

A Smoke Generation System And Method For An Aircraft

FIELD OF INVENTION

The invention relates broadly to a smoke generation system for an aircraft. In particular,
5 the invention relates to a smoke generation system for an aircraft used in an aerobatic display.

BACKGROUND

A fighter aircraft can be provided with a centerline drop tank (CDT) that is externally
10 mounted to the fuselage of the aircraft. The main purpose of the CDT is to carry additional fuel to support long flight missions. Additionally, the CDT can also be used to generate smoke during an aerobatic display.

Fighter aircraft are capable of making numerous maneuvers, such as rolling, diving,
15 banking, inverted, and upright flight maneuvers. An aerobatic display combining one or more of the above maneuvers with smoke generation provides outstanding visual effects to an audience.

Figure 1 is a block diagram of a conventional smoke generation system 100 for an aircraft.
20 A fuel tank 101 containing a fuel required for smoke generation is provided in the ammo drum bay. A displacement pump 103 provides a uniform fuel flow to a fuel line 107 for generating smoke through an exhaust 109. An accumulator 105, located at the gun barrel of the aircraft, is pressurized to a pressure of 300 psi ($\approx 21 \text{ kg/cm}^2$). The accumulator 105 provides a constant output of fuel at the exhaust 109 of the aircraft. The accumulator 105
25 also eliminates the pulsating output effect of the displacement pump 103.

The current smoke generation system for a fighter aircraft (e.g. an F-16) does not support inverted flight maneuvers. Furthermore, fighter aircraft used in an aerobatic display are custom built and not operationally ready for conducting military missions, such as an air
30 raid. Additionally, it is not possible to control the quality of smoke output in the existing aircraft so as to provide better visual effects during an aerobatic display.

There is thus a need to provide a smoke generation system for an aircraft that seeks to address one or more of the above disadvantages.

SUMMARY

According to a first aspect of the invention, there is provided a smoke generation system for an aircraft comprising: a sump installed inside a fuel tank of the aircraft, and a fuel pump installed inside the fuel tank, the fuel pump operable to increase the pressure inside the fuel tank, wherein when the aircraft is flying in a normal position, the pressurized fuel from the fuel tank is expelled to generate smoke from an engine exhaust, and the sump accumulates a reserve volume of fuel via an opening on a lower surface of the sump, and when the fuel tank is flying in an inverted position, the reserve volume of fuel accumulated in the sump is driven out by bleed air pressurization in the fuel tank to generate smoke from the engine exhaust.

The sump may have one or more partition walls to provide continuity in the fuel flow when the aircraft is in transition from the inverted position to the normal position, each partition wall having one or more slots to provide fluid communication within the sump.

The sump may have a predetermined length, breadth and height, and the height of the sump may be substantially smaller compared to the length of the sump such that a top surface of the sump may be substantially below a horizontal centreline of the fuel tank.

The sump may comprise: a first flapper valve mounted to the top surface of the sump, the first flapper valve operable to allow fuel entry into the sump when the aircraft is flying in the normal position.

The smoke generation system may further comprise an elongate and hollow sub-tank mounted on the sump, wherein the sub-tank is in fluid communication with the sump, and the sub-tank has a smaller volume than the sump.

The sub-tank may comprise: a second flapper valve mounted on its top surface; one or more partition walls, each partition wall having a third flapper valve for restricting fluid flow within the sub-tank; and one or more slots on a bottom surface of the sub-tank to provide fluid communication with the sump.

The smoke generation system may further comprise an interconnect mounted within the fuel tank, the interconnect connecting an output pipe of the fuel pump and an output pipe of the sub-tank, the top surface of the interconnect being mounted to an outer wall of the

fuel tank, while the bottom surface of the interconnect has a fourth flapper valve, the fourth flapper valve being operable to close when the aircraft is in the normal position.

When the aircraft is flying in the normal position, the fuel pump may be operable to create a high pressure within the fuel tank thereby closing the fourth flapper valve and allowing continuous fuel flow via the interconnect regardless of the fuel level in the fuel tank.

When the aircraft is flying in the inverted position, the first and second flapper valves may be closed, thereby trapping a volume of fuel within the sump, the fuel pump may run without pressurizing the fuel tank, and the trapped fuel may be expelled through the engine exhaust by bleed air pressurization inside the fuel tank.

The density of smoke generation can be controlled by variation of the pressure inside the fuel tank by the fuel pump, or by resizing an orifice inside the interconnect.

The smoke generation system may further comprise: a first fluid pipe connecting the fuel pump and the interconnect, a second fluid pipe connecting the sub-tank and the interconnect, and a third fluid pipe connecting the interconnect to a shut-off valve, wherein the fuel from the fuel tank is spouted out through an exhaust at the distal end of the third fluid pipe.

The opening and closing of the shut-off valve may be remotely controlled by a pilot of the aircraft. The fuel tank may be a centerline drop tank. An aircraft comprising a centerline drop tank including the smoke generation system.

According to a second aspect of the invention, there is provided a sump for use inside a fuel tank of an aircraft to generate smoke from an engine exhaust, wherein a fuel pump is installed inside the fuel tank, the fuel pump operable to increase the pressure inside the fuel tank, wherein: when the aircraft is flying in a normal position, the pressurized fuel from the fuel tank is expelled to generate smoke from an engine exhaust, and the sump accumulates a reserve volume of fuel via an opening on a lower surface of the sump, and when the fuel tank is in an inverted position, the reserve volume of fuel accumulated from the sump is driven out by bleed air pressurization in the fuel tank to generate smoke from the engine exhaust.

The sump may have one or more partition walls to provide continuity in the fuel flow when the aircraft is in transition from the inverted position to the normal position, each partition wall having one or more slots to provide fluid communication within the sump.

The sump may have a predetermined length, breadth and height, and the height of the sump is substantially smaller compared to the length of the sump such that a top surface of the sump is substantially below a horizontal centreline of the fuel tank.

The sump may further comprise: a first flapper valve mounted to the top surface of the sump, the first flapper valve operable to allow fuel entry into the sump when the aircraft is flying in the normal position.

The sump may further comprise an elongate and hollow sub-tank mounted on a rear edge of the sump, wherein the sub-tank is in fluid communication with the sump, and the sub-tank has a smaller volume than the sump.

The sub-tank may comprise: a second flapper valve mounted on its top surface; one or more partition walls, each partition wall having a third flapper valve for restricting fluid flow within the sub-tank; and one or more slots on a bottom surface of the sub-tank to provide fluid communication with the sump.

The sump may further comprise an interconnect mounted within the fuel tank, the interconnect connecting an output pipe of the fuel pump and an output pipe of the sub-tank, the top surface of the interconnect being mounted to an outer wall of the fuel tank, while the bottom surface of the interconnect has a fourth flapper valve, the fourth flapper valve being operable to close when the aircraft is in the normal position.

When the aircraft is flying in the normal position, the fuel pump may be operable to create a high pressure within the fuel tank thereby closing the fourth flapper valve and allowing continuous fuel flow via the interconnect regardless of the fuel level in the fuel tank.

When the aircraft is flying in the inverted position, the first and second flapper valves may be closed, thereby trapping a volume of fuel within the sump, the fuel pump may run

without pressurizing the fuel tank, and the trapped fuel may be expelled through the engine exhaust by bleed air pressurization inside the fuel tank.

The density of smoke generation can be controlled by variation of the pressure inside the fuel tank by the fuel pump, or by resizing an orifice inside the interconnect.

The sump may further comprise: a first fluid pipe connecting the fuel pump and the interconnect, a second fluid pipe connecting the sub-tank and the interconnect, and a third fluid pipe connecting the interconnect to a shut-off valve, wherein the fuel from the fuel tank is spouted out through an exhaust at the distal end of the third fluid pipe.

The opening and closing of the shut-off valve may be remotely controlled by a pilot of the aircraft. The fuel tank may be a centerline drop tank. An aircraft comprising a centerline drop tank including the above sump.

According to a third aspect of the invention, there is provided a method of smoke generation for an aircraft comprising the steps of: providing a sump inside a fuel tank of the aircraft, providing a fuel pump inside the fuel tank, the fuel pump operable to increase the pressure inside the fuel tank, accumulating a reserve volume of fuel in the sump via an opening on a lower surface of the sump and expelling the pressurized fuel from the fuel tank to generate smoke from an engine exhaust when the aircraft is flying in a normal position, and driving out the reserve volume of fuel accumulated in the sump by bleed air pressurization in the fuel tank to generate smoke from the engine exhaust when the aircraft is flying in an inverted position.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will be better-understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

Figure 1 is a block diagram of a prior art smoke generation system for an aircraft;

Figure 2 is a perspective view of an internal portion of a centreline drop tank of an aircraft with a smoke generation system in accordance with an embodiment of the present invention;

Figure 3 is a schematic diagram of the centreline drop tank of Figure 2 in accordance with an embodiment of the present invention;

Figure 4 is a perspective view of a sump utilised in the centreline drop tank of an aircraft in accordance with an embodiment of the present invention;

Figure 5 is a cut-away perspective view of the sump of Figure 4; and

Figure 6 is another cut-away perspective view of the sump of Figure 4.

DETAILED DESCRIPTION

Embodiments of the present invention are capable of generating smoke from an aircraft when performing various maneuvers, including an inverted flight maneuver.

Embodiments of the present invention are capable of increasing the fuel flow rate in an aircraft smoke generator, resulting in thicker smoke generation, and providing better visual effects to an audience watching an aerobatic display.

Embodiments of the present invention utilise a modular smoke generation system without sacrificing the operational capability of an aircraft. i.e. the aircraft can be converted back to its operational state with minimum effort.

In this description, an aircraft is considered to be flying in a "normal position" when the net gravitational force acting on the aircraft is positive, while an aircraft is considered to be flying in an "inverted position" when the net gravitational force acting on the aircraft is negative.

Figure 2 is a perspective view of an internal portion of a centerline drop tank 200 with a smoke generation system in accordance with an embodiment of the present invention.

The centerline drop tank (CDT) 200 is shown without its outer casing 302 (refer to Figure 3). Mounted to the inner circumference of the outer casing 302 are four solid ring-like supports 203, 205, 207, 209. The outer and the inner circumference of the four solid ring-like supports 203, 205, 207, 209 are elliptical in shape. The CDT 200 is mounted below the fuselage of an aircraft such that the edge closer to the ring-like support 203 faces the

nose of the aircraft, while the edge closer to the ring-like support 209 faces the tail of the aircraft.

The ring-like supports 203, 209 are mounted at the two edges of the mid section of the centerline drop tank 200, while the ring-like supports 205, 207 are axially mounted in between the tank supports 203, 209. A cylindrical support 227 is centrally mounted to the longer diameter of the ring-like supports 205, 207.

An elongate and hollow sump 201 having a rectangular cross section is mounted to the inner edges of the ring-like supports 203, 209 by a pair of brackets 211, at the bottom of the CDT 200. The sump 201 is operable to trap a volume of fuel from the CDT 200 for use during inverted flight maneuvers. The height of the sump 201 is substantially smaller than its length such that the upper surface of the sump 201 is substantially below the cylindrical supports 227. It is understood that the size and shape of the sump 201 can be altered according to the size and shape of the CDT 200.

The sump 201 has an opening 303 (refer to Figure 3) on its bottom surface 430 (refer to Figure 4). A flapper valve 213 is mounted to a top surface 440 (refer to Figure 4) of the sump 201, in between the ring-like supports 203 and 205. The flapper valve 213 and opening 303 allow fuel entry into the sump 201 when the CDT 200 is in a normal position. Thus, a volume of fuel from the CDT 200 is accumulated in the sump 201 and the sump 201 is in fluid communication with the CDT 200. The volume of fuel accumulated in the sump is sufficient to supply the fuel for smoke generation when the CDT and the aircraft are in an inverted position. The dimensions of the sump 201 can be tailored depending on the capacity and dimensions of the CDT 200.

An elongate and hollow sub-tank 223 can be orthogonally mounted on the sump 201, towards the rear end of the sump 201 and near the ring-like support 209. The width of the sub-tank 223 can be substantially smaller than its length and the length of the sub-tank 223 is equal to the width of the sump 201. The front surface of the sub-tank 223 faces the front end of the CDT 200, while the rear surface is flush with the rear surface of the sump 201. The top surface of the sub-tank 223 has a flapper valve 215, while the bottom surface 305 (refer to Figure 4) of the sub-tank 223 has slots 409 (refer to Figure 4), whereby the sump 201 is in fluid communication with the sub-tank 223. The flapper valve 215 is operable to enable fuel entry when the CDT 200 is in the normal position.

An interconnect 225 connects sub-tank 223 and the fuel pump 217. A top surface 235 of the interconnect 225 is mounted to the outer casing 302 (refer to Figure 3) of the CDT 200. A bottom surface 245 of the interconnect 225 has a flapper valve 307 (refer to Figure 3) covering an orifice 247. The flapper valve 307 closes when the CDT 200 is in the normal position.

A fuel pump 217 is mounted on a bracket 231, which is attached to the ring-like support 209 and the bracket 211. The fuel pump 217 receives power through a tube 229 attached to the cylindrical supports 227. An inlet 320 supplies bleed air into the CDT 200. The fuel pump 217 is operable to increase the fluid pressure inside the CDT 200. The increased pressure inside the CDT 200 helps to increase the fuel flow rate, which, in turn, increases the smoke quality.

Figure 3 is a schematic diagram of the CDT 200 of Figure 2 in accordance with an embodiment of the present invention.

With reference to Figures 2 and 3, a first fluid pipe 219 connects the pump 217 and the interconnect 225. A second fluid pipe 218 connects the sub-tank 223 and the interconnect 225. For example, the first fluid pipe 219 and the second fluid pipe 218 that are connected to the interconnect 225 may be tubing fittings. A third fluid pipe 221 connects the interconnect 225 to a shut-off valve 309. The compressed fuel from the CDT 200 is discharged through an engine exhaust (not shown) located at the distal end of an output pipe 311. A pilot of the aircraft can control the opening and closing of the shut-off valve 309.

During normal operation (i.e. when the aircraft is flying in the normal position and the CDT 200 is in the normal position), the pressure created by the fuel pump 217 and the bleed air pressure inside the CDT 200 drives the fuel inside the CDT 200 to the output pipe 311 via the interconnect 225. During an inverted flight maneuver (when the i.e. when the aircraft and the CDT 200 is turned up side down), the fuel trapped inside the sump 201 is discharged by bleed air pressurization within the CDT 200. The engine exhaust (not shown) located at the distal end of the output pipe 311 then vaporizes the discharged fuel resulting in smoke generation.

During non-inverted maneuvers, the fuel pump 217 creates a high pressure within the interconnect 225 resulting in the closure of the flapper valve 307. This allows continuous

fuel flow even when the fuel level in the CDT 200 is below the opening 303 of the sump 201.

During inverted flight maneuvers, the flapper valves 213 and 215 are closed, thus trapping a predetermined volume of fuel within the sump 201. At this position, the fuel pump 217 runs dry (i.e. it does not create any pressure within the first fluid pipe 219) and bleed air pressurization inside the CDT 200 pushes the trapped diesel within the sump 201, through the flapper valve 307 to the interconnect 225, which results in smoke generation.

The density of smoke generation can be controlled by variation of the pressure inside the CDT 200 by the fuel pump 217, or by resizing the orifice 247 inside the interconnect.

Figure 4 is a perspective view of a sump 201 utilised in the centreline drop tank 200 of an aircraft in accordance with an embodiment of the present invention.

The sump 201 is an elongate and hollow structure. In this embodiment, the height of the sump 201 is substantially smaller than its length. The sump 201 has a rectangular cross section. The sump 201 is operable to trap a volume of fuel for use during inverted flight maneuvers. The size and shape of the sump 201 can be altered according to the size and shape of the CDT 200.

The sump 201 has a flat top surface 440 and a bottom surface 430. The bottom surface 430 has an opening 303 to receive fuel from the CDT 200. A flapper valve 213 is mounted to the top surface 440 of the sump 201.

In order to ensure continuity in the fluid flow when an aircraft is in transition from inverted flight to normal flight, the sump 201 has a plurality of partitions. In an embodiment, the sump 201 has a first partition wall 401 that is parallel to the front surface 450 of the sump 201 and a second partition wall 403 that is perpendicular to the front surface 450 of the sump 201. The first partition wall 401 has two rectangular slots 405 for restricting fluid flow within various chambers of the sump 201. The number and size of partitions as well as the slots inside the sump 201 can be altered according to the capacity of the CDT 200.

An elongate and hollow sub-tank 223 is orthogonally mounted on the sump 201, towards the rear surface 410. In this embodiment, the width of the sub-tank 223 is substantially smaller than its length and the length of the sub-tank 223 is equal to the width of the sump 201. The front surface of the sub-tank 223 is parallel to the front surface 450 of the sump

201, while the rear surface of the sub-tank 223 is flush with the rear surface 410 of the sump 201. A flapper valve 215 is mounted to the top surface 460 of the sub-tank 223, while the bottom surface 305 of the sub-tank 223 has a plurality of rectangular slots 409 for restricting fluid flow to/from the sub-tank 223.

5 In order to ensure continuity in the fluid flow when an aircraft is in transition from inverted flight to normal flight, the sub-tank 223 also has two partitions 411 that are parallel to each other. Each of the partitions is perpendicular to a rear surface 420 of the sub-tank 223. A flapper valve 417 is mounted to each of the partitions 411 (refer to Figure 5) for restricting
10 fluid flow within the sub-tank 223.

The sump 201 and the sub-tank 223 may be made of a material, such as aluminium. It is understood that other materials can be used.

15 Figure 5 is a cut-away perspective view of the sump 201 of Figure 4, in which part of the sump 201 and the sub-tank 223 are exposed. The sump 201 has a pair of sidewalls 501 on either end. The first partition wall 401 is located approximately halfway between the two sidewalls 501. The first partition wall 401 has a pair of slots 405 to restrict fluid flow within the sump 201. The second partition wall 403 is perpendicular to the first partition wall 401.
20 The sidewalls 501 and the first partition wall 401 are parallel to each other and are held between the top surface 440 and the bottom surface 430 of the sump by a plurality of brackets 511, 515 and frames 517.

The sub-tank also has a pair of partition walls 411 that are parallel to the sidewalls 519, 521. Each partition wall 411 has a flapper valve 417 for trapping fuel inside the sub-tank
25 223.

Figure 6 is another cut-away perspective view of a portion of the sump of Figure 4 in which the top surface 440 and the bottom surface 430 of the sump 201 are removed to
30 show the positioning of the partitions 401 and 403.

Embodiments of the present invention use both pumping and bleed air pressurization to increase the efficiency of smoke generation.

35 Furthermore, since embodiments of the invention use simple flapper valves instead of complicated control systems to determine the mode of fuel transfer, smoke generation becomes simple and effective.

The modularity of the system allows it to be incorporated without compromising the operational capability of the aircraft.

It will be appreciated by a person skilled in the art that numerous variations and/or
5 modifications may be made to the present invention as shown in the specific embodiments
without departing from the spirit or scope of the invention as broadly described. The
present embodiments are, therefore, to be considered in all respects to be illustrative and
not restrictive.

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Claims:

1. A smoke generation system for an aircraft comprising:
a sump installed inside a fuel tank of the aircraft, and
a fuel pump installed inside the fuel tank, the fuel pump operable to increase the pressure inside the fuel tank, wherein
when the aircraft is flying in a normal position, the pressurized fuel from the fuel tank is expelled to generate smoke from an engine exhaust, and the sump accumulates a reserve volume of fuel via an opening on a lower surface of the sump, and
when the fuel tank is flying in an inverted position, the reserve volume of fuel accumulated in the sump is driven out by bleed air pressurization in the fuel tank to generate smoke from the engine exhaust.
2. The smoke generation system of claim 1 wherein, the sump has one or more partition walls to provide continuity in the fuel flow when the aircraft is in transition from the inverted position to the normal position, each partition wall having one or more slots to provide fluid communication within the sump.
3. The smoke generation system of claim 1 or 2 wherein, the sump has a predetermined length, breadth and height, and
the height of the sump is substantially smaller compared to the length of the sump such that a top surface of the sump is substantially below a horizontal centreline of the fuel tank.
4. The smoke generation system of claim 3 wherein, the sump comprises:
a first flapper valve mounted to the top surface of the sump, the first flapper valve operable to allow fuel entry into the sump when the aircraft is flying in the normal position.

5. The smoke generation system of claim 4, further comprising an elongate and hollow sub-tank mounted on the sump, wherein the sub-tank is in fluid communication with the sump, and the sub-tank has a smaller volume than the sump.
6. The smoke generation system of claim 5 wherein, the sub-tank comprises:
 - a second flapper valve mounted on its top surface;
 - one or more partition walls, each partition wall having a third flapper valve for restricting fluid flow within the sub-tank; and
 - one or more slots on a bottom surface of the sub-tank to provide fluid communication with the sump.
7. The smoke generation system of claim 6, further comprising an interconnect mounted within the fuel tank, the interconnect connecting an output pipe of the fuel pump and an output pipe of the sub-tank, the top surface of the interconnect being mounted to an outer wall of the fuel tank, while the bottom surface of the interconnect has a fourth flapper valve, the fourth flapper valve being operable to close when the aircraft is in the normal position.
8. The smoke generation system of claim 7 wherein, when the aircraft is flying in the normal position, the fuel pump is operable to create a high pressure within the fuel tank thereby closing the fourth flapper valve and allowing continuous fuel flow via the interconnect regardless of the fuel level in the fuel tank.
9. The smoke generation system of claim 6, wherein when the aircraft is flying in the inverted position,
 - the first and second flapper valves are closed, thereby trapping a volume of fuel within the sump,
 - the fuel pump runs without pressurizing the fuel tank, and
 - the trapped fuel is expelled through the engine exhaust by bleed air pressurization inside the fuel tank.
10. The smoke generation system of claim 7, wherein the density of smoke generation can be controlled by variation of the pressure inside the fuel tank by the fuel pump, or by resizing an orifice inside the interconnect.
11. The smoke generation system of claim 7, further comprising:
 - a first fluid pipe connecting the fuel pump and the interconnect,
 - a second fluid pipe connecting the sub-tank and the interconnect, and
 - a third fluid pipe connecting the interconnect to a shut-off valve, wherein the fuel from the fuel tank is spouted out through an exhaust at the distal end of the third fluid pipe.

12. The smoke generation system of claim 11, wherein the opening and closing of the shut-off valve are remotely controlled by a pilot of the aircraft.

13. The smoke generation system of any one of the preceding claims, wherein the fuel tank is a centerline drop tank.

14. An aircraft comprising a centerline drop tank including the smoke generation system of any one of claims 1 to 12.

15. A sump for use inside a fuel tank of an aircraft to generate smoke from an engine exhaust, wherein a fuel pump is installed inside the fuel tank, the fuel pump operable to increase the pressure inside the fuel tank, wherein:

when the aircraft is flying in a normal position, the pressurized fuel from the fuel tank is expelled to generate smoke from an engine exhaust, and the sump accumulates a reserve volume of fuel via an opening on a lower surface of the sump, and

when the fuel tank is in an inverted position, the reserve volume of fuel accumulated from the sump is driven out by bleed air pressurization in the fuel tank to generate smoke from the engine exhaust.

16. The sump of claim 15, wherein the sump has one or more partition walls to provide continuity in the fuel flow when the aircraft is in transition from the inverted position to the normal position, each partition wall having one or more slots to provide fluid communication within the sump.

17. The sump of claim 15 or 16, wherein the sump having a predetermined length, breadth and height, and

the height of the sump is substantially smaller compared to the length of the sump such that a top surface of the sump is substantially below a horizontal centreline of the fuel tank.

18. The sump of claim 17, wherein the sump comprises:

a first flapper valve mounted to the top surface of the sump, the first flapper valve operable to allow fuel entry into the sump when the aircraft is flying in the normal position.

19. The sump of claim 18, further comprising an elongate and hollow sub-tank mounted on a rear edge of the sump, wherein the sub-tank is in fluid communication with the sump, and the sub-tank has a smaller volume than the sump.

20. The sump of claim 19, wherein the sub-tank comprises:

a second flapper valve mounted on its top surface;

one or more partition walls, each partition wall having a third flapper valve for restricting fluid flow within the sub-tank; and

one or more slots on a bottom surface of the sub-tank to provide fluid communication with the sump.

21. The sump of claim 20, further comprising an interconnect mounted within the fuel tank, the interconnect connecting an output pipe of the fuel pump and an output pipe of the sub-tank, the top surface of the interconnect being mounted to an outer wall of the fuel tank, while the bottom surface of the interconnect has a fourth flapper valve, the fourth flapper valve being operable to close when the aircraft is in the normal position.

22. The sump of claim 21 wherein, when the aircraft is flying in the normal position, the fuel pump is operable to create a high pressure within the fuel tank thereby closing the fourth flapper valve and allowing continuous fuel flow via the interconnect regardless of the fuel level in the fuel tank.

23. The sump of claim 20, wherein when the aircraft is flying in the inverted position, the first and second flapper valves are closed, thereby trapping a volume of fuel within the sump,

the fuel pump runs without pressurizing the fuel tank, and

the trapped fuel is expelled through the engine exhaust by bleed air pressurization inside the fuel tank.

24. The sump of 21, wherein the density of smoke generation can be controlled by variation of the pressure inside the fuel tank by the fuel pump, or by resizing an orifice inside the interconnect.

25. The sump of claim 21, further comprising:
a first fluid pipe connecting the fuel pump and the interconnect,
a second fluid pipe connecting the sub-tank and the interconnect, and
a third fluid pipe connecting the interconnect to a shut-off valve, wherein the fuel from the fuel tank is spouted out through an exhaust at the distal end of the third fluid pipe.
26. The sump of claim 25, wherein the opening and closing of the shut-off valve are remotely controlled by a pilot of the aircraft.
27. The sump of any one of claims 15 to 26, wherein the fuel tank is a centerline drop tank.
28. An aircraft comprising a centerline drop tank including the sump of any one of claims 15 to 26.
29. A method of smoke generation for an aircraft comprising the steps of:
providing a sump inside a fuel tank of the aircraft,
providing a fuel pump inside the fuel tank, the fuel pump operable to increase the pressure inside the fuel tank,
accumulating a reserve volume of fuel in the sump via an opening on a lower surface of the sump and expelling the pressurized fuel from the fuel tank to generate smoke from an engine exhaust when the aircraft is flying in a normal position, and
driving out the reserve volume of fuel accumulated in the sump by bleed air pressurization in the fuel tank to generate smoke from the engine exhaust when the aircraft is flying in an inverted position.

A Smoke Generation System And Method For An Aircraft

ABSTRACT

A smoke generation system and method for an aircraft are disclosed. The smoke generation system comprise: a sump installed inside a fuel tank of the aircraft, wherein when the aircraft is in a normal position, fuel from the fuel tank is expelled to generate smoke from an engine exhaust, and the sump accumulates fuel, and when the fuel tank is in an inverted position, the accumulated fuel from the sump is expelled to generate smoke from the engine exhaust.

Figure 3