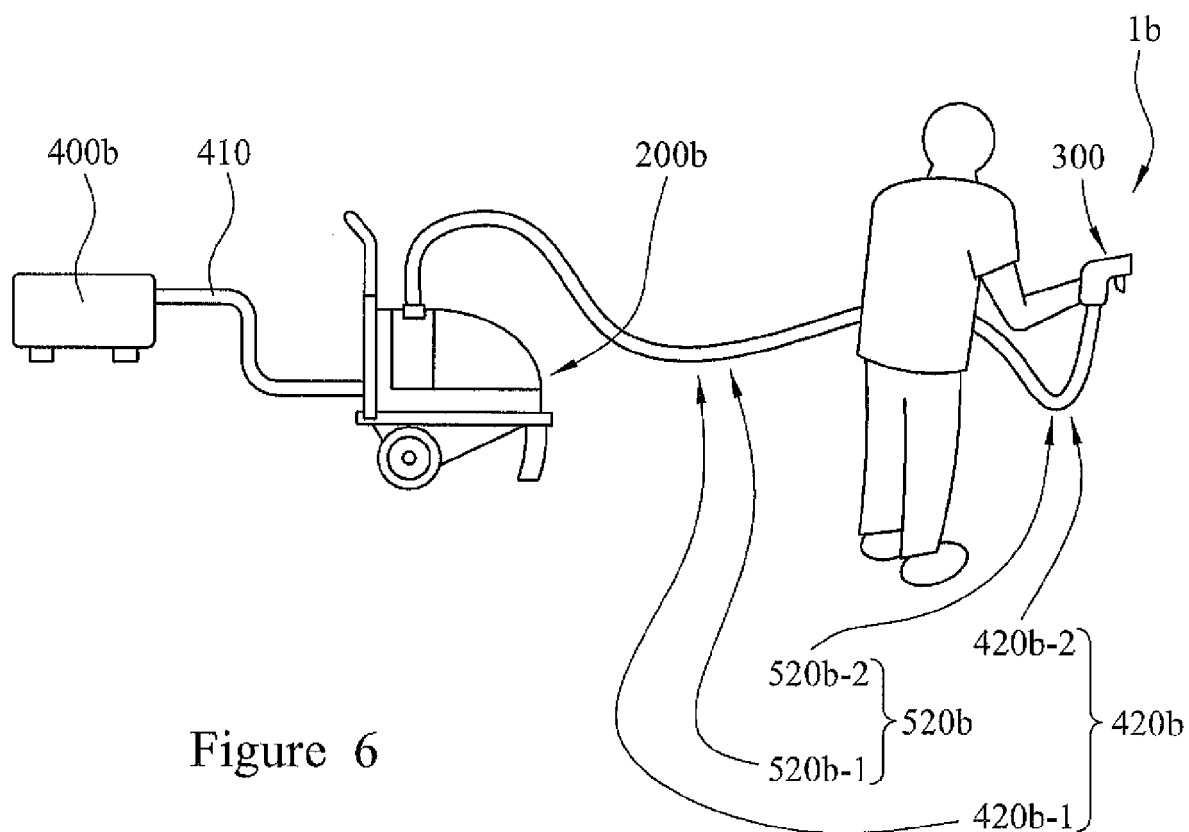


Figure 6

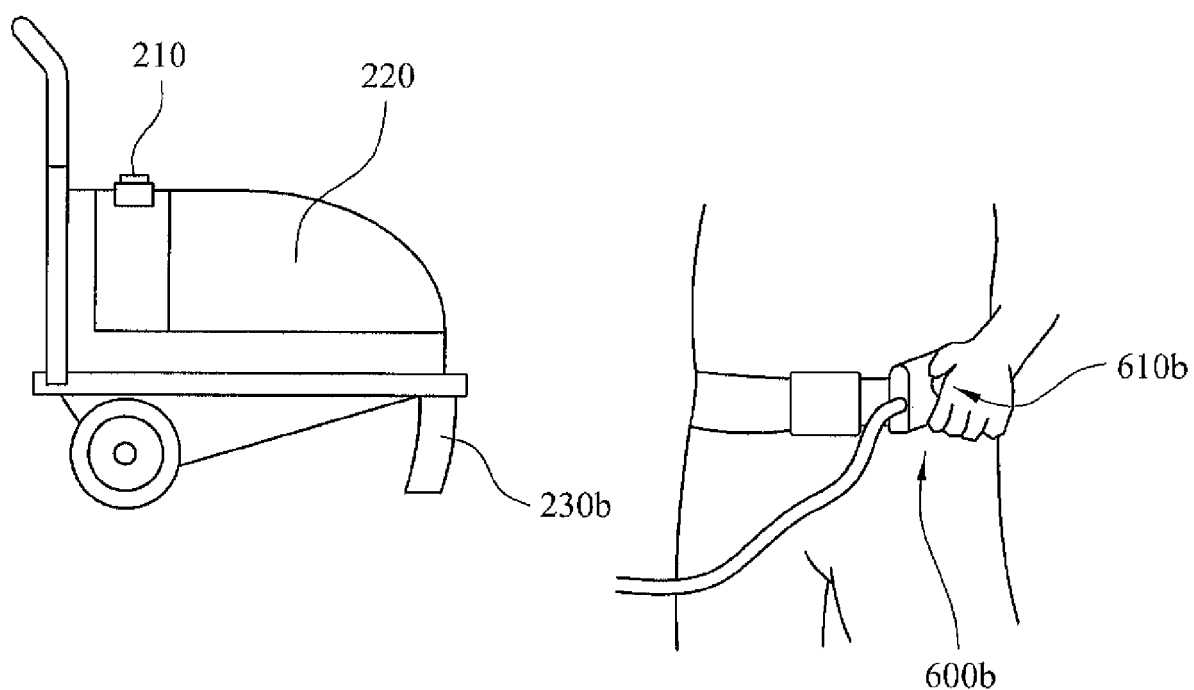


Figure 7

Figure 8

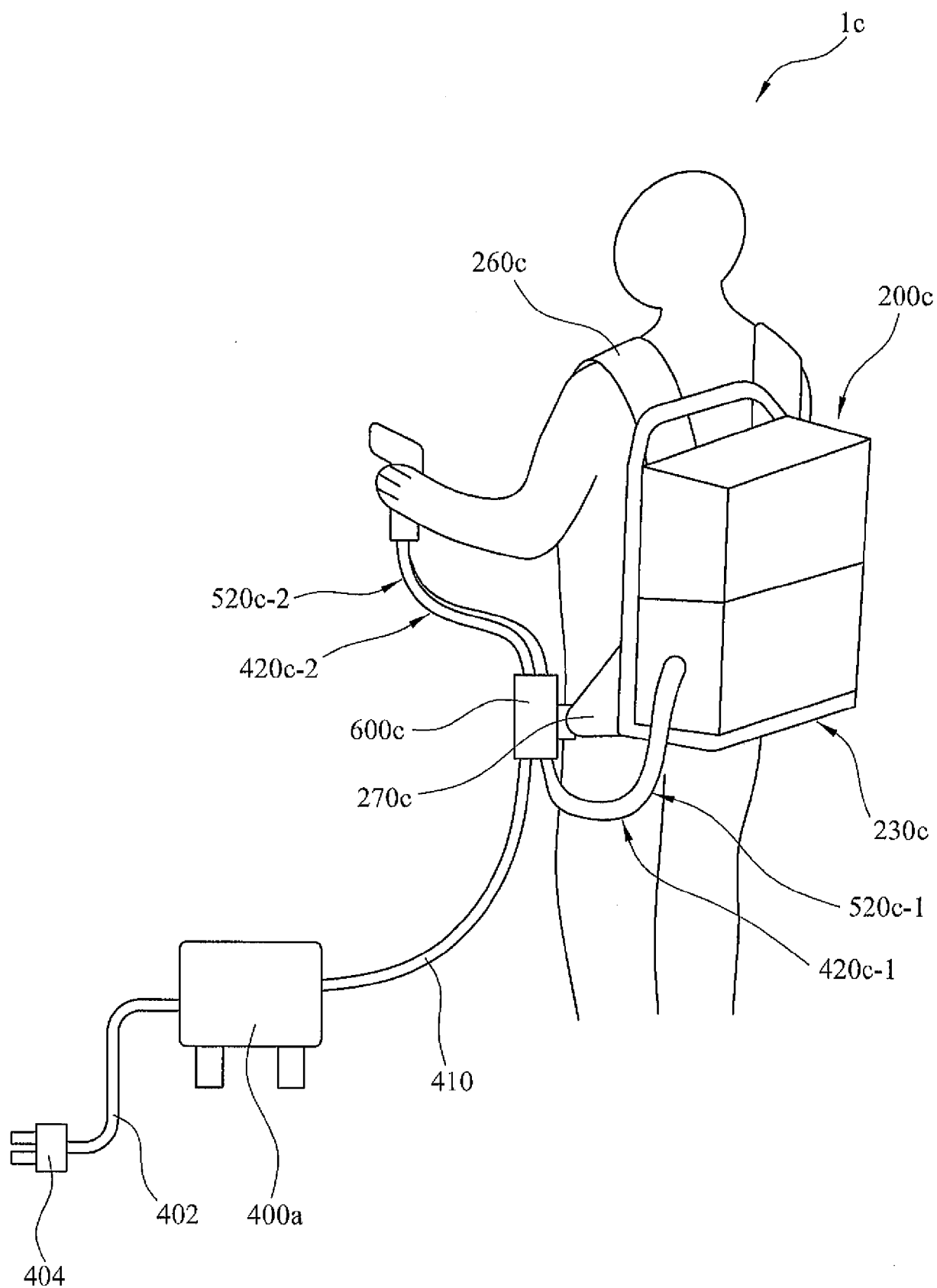


Figure 9

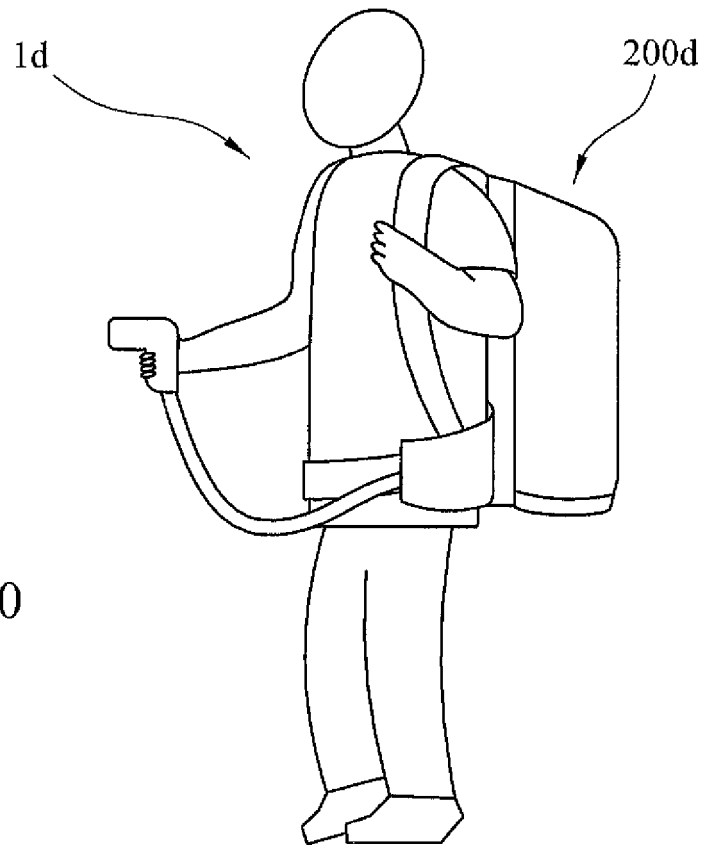


Figure 10

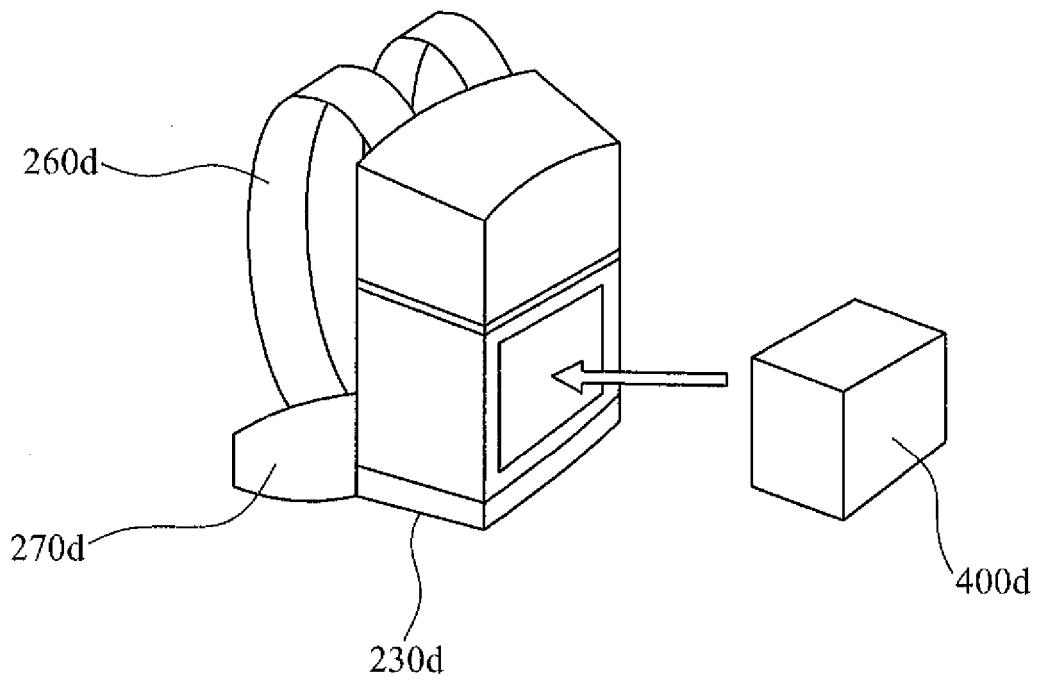


Figure 11

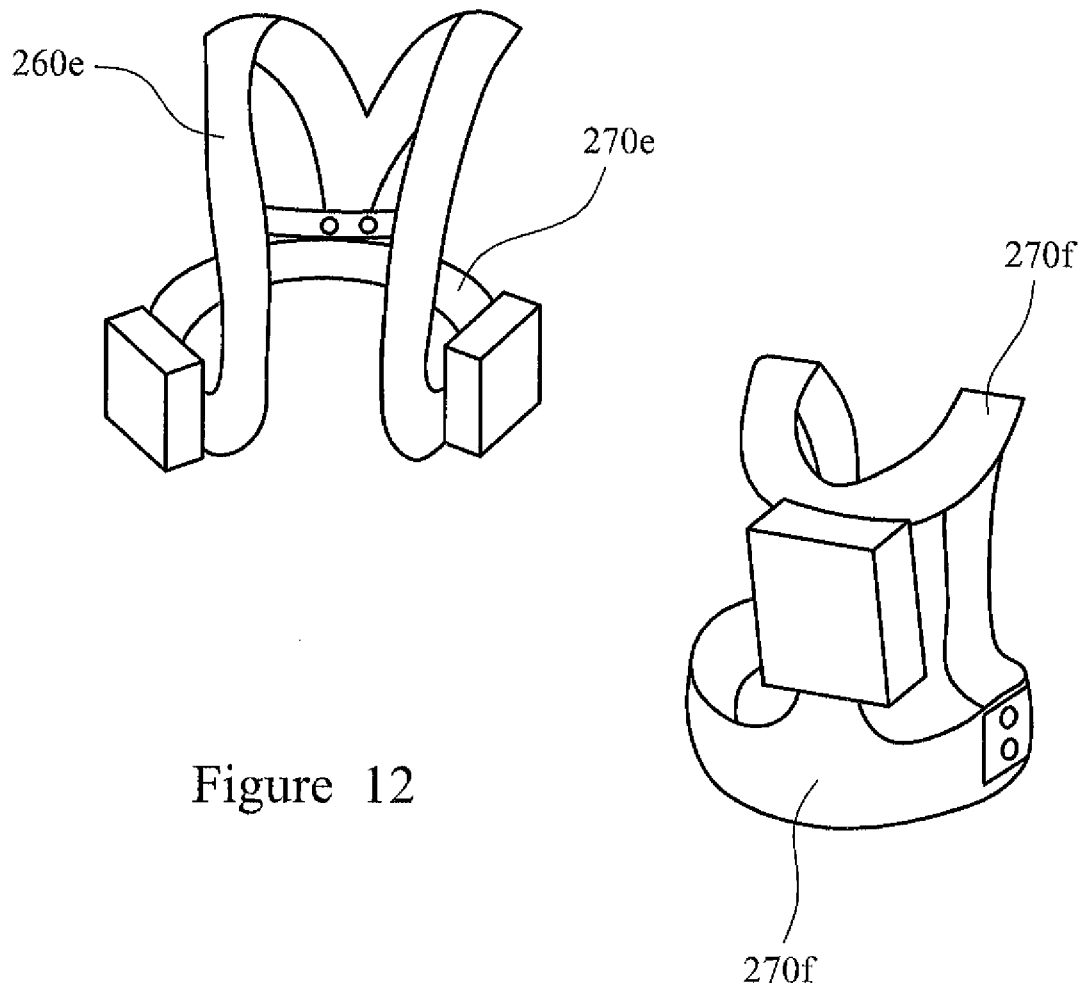


Figure 12

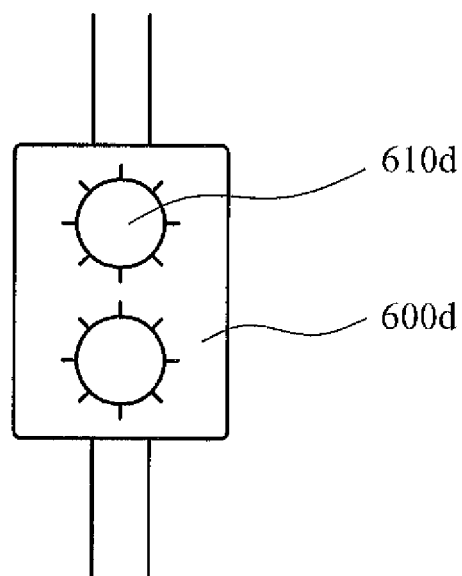


Figure 13

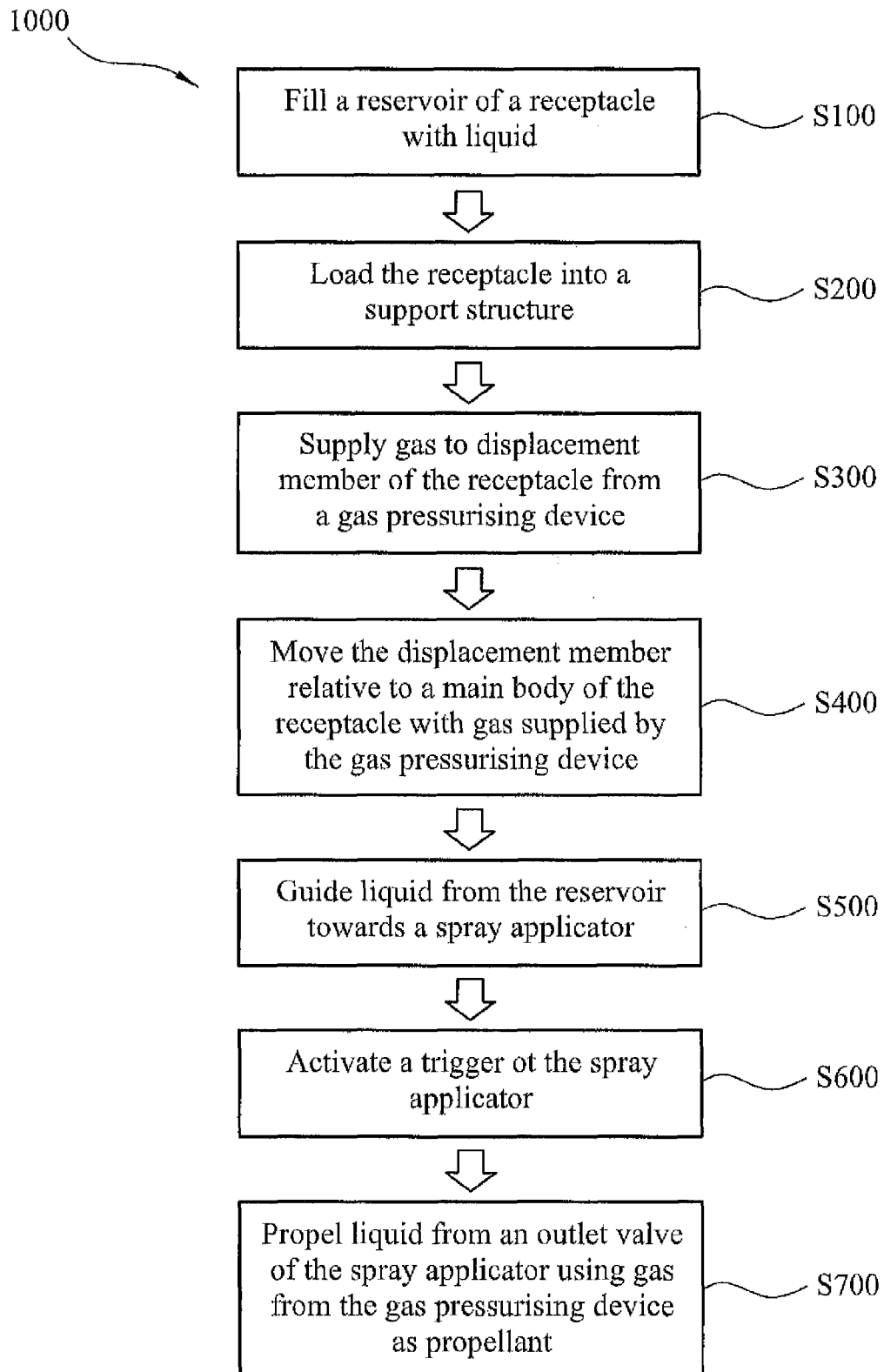


Figure 14



EUROPEAN SEARCH REPORT

Application Number
EP 17 20 2920

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			B05B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 19 September 2018	Examiner Gineste, Bertrand
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03/82 (P04/C01)



Application Number

EP 17 20 2920

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☒ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☐ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 17 20 2920

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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