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(54) **RAPID SHUTDOWN AND ECOLOGY SYSTEM**

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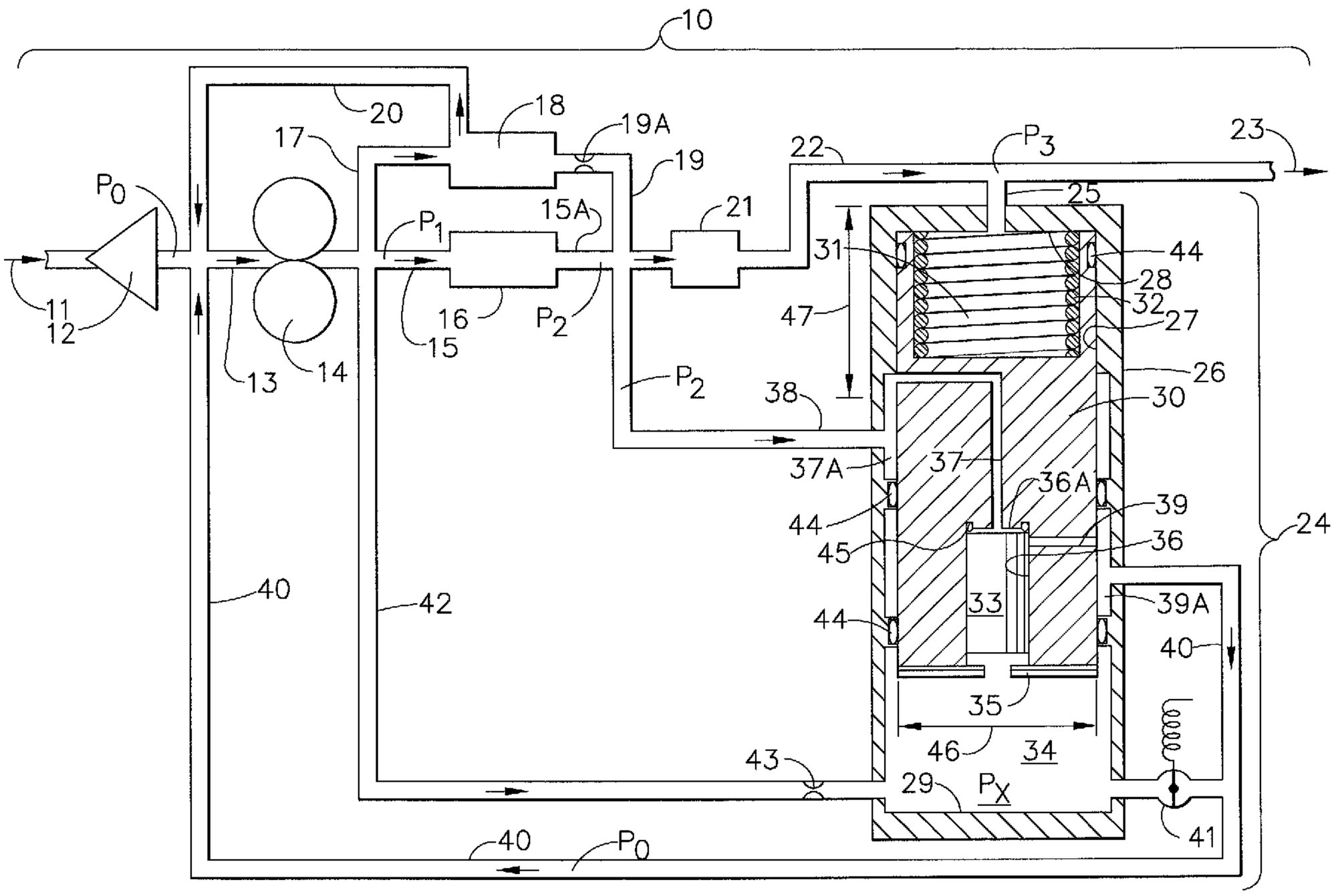
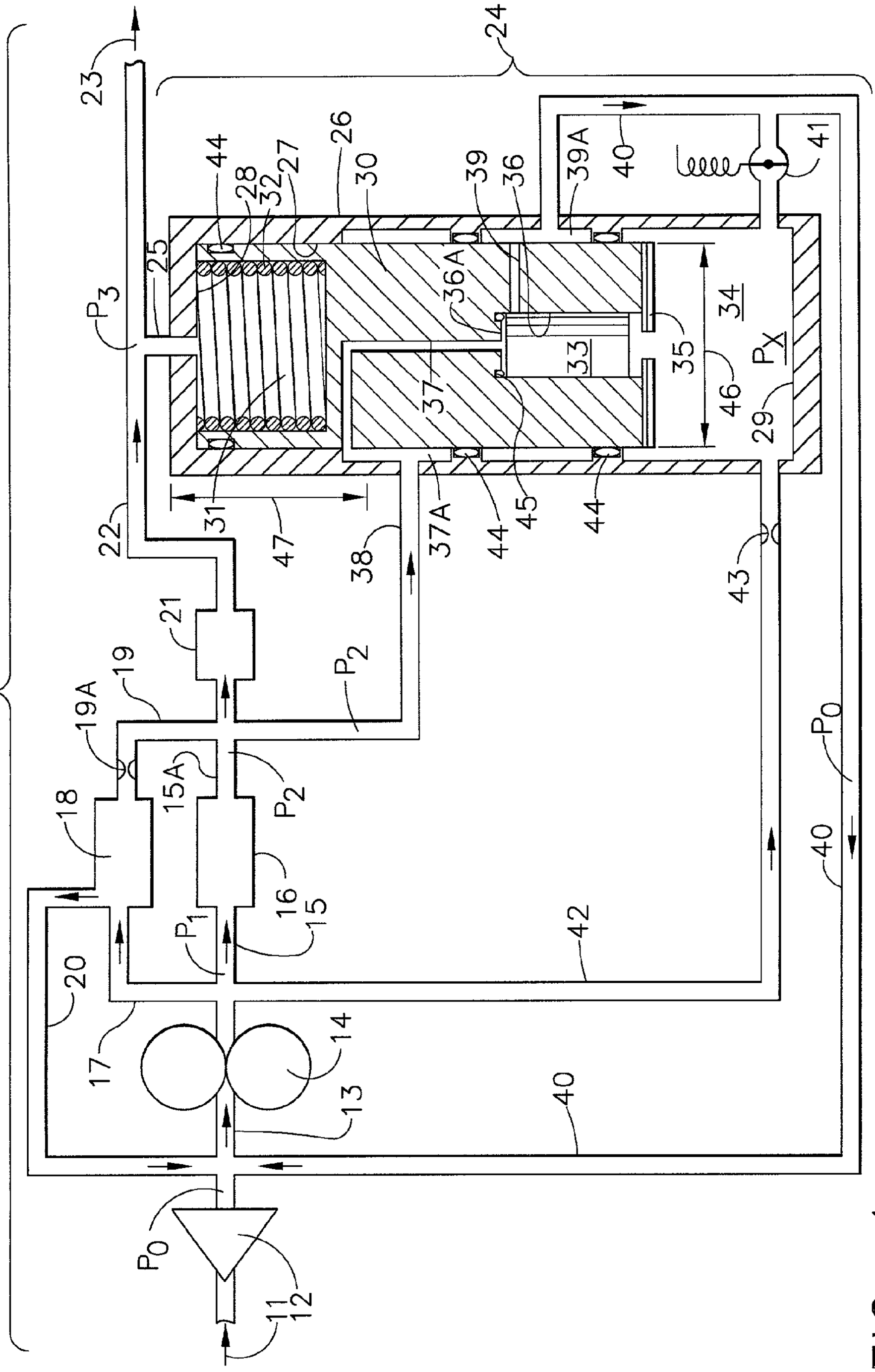
(57) **ABSTRACT**

A dual function rapid shutdown and ecology system for fuel delivery systems for engines, specially aircraft gas turbine engines, is disclosed. The dual function is accomplished in a single module operated by a single electromagnetic solenoid valve commanded by the engine electronic control unit. Upon actuation of the solenoid valve, a large spring loaded piston strokes to the extreme of its travel creating a cavity having a volume sufficient to accommodate all fuel leftover in the fuel manifold and distribution system at shutdown, thus preventing atmospheric pollution or engine damage upon subsequent operation. Simultaneous with actuation of the solenoid valve, fuel pressure differentials cause a small piston to stroke to the extreme of its travel opening fuel passageways and causing all the fuel being delivered to the engine combustion chamber to be bypassed back to pump inlet, thus effectively accomplishing the rapid shutdown function. An alternate embodiment allows for use of the dual function system on engines employing low pressure differentials along the various stages of the fuel control system manifold or where the ecology function is not required.

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P_X
P_3
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37A
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P_0
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19A
P_2
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FIG. 1

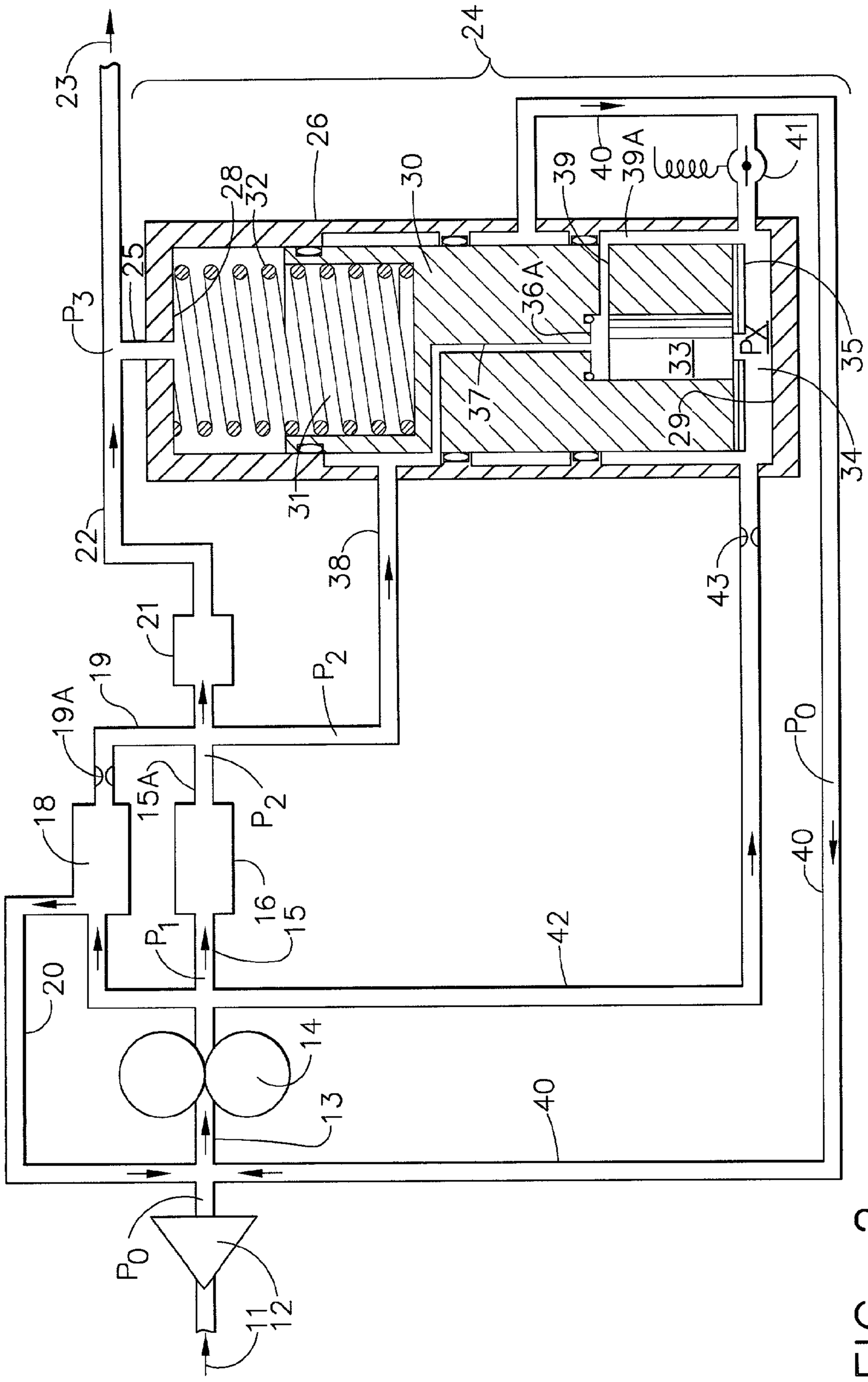
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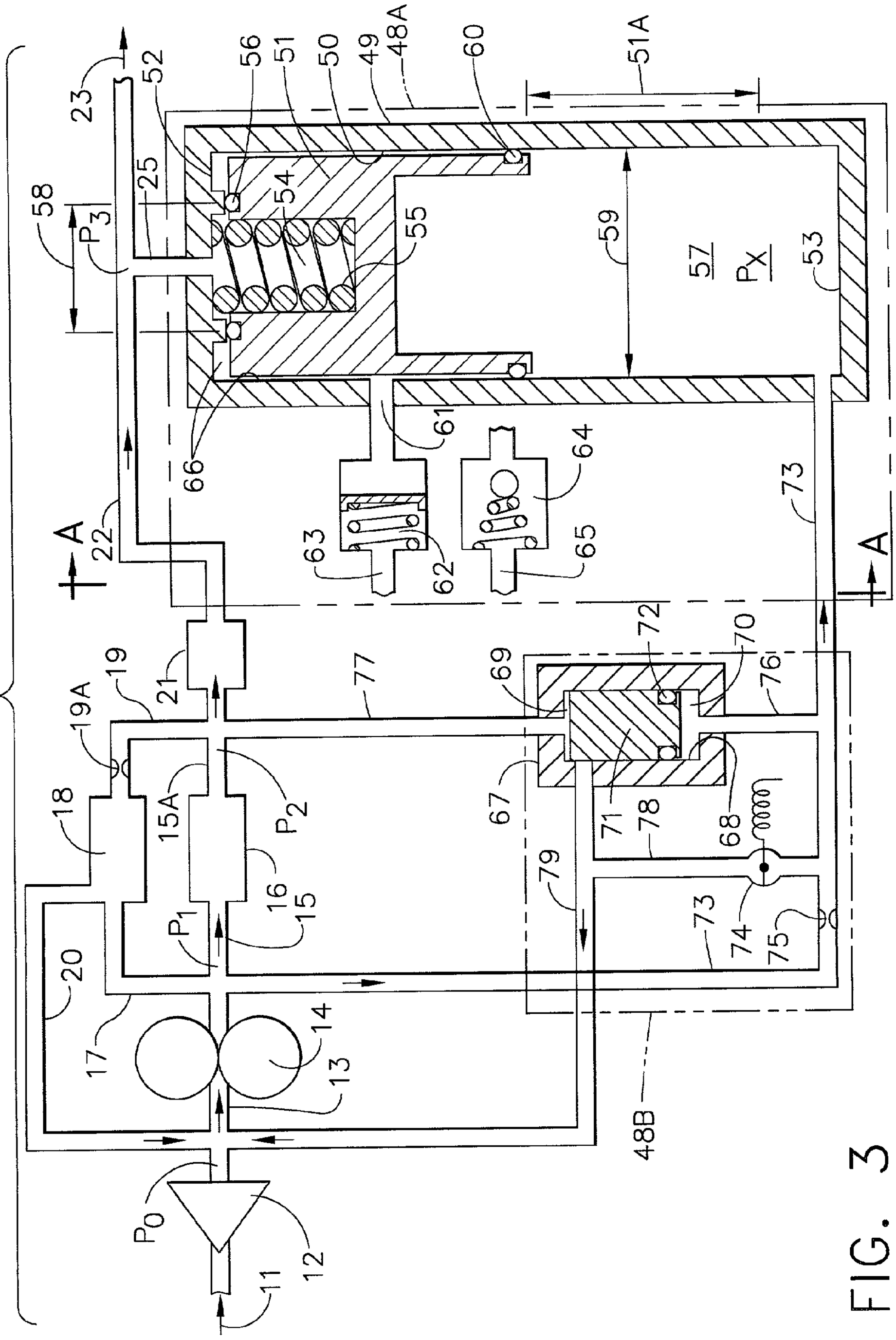
FIG. 2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48A
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P_3
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P_X
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66
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63
62
65
73
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22
72
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21
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19A
76
67
71
78
68
18
15A
P_2
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74
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P_1
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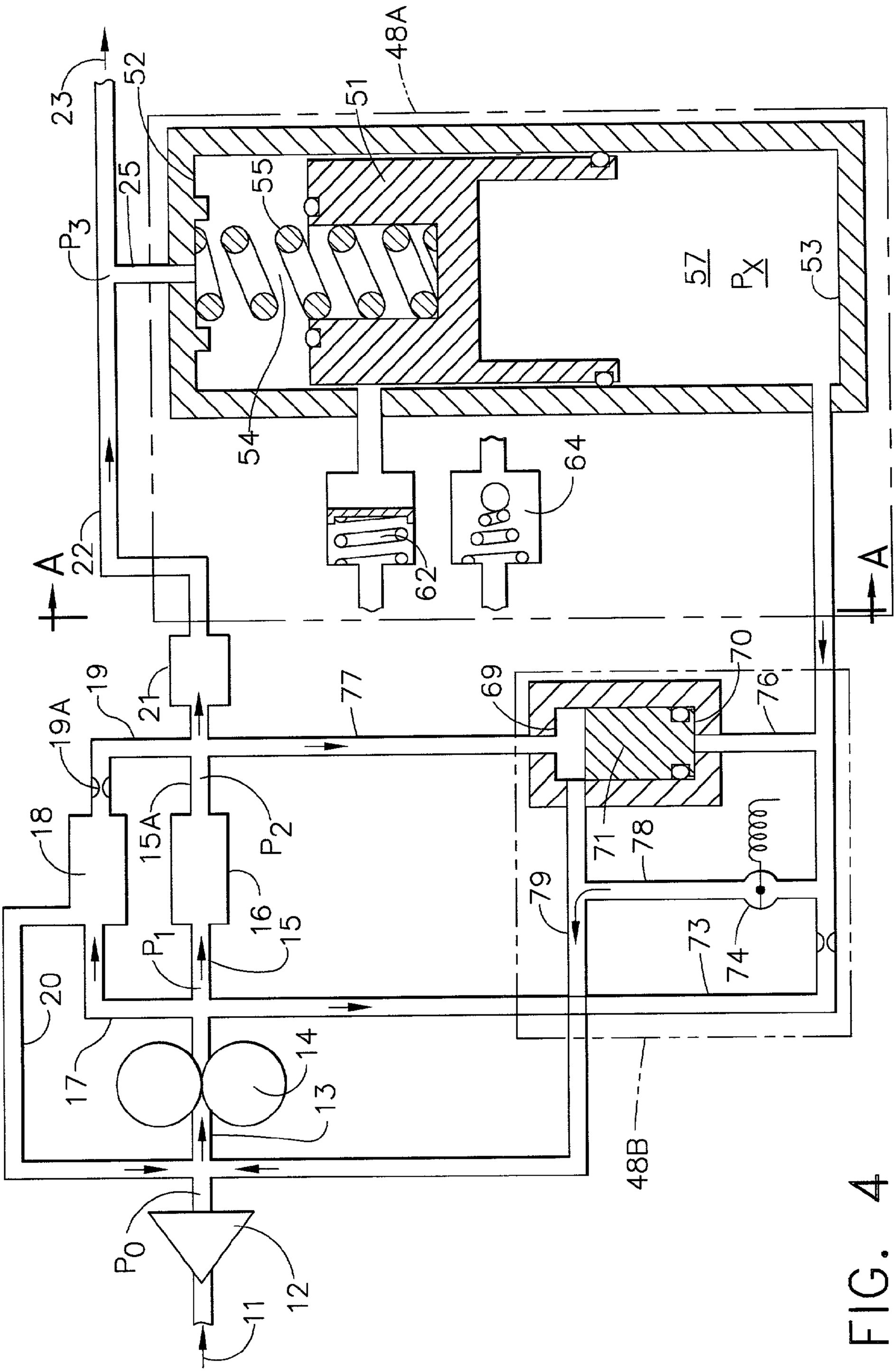
48B
P_0
12
11

FIG. 3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19A
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74
P1
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17
14
13
48B
P0
12
11

FIG. 4

RAPID SHUTDOWN AND ECOLOGY SYSTEM

BACKGROUND OF THE INVENTION

[0001] The present invention relates generally to fuel delivery systems for engines, especially aircraft gas turbine engines, and, more particularly, to a dual function rapid shutdown and ecology system for such fuel delivery systems, which performs its function upon engine shutdown.

[0002] Two of the functions provided by the fuel control system of a gas turbine engine are fuel shutoff/turn-on and ecology fuel management. The first function, fuel shutoff/turn-on, may be manually commanded from the control system (for instance, by the pilot for aircraft applications), or it may be triggered automatically through an overspeed detection system provided by the engine's electronic control. In the later case, the response of the system must be extremely fast so as to limit the engine speed excursions above the normal operating range.

[0003] A second function of the fuel control system is ecology management, and requires that the fuel in the manifold be disposed of properly during shutdown and not be allowed to drain into the engine where it will vaporize and/or smoke when in contact with the still-hot combustion chamber, thereby creating atmospheric pollution. Also, after any type of shutdown, it is necessary that fuel remaining in the engine fuel manifold be removed rapidly to keep it from puddling. Fuel left in the manifold can cause hot starts upon subsequent engine operation and will also coke the engine's fuel nozzles, a condition which hinders nozzle performance, leading to premature failure.

[0004] An examination of prior art shows that there have been many and varied attempts to address one or both of the aforementioned fuel control system functions. Of particular interest in this regard are the following references and examples:

[0005] U.S. Pat. No. 4,206,595 discloses a system to collect fuel left over in the fuel manifold upon engine shutdown and reintroduce it on the next engine start. The system uses two check valves, two springs and two pistons to accomplish this function.

[0006] U.S. Pat. No. 5,809,771 teaches a system which uses flow divider differential pressure to remove fuel from the fuel manifold upon engine shutdown and which temporarily stores the fuel until the engine is subsequently restarted.

[0007] U.S. Pat. No. 6,195,978 B1, assigned to the assignee of this application, involves a system whereby fuel flow is reversed upon engine shutoff by adding one valve to the main fuel control and modifying the main fuel control pressurizing valve to include a pressure switch function. The invention is also directed toward gas turbine engines that include both primary and secondary manifold systems.

[0008] U.S. patent application Ser. No. 09/361,932, also assigned to the assignee of this application, discloses a fuel divider and ecology system adapted for engines requiring three discrete fuel manifolds. The ecology function is accomplished using one single chamber staged valve and modifying the main fuel control pressurizing valve to include a pressure switching function.

[0009] Various other prior art fuel systems have addressed fuel shutoff/turn-on concerns as well as ecology issues and have introduced various other techniques in an effort to control both problems. Examples include: draining fuel overboard after engine shutdown, blowing unburned fuel into and through the engine at shutdown, and draining unburned fuel into a tank that must be manually emptied.

[0010] None of the above cited prior art provide a single, simple, module that accomplishes the dual functions of rapid shutoff (or turn on) of fuel flow as well as ecology management.

SUMMARY OF THE INVENTION

[0011] The present invention accomplishes the dual function of rapid shutdown and ecology management in a single module operated by a single electromagnetic solenoid valve. In one aspect of the present invention, a cylindrically shaped valve body is provided to house a large spring loaded piston member, which when extended due to pressure differentials caused by actuation of the solenoid valve, provides sufficient volume to accommodate all fuel left over in the fuel manifold and distribution system at shutdown. Simultaneously, a secondary small piston member, which is housed internal to the underside of the large piston member, also actuates causing all fuel being delivered to the engine combustion chamber to be bypassed back to pump inlet.

[0012] In another aspect of the present invention, separate cylindrically shaped valve bodies are provided to house the large spring loaded piston member and the small piston member. This alternate embodiment is intended for use on fuel control systems employing low pressure differentials along various stages of the fuel control system manifold. The large spring loaded piston member extends at low pressure differentials caused by actuation of the solenoid valve, and provides sufficient volume to accommodate all fuel left over in the fuel manifold and distribution system at shutdown. A small accumulator, or alternatively a check valve, is provided to accommodate a small amount of fuel displaced upon actuation of the large piston member. Simultaneously, with actuation of the solenoid valve, the remotely located small piston member, also actuates causing all fuel being delivered to the engine combustion chamber to be bypassed back to pump inlet.

[0013] These and other objects, features and advantages of the present invention, are specifically set forth in, or will become apparent from, the following detailed description of embodiments of the invention when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] **FIG. 1** is a schematic and partial cross sectional representation of a gas turbine engine fuel control system, including an embodiment of the inventive rapid shutdown and ecology system, shown in its first position during engine operation;

[0015] **FIG. 2** is a similar schematic and partial cross sectional representation of a gas turbine engine fuel control system, including an embodiment of the inventive rapid shutdown and ecology system, shown in its second position at engine shut down;

[0016] **FIG. 3** is a schematic and partial cross sectional representation of a gas turbine engine fuel control system,

including an alternate embodiment of the inventive rapid shutdown and ecology system, shown in its first position during engine operation; and

[0017] **FIG. 4** is a similar schematic and partial cross sectional representation of a gas turbine engine fuel control system, including an alternate embodiment of the inventive rapid shutdown and ecology system, shown in its second position at engine shut down.

DETAILED DESCRIPTION OF THE INVENTION

[0018] The following detailed description is for the best currently contemplated methods for carrying out the invention. The description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general principles of the invention.

[0019] In order to fully appreciate this invention, it is best to describe the details of the component parts in connection with the operational modes of the gas turbine engine's fuel control system. In this light the descriptions that follow address both engine operation and shutdown modes for two embodiments of the inventive rapid shutdown and ecology system.

[0020] In **FIG. 1**, an illustrative gas turbine engine fuel control system **10** of a mostly conventional configuration known to those skilled in the art includes fuel supply **11** originating from fuel tanks (not shown) entering a low pressure fuel pump **12**, which increases the pressure in line **13** to level Po. Fuel then proceeds to high pressure pump **14**, which further increases fuel pressure to level P1 in line **15**, at which point it enters metering valve **16** for modulating the rate of flow from the fuel supply to the combustor atomizers (not shown). Fuel pressure in line **15**A downstream of metering valve **16** decreases to level P2 (by the setting of bypass valve **18**) and thereafter further decreases to level P3 in line **22** after passing through pressurizing valve **21**, which controls and establishes a minimum pressure of fuel delivered to the combustor atomizers downstream of flow arrow **23**. The bypass valve **18** returns, via lines **19** and **20**, pump flow in excess of metered flow and also controls fuel pressure such that P1 is always higher than P3, usually about 25 psi or greater. Additionally, at low fuel flow rates, P1 will be additionally higher than P3 by the setting of pressure rising valve **21**. Orifice **19**A is provided on line **19** to create a damping pressure drop to stabilize bypass valve **18**. All functions of the gas turbine engine fuel control system **10** are commanded by the engine electronic control unit (ECU), which is not shown on the drawings, by repositioning the metering valve **16**.

[0021] The inventive rapid shutdown and ecology system **24** communicates with line **22** by means of line **25**, and is positioned to be downstream of pressure rising valve **21** and upstream of the combustor atomizers. It is comprised of a metallic cylindrically shaped valve body **26** internally bored to define valve chamber **27** having an upper end **28** and an a lower end **29** at the longitudinal extremities. A large piston member "B"**30** is movable along the longitudinal axis of the valve chamber **27** between upper end **28** and lower end **29**. The flat surface of large piston member "B"**30** at the upper end **28** is bored to form fuel cavity "B"**31**. The depth and diameter of said fuel cavity "B"**31** are sized to provide a scavenge volume sufficient to accommodate all fuel in the fuel control system **10** downstream of pressure rising valve **21**, when the large piston member "B"**30** has moved to the extreme of its stroke in the direction of lower end **29**. A spirally wound spring **32** is positioned along the axial periphery of fuel cavity "B"**31**, such that when compressed, one end bears on upper end **28** and the other end bears on the base of fuel cavity "B"**31**. Spring **32** is designed to remain fully compressed when fuel pressure Px in fuel cavity "A"**34** is sufficiently greater than P3, the pressure immediately downstream of pressure rising valve **21**. In other words, the difference between Px and P3 times the area of piston B must be greater than the load in spring **32**. O-ring seals **44** are provided at three circumferential levels to prevent fuel flow between the inner surface of valve chamber **27** and the exterior surface of large piston member "B"**30** when the latter strokes along the longitudinal axis of valve chamber **27**.

[0022] Small piston member "A"**33** is placed internal to a close tolerance cylindrically bored cavity **36** located along the longitudinal centerline of large piston member "B"**30** at lower end **29**. Small piston member "A"**33** may be equipped with an o-ring seat **45** to prevent any leakage of metered fuel during normal engine operation. Face plate **35**, secured to large piston member "B"**30**, interlocks small piston member "A"**33** within bored cavity **36**. Two fuel passages extending from bored cavity upper end **36**A provide communication with elements of the fuel control system **10** manifold as follows: Passageway **37** leads to annular cavity **37**A on valve body **26**, and then to line **38**, thus permitting free flow of fuel from downstream of metering valve **16** to small piston member "A"**33** at the bored cavity upper end **36**A. Fuel passageway **39** leads to annular cavity **39**A on valve body **26**, and then via line **40** to line **13** downstream of the low pressure fuel pump **12**. Electro-magnetic solenoid valve **41**, which is commanded by the ECU, connects line **40** with fuel cavity "A" at lower end **29**. On the opposite side of valve body **26**, line **42** connects fuel cavity "A"**34** with line **15**, immediately downstream of high pressure pump **14**. A small orifice **43** is provided on line **42** to establish a pressure drop from P1 to Px when solenoid valve **41** is open. For one embodiment, diameter **46** of large piston member "B"**30** is about 2.5 inches and stroke **47** is about 1.5 inches. Those dimensions will vary as a function of the specific gas turbine engine's fuel control system configuration.

[0023] Still referring to **FIG. 1**, the fuel control system is shown in its first position during engine operation. Solenoid valve **41** is closed and pressure in fuel cavity "A"**34**, Px, is equal to P1, which is always higher than P3 (by at least about 25 psi). Accordingly, large piston member "B"**30** is fully stroked toward upper end **28**, and spring **32** is fully compressed. Simultaneously, since Px is higher than P2, small piston member "A"**33** is fully stroked toward bored cavity upper end **36**A, thus preventing fuel flow from line **38** to line **40**. Therefore, during engine operation, the inventive rapid shutdown and ecology system remains inoperative.

[0024] Referring now to **FIG. 2**, there is shown the same gas turbine engine fuel control system schematic as in **FIG. 1** with the exception that the embodiment of the inventive rapid shutdown and ecology system **10** is now shown in its second position at engine shut down. It is at this phase that it accomplishes its intended dual function of rapid shutoff (or turn on) of fuel flow as well as ecology fuel management.

[0025] When the gas turbine engine is shut down either by manual command from the control system (for instance, by the pilot for aircraft applications) or automatically through an overspeed, overtemperature or other fault detection system, the ECU opens solenoid valve **41** and shortly thereafter, when P2 falls below a predetermined level, pressure rising valve **21** closes. Closure of pressure rising valve **21** terminates fuel delivery to the combustor atomizers and opening of solenoid valve **41** immediately establishes a communication path between the upstream and downstream sides of high pressure pump **14** (via line **42**, fuel cavity "A"**34**, solenoid valve **41**, and line **40**). Due to the pressure drop of orifice **43**, fuel pressure in fuel cavity "A"**34**, Px, thus drops to Po, causing spring **32** to shift large piston member "B"**30** to the extreme of its stroke in the direction of lower end **29**. This action increases the volume of fuel cavity "B"**31** thereby collecting all the fuel in the fuel control system **10** downstream of pressure rising valve **21**, and preventing it from draining into the engine creating atmospheric pollution and/or puddling, causing hot starts upon subsequent engine operation.

[0026] Simultaneously with the reduction of Px to Po, small piston member "A"**33** moves toward lower end **29**, thus establishing an open communication path between passageways **37** and **39**, annular cavity **39**A, and line **40**. In addition, as the pressure in lines **37**, **38** and **19** fall to the Po level the bypass valve **18** moves toward orifice **19**A. These actions cause all of the fuel being delivered to the chamber atomizers to be immediately bypassed back to the high pressure pump **14** inlet, either through the bypass valve itself or through piston "A" cavity upper end **36**A. The rapid shutoff of fuel flow to the engine has therefore been achieved.

[0027] When solenoid valve **41** is again closed by ECU command, the reverse process takes place. Fuel cavity "A" pressure Px increases to P1 forcing small piston member "A"**33** to move toward bored cavity upper end **36**A, closing passageway **39** and terminating the fuel bypass condition. Large piston "B"**30** also moves toward upper end **28**, compressing spring **32**, and forcing the fuel previously collected in fuel cavity "B"**31** to return to the fuel control system manifold downstream of pressure rising valve **21**. Rapid turn on of fuel flow to the engine has therefore been achieved and atmospheric pollution has been prevented.

[0028] On some gas turbine engine fuel control systems, the setting of bypass valve **18** is quite low and pressure rising valve **21** is referenced to Po rather than P2. Under those conditions, the difference between P1 and P3 is insufficient to compress spring **32** and hold large piston member "B"**30** fully stroked toward upper end **28**, as shown in **FIG. 1**. To accommodate those conditions and still provide the intended dual function of rapid shut down (or turn on) of fuel flow as well as ecology fuel management, another embodiment of the inventive rapid shut down and ecology system has been devised and is shown on **FIGS. 3 and 4**.

[0029] In **FIG. 3**, another embodiment of the inventive rapid shutdown and ecology system is shown in its first position during engine operation. The gas turbine engine fuel control system **10** is the same as that shown of **FIGS. 1 and 2**, and is comprised of the same conventional components, including low pressure fuel pump **12**, high pressure pump **14**, metering valve **16**, bypass valve **18**, pressurizing valve **21**, and various inter-communicating fuel lines, and all functions are commanded by the engine electronic control unit (ECU).

[0030] The other embodiment is comprised of two separately functioning subsystems, one for the ecology management function **48**A and another for the rapid shutdown function **48**B. The ecology management subsystem is shown to the right of view line A-A, and may be remotely located from the remaining fuel control system. It is comprised of a cylindrically shaped valve body **49** internally bored to define valve chamber **50** having an upper end **52** and an a lower end **53** at the longitudinal extremities. A large piston member "B"**51** is movable along the longitudinal axis of valve chamber **50** between upper end **52** and lower end **53**. The flat surface of large piston member "B"**51** at the upper end **52** is bored to form fuel cavity "B"**54**. The depth and diameter of said fuel cavity "B"**54** are sized to provide a scavenge volume sufficient to accommodate all fuel in the fuel control system **10** downstream of pressure rising valve **21**, when the large piston member "B"**51** has moved to the extreme of its stroke in the direction of lower end **53**. A spirally wound spring **55** is positioned along the axial periphery of fuel cavity "B"**54**, such that when compressed, one end bears on upper end **52** and the other end bears on the base of fuel cavity "B"**54**. Spring **55** is designed to remain fully compressed when fuel pressure Px, in fuel cavity "A"**57**, acting on piston diameter "A"**59** produces a force which is greater that the force produced by pressure P3 acting on the smaller piston diameter "B"**58**.

[0031] When large piston member "B"**51** is in contact with upper end **52** during engine operation, fuel leakage from P3 to Px is prevented by circumferential o-ring seal **56** and annular o-ring seal **60**. Under this condition, the small amount of fuel displaced into large piston annular cavity **66** is routed via fuel port **61** into a small, spring loaded, accumulator valve **62** where it is temporarily stored until engine shut down, at which time the spring load forces its return to fuel cavity "B"**54**. A "witness" drain **63** is provided to collect any inadvertent fuel leakage past accumulator valve **62**. An alternate embodiment involves use of a spring loaded check valve **64** in lieu of accumulator valve **62**. In such a case, the displaced fuel is released via line **65** to any fuel line, such as line **40**, having pressure Po.

[0032] For another embodiment of the ecology management subsystem **48**A, piston diameter "A"**59** is about 2.5 inches and piston diameter "B"**58** is about 2.0 inches, while stroke **51**A is about 1.5 inches. Those dimensions will vary as a function of the specific gas turbine engine's fuel control system configuration.

[0033] Still referring to **FIG. 3**, the rapid shutdown subsystem **48**B is comprised of a metallic cylindrically shaped valve body **67** internally bored to define valve chamber **68** and having an upper end **69** and a lower end **70**. A closely fitting cylindrically shaped small piston **71** placed internal to valve body **67** and is movable along the longitudinal axis of valve chamber **68** between the upper end **69** and the lower end **70**. An o-ring seal **72** is fitted along the periphery of small piston **70** to prevent fuel passage between upper **69** and lower **70** ends of valve chamber **68**.

[0034] The rapid shutdown subsystem **48**B communicates with the ecology subsystem **48**A and other elements of the

fuel control system **10** by means of the following fuel lines: Line **73** is connected to line **15** downstream of high pressure pump **14** and leads to solenoid valve **74** (which is commanded by the ECU) and then to fuel cavity "A"**57** of the ecology subsystem **48**A. An orifice **75** is provided to create a pressure drop from P1 to PX when the solenoid valve **74** is open. Line **76** connects line **73** to valve body **67**, thus exposing the lower end **70** of small piston **71** to pressure P1. Line **77** connects to line **15**A and exposes the upper end **69** of small piston **71** to pressure P2, which is lower than P1. Finally, line **79** communicates between the upper end **69** of valve body **67** and line **13**, immediately downstream of low pressure pump **12**, which is at pressure Po, and line **78** connects line **79** to solenoid valve **74**.

[**0035**] The fuel control system as shown in **FIG. 3** is in its first position during engine operation. Solenoid valve **74** is closed and pressure in fuel cavity "A"**57**, Px, is equal to P1 by virtue of fuel flow through line **73**. Accordingly, large piston member "B"**51** is fully stroked toward upper end **52**, and spring **55** is fully compressed. Simultaneously, since Px is higher than P2, small piston **71** is fully stroked toward the upper end **69**, thus preventing fuel flow from line **77** (pressure P2) to line **79** (pressure Po). Therefore, during engine operation, the other embodiment of the inventive rapid shutdown and ecology system remains inoperative.

[**0036**] Referring now to **FIG. 4**, there is shown the same gas turbine engine fuel control system schematic as in **FIG. 3** with the exception that the other embodiment of the inventive rapid shutdown and ecology system **10** is now shown in its second position at engine shut down. It is at this phase that it accomplishes its intended dual function of rapid shutoff (or turn on) of fuel flow as well as ecology fuel management.

[**0037**] When the gas turbine engine is shut down either by manual command from the control system (for instance, by the pilot for aircraft applications) or automatically through an overspeed, overtemperature or other fault detection system, the ECU opens solenoid valve **74** and shortly thereafter, when P2 falls below a predetermined level, pressure rising valve **21** closes. Closure of pressure rising valve **21** terminates fuel delivery to the combustor atomizers and opening of solenoid valve **74** immediately establishes a communication path between the upstream and downstream sides of high pressure pump **14** (via line **73**, solenoid valve **74**, and lines **78** and **79**). Fuel pressure in fuel cavity "A"**57**, Px, thus drops to Po, causing spring **55** to shift large piston member "B"**51** to the extreme of its stroke in the direction of lower end **53**. This action increases the volume of fuel cavity "B"**54** thereby collecting all the fuel in the fuel control system **10** downstream of pressure rising valve **21**, and preventing it from draining into the engine creating atmospheric pollution and/or puddling, causing hot starts upon subsequent engine operation.

[**0038**] Simultaneously, at rapid shutdown subsystem **48**B, with the reduction of Px to Po, small piston **71** moves toward lower end **70**, thus establishing an open communication path between line **77** and line **79**. In addition, as the pressure in lines **77** and **19** fall to the P0 level the bypass valve **18** moves toward orifice **19**A. These actions causes all of the fuel being delivered to the chamber atomizers to be immediately bypassed back to the high pressure pump **14** inlet, either through the bypass valve itself or through piston "A" cavity upper end **69**. The rapid shutoff of fuel flow to the engine has therefore been achieved.

[**0039**] When solenoid valve **74** is again closed by ECU command, the reverse process takes place. Fuel cavity "A"**57** pressure Px increases to P1 forcing small piston **71** to move toward upper end **69**, stopping flow through line **77** thus terminating the fuel bypass condition. On the ecology management subsystem, **48**A, large piston member "B"**51** also moves toward upper end **52**, compressing spring **55**, and forcing the fuel previously collected in fuel cavity "B"**54** to return to the fuel control system manifold downstream of pressure rising valve **21**. Rapid turn on of fuel flow to the engine has therefore been achieved and atmospheric pollution has been prevented.

[**0040**] The other embodiment also has the advantage that the ecology and rapid shutdown features can be separated, along line A-A of **FIGS. 3 and 4**, in the event the ecology function is not required, such as on military engines.

[**0041**] Although the present invention has been described in considerable detail with reference to certain preferred versions thereof, other versions are possible. Therefore, the spirit and scope of the appended claims should not be limited to the description of the preferred versions contained therein.

We claim:

1. A gas turbine engine fuel control rapid shut down and ecology system comprising:

a cylindrically shaped valve body, internally bored to define a valve chamber having upper and lower ends;

a first cylindrical piston member placed internal to the valve chamber and movable therein along the longitudinal axis thereof;

a bored cavity at the upper end and along the longitudinal axis of the first cylindrical piston member;

a spirally wound spring positioned internal to the bored cavity at the upper end of the first cylindrical piston member, one end bearing on the base of the bored cavity and the other end bearing on the upper internal end of the valve chamber;

a bored cavity at the lower end and along the longitudinal axis of the first cylindrical piston member;

a second cylindrical piston member placed internal to the bored cavity at the lower end of the first cylindrical piston member and movable therein along the longitudinal axis thereof;

an annular shaped face plate attached to the lower end of the first cylindrical piston member to interlock the second cylindrical piston member within the bored cavity;

a fluid passageway connecting the upper end of the valve chamber to a gas turbine engine fuel manifold immediately upstream of combustion chamber atomizers;

a fluid passageway connecting a gas turbine engine fuel manifold immediately downstream of a high pressure fuel pump to the lower end of the valve chamber;

a fluid passageway, including an electrically actuated solenoid valve, connecting the lower end of the valve

chamber to a gas turbine engine fuel manifold immediately downstream of a low pressure fuel pump;

a plurality of fluid passageways connecting the bored cavity along the upper end of the second cylindrical piston member to a gas turbine engine fuel manifold downstream of the low pressure fuel pump and upstream of a valve controlling the fuel pressure delivered to combustion chamber atomizers;

whereby when said gas turbine engine is turned off, said solenoid valve will simultaneously close causing fuel pressure differentials to drive both first and second cylindrical piston members downward thus rapidly terminating further fuel flow to the combustion chamber atomizers, and providing a temporary cavity to accommodate all fuel leftover in the manifold and distribution system at shutdown.

2. The gas turbine engine fuel control rapid shut down and ecology system of claim 1, wherein o-ring seals are provided at three circumferential locations of the valve chamber.

3. The gas turbine engine fuel control rapid shut down and ecology system of claim 2, wherein an o-ring seat is provided on the base of the bored cavity at the lower end of the first cylindrical piston member.

4. The gas turbine engine fuel control rapid shut down and ecology system of claim 1, wherein the diameter of the first cylindrical piston member is about 2.5 inches.

5. The gas turbine engine fuel control rapid shut down and ecology system of claim 4, wherein the stroke of the first cylindrical piston member within the valve chamber is about 1.5 inches.

6. The gas turbine engine fuel control rapid shut down and ecology system of claim 1, wherein a small orifice is provided on the fluid passageway connecting a gas turbine engine fuel manifold immediately downstream of a high pressure fuel pump to the lower end of the valve chamber.

7. The gas turbine engine fuel control rapid shut down and ecology system of claim 1, wherein the depth and diameter of the bored cavity at the upper end and along the longitudinal axis of the first cylindrical piston member is sized to provide a scavenge volume sufficient to accommodate all fuel leftover in the manifold and distribution system after shutdown.

8. A gas turbine engine fuel control rapid shut down and ecology system comprising:

a first cylindrically shaped valve body, internally bored to define a valve chamber having upper and lower ends;

a first cylindrical piston member placed internal to the valve chamber and movable therein along the longitudinal axis thereof;

a bored cavity at the upper end and along the longitudinal axis of the first cylindrical piston member;

a bored cavity at the lower end and along the longitudinal axis of the first cylindrical piston member, said bored cavity having a diameter larger than the bored cavity on the opposite end of the first cylindrical piston member;

a spirally wound spring positioned internal to the bored cavity at the upper end of the first cylindrical piston member, one end bearing on the base of the bored cavity and the other end bearing on the upper internal end of the valve chamber;

a fuel passageway leading from an annular cavity along the outer surface of the first cylindrical piston member to a spring loaded accumulator valve;

a fuel passageway leading from the spring loaded accumulator valve to a witness drain;

a second cylindrically shaped valve body, internally bored to define a second valve chamber having upper and lower ends;

a second cylindrical piston member placed internal to the second valve chamber and movable therein along the longitudinal axis thereof;

a fluid passageway connecting the upper end of the first valve chamber to a gas turbine engine fuel manifold immediately upstream of combustion chamber atomizers;

a fluid passageway connecting a gas turbine engine fuel manifold immediately downstream of a high pressure fuel pump to the lower ends of both first and second valve chambers;

a fluid passageway, including an electrically actuated solenoid valve, connecting the lower end of the first valve chamber and upper end of the second valve chamber to a gas turbine engine fuel manifold immediately downstream of a low pressure fuel pump;

a fluid passageway connecting the upper end of the second valve chamber to a gas turbine engine fuel manifold upstream of a valve controlling the fuel pressure delivered to combustion chamber atomizers;

whereby when said gas turbine engine is turned off, said solenoid valve will simultaneously close causing fuel pressure differentials to drive both first and second cylindrical piston members downward thus rapidly terminating further fuel flow to the combustion chamber atomizers, and providing a temporary cavity to accommodate all fuel leftover in the manifold and distribution system at shutdown as well as all fuel contained in the annular cavity along the outer surface of the first cylindrical piston member.

9. The gas turbine engine fuel control rapid shut down and ecology system of claim 8, wherein o-ring seals are provided on the first cylindrical piston member at the upper transverse surface and at the bottom peripheral surface.

10. The gas turbine engine fuel control rapid shut down and ecology system of claim 8, wherein an o-ring seal is provided on the lower peripheral surface of the second cylindrical piston.

11. The gas turbine engine fuel control rapid shut down and ecology system of claim 8, wherein the diameter of the first cylindrical piston member at the lower end is about 2.5 inches.

12. The gas turbine engine fuel control rapid shut down and ecology system of claim 11, wherein the diameter of the of the first cylindrical piston member at the location of the o-ring seals on the upper transverse surface is about 2 inches.

13. The gas turbine engine fuel control rapid shut down and ecology system of claim 8, wherein the stroke of the first cylindrical piston member within the valve chamber is about 1.5 inches.

14. The gas turbine engine fuel control rapid shut down and ecology system of claim 8, wherein an orifice is provided on the fluid passageway connecting a gas turbine engine fuel manifold immediately downstream of a high pressure fuel pump to the lower end of the valve chamber.

15. The gas turbine engine fuel control rapid shut down and ecology system of claim 8, wherein the depth and diameter of the bored cavity at the upper end and along the longitudinal axis of the first cylindrical piston member is sized to provide a scavenge volume sufficient to accommodate all fuel left over in the manifold and distribution system at shutdown.

16. The gas turbine engine fuel control rapid shut down and ecology system of claim 8 wherein a fuel passageway leading from an annular cavity along the outer surface of the first cylindrical piston member is connected to a spring loaded check valve and thereafter to a fluid passageway downstream of the low pressure pump, thereby allowing for remote location of the first cylindrical piston member and valve chamber;

17. A gas turbine engine fuel control rapid shut down and ecology system comprising:

a valve chamber containing a first spring loaded piston member movable along the longitudinal axis thereto and including a bored cavity for temporary storage of fuel;

a second piston member movable along the longitudinal axis thereto and placed internal to a bored cavity at the lower end and along the longitudinal axis of the first cylindrical piston member;

a plurality of fluid passageways connecting the valve chamber to a gas turbine engine fuel manifold at points downstream of the low pressure pump, high pressure pump, fuel pressure and flow control valves;

an electrically actuated solenoid valve placed on the fluid passageway from the valve chamber to a gas turbine engine fuel manifold immediately downstream of a low pressure fuel pump;

whereby when said gas turbine engine is turned off, said solenoid valve will simultaneously close causing fuel pressure differentials to drive both first and second cylindrical piston members downward thus rapidly terminating further fuel flow to the combustion chamber atomizers, and providing a temporary cavity to accommodate all fuel leftover in the manifold and distribution system at shutdown.

18. The gas turbine engine fuel control rapid shut down and ecology system of claim 17, wherein a separate second valve chamber is provided for housing the second piston member there within.

19. The gas turbine engine fuel control rapid shut down and ecology system of claim 18, wherein a fuel passageway leads from an annular cavity along the outer surface of the first piston member to a spring loaded accumulator valve.

20. The gas turbine engine fuel control rapid shut down and ecology system of claim 17, whereby a fuel passageway leads from an annular cavity along the outer surface of the first cylindrical piston member to a spring loaded check valve and thereafter to a fuel control system manifold downstream of the low pressure pump thereby allowing for remote location of the first cylindrical piston member and valve chamber.

21. A method of rapidly terminating fuel flow to gas turbine engine combustion chamber atomizers and providing a temporary storage volume to accommodate fuel left in the manifold after shutdown, said method comprising the steps of:

providing a fuel passageway from a gas turbine engine fuel manifold upstream of fuel chamber atomizers and leading to a valve chamber containing a first spring loaded piston member movable along the longitudinal axis thereto and including a bored cavity for temporary storage of fuel;

providing a plurality of fluid passageways from a gas turbine engine fuel manifold at points downstream of the low pressure pump, high pressure pump, fuel pressure and flow control valves, and leading to a second piston member movable along its longitudinal axis and placed internal to a bored cavity at the lower end and along the longitudinal axis of the first cylindrical piston member;

providing an electrically actuated solenoid valve placed on the fluid passageway from the valve chamber to a gas turbine engine fuel manifold immediately downstream of a low pressure fuel pump;

actuating said solenoid valve thereby causing fuel pressure differentials to drive both first and second cylindrical piston members downward thus rapidly terminating further fuel flow to the combustion chamber atomizers, and providing a temporary storage volume to accommodate all fuel left in the manifold after shutdown.

22. The method of claim 21, wherein a separate second valve chamber is provided for housing the second piston member there within.

23. A method of rapidly terminating fuel flow to gas turbine engine combustion chamber atomizers and providing a temporary storage volume to accommodate fuel left in the manifold after shutdown, said method comprising the steps of:

providing a scavenge volume of sufficient size to accommodate, for temporary storage, fuel remaining in a gas turbine engine fuel manifold upstream of fuel chamber atomizers after engine shutdown;

returning to a gas turbine engine fuel manifold, upon startup, said fuel that has been temporarily stored after engine shutdown;

terminating rapidly upon commanded shutdown any continued fuel flow to a gas turbine engine combustion chamber.

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