

Nov. 15, 1966

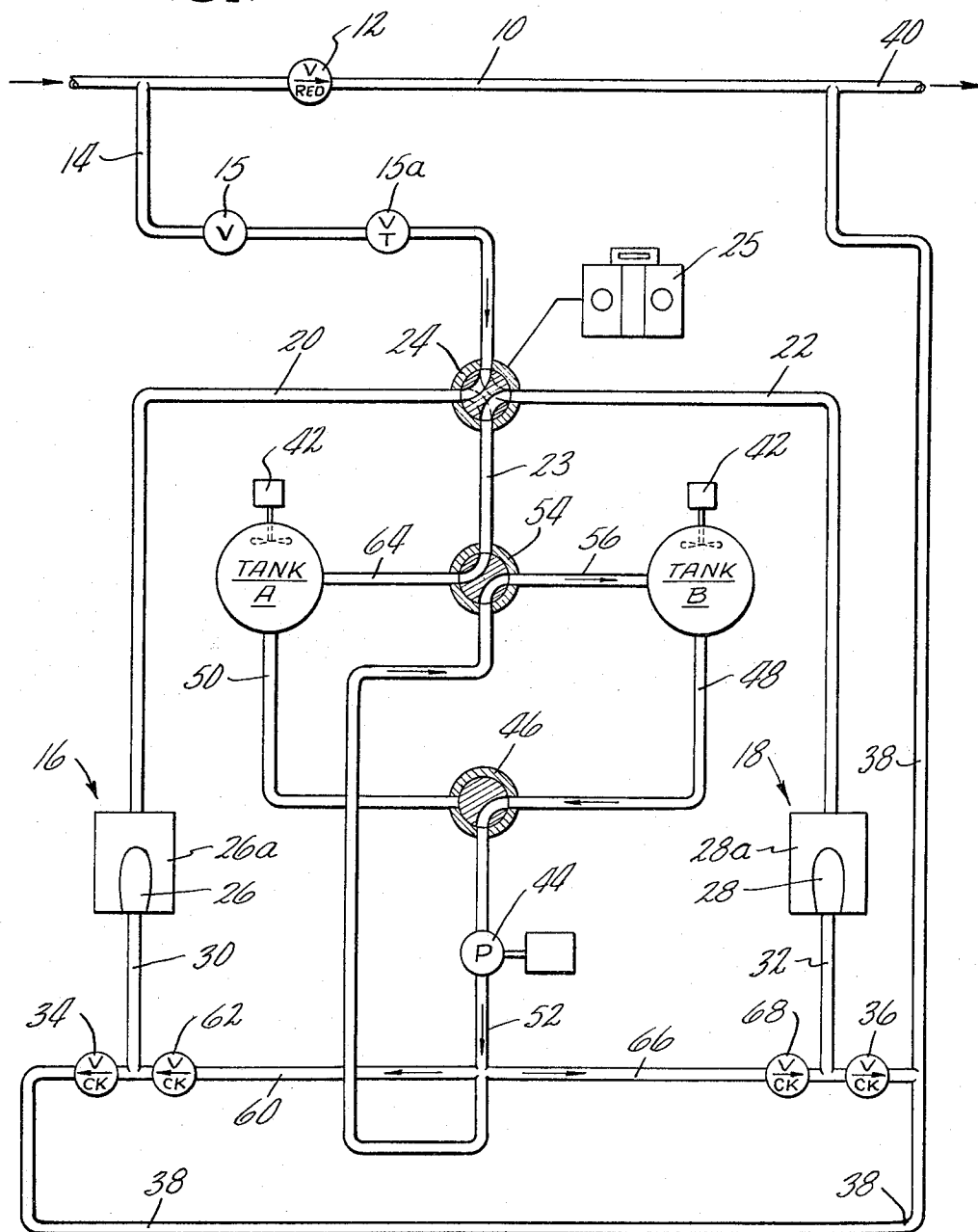
H. R. MESSENGER
CONTAMINATION SYSTEM

3,285,272

Filed Feb. 23, 1965

2 Sheets-Sheet 1

FIG. 1



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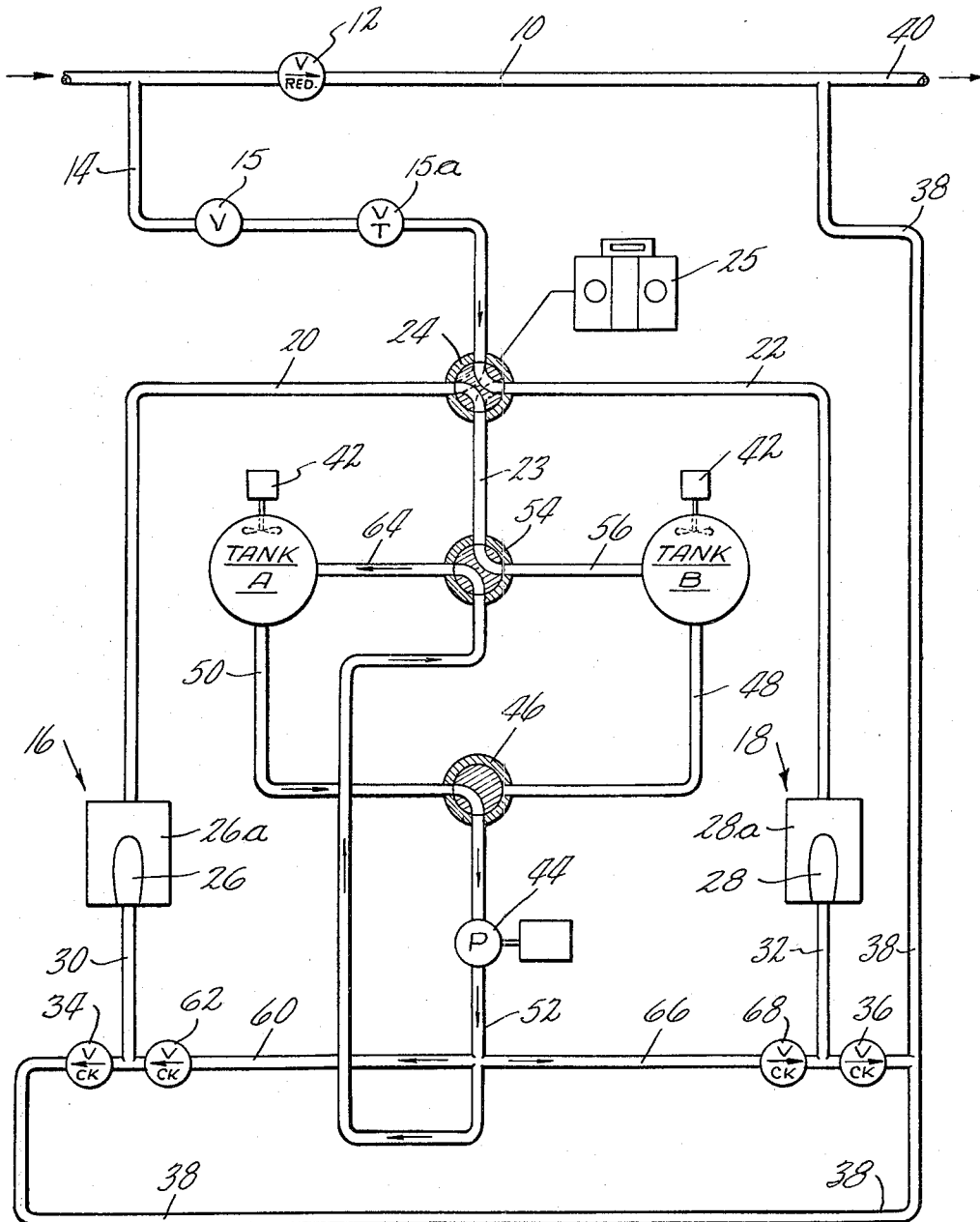
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FIG. 2



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CONTAMINATION SYSTEM

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16 Claims. (Cl. 137-256)

This invention relates to mechanism for injecting contamination into a test rig which is set up to pass a pressurized fuel flow through a device, such as a jet engine fuel control, to determine the effect of various contaminating materials on the device being tested.

Many problems are presented in producing a mechanism for this purpose. The fuel supply line for the rig into which the contaminates are to be introduced may be under pressure as high as 3000 p.s.i., the contaminating materials may not be soluble in the fuel, and they may be abrasive, corrosive or fleecy and thus not lend themselves to the use of conventional high-pressure pumps utilizing moving parts such as pistons and valves. Further the mechanism must be capable of injecting the contaminating materials into the high pressure fuels at a constant rate, at a uniform concentration and over a long period of time in order to determine the effects of the contaminating materials on the device under test.

It is therefore an object of this invention to provide improved mechanism for the injection of contamination into a high pressure fuel line for the purpose above outlined.

Another object of this invention is to provide a reliable pump that can handle fuel and contaminates at pressures required for fuel control and similar component test work.

A further object of this invention is the provision of a mechanism as above outlined which is capable of introducing contaminates into a high pressure fuel line which are corrosive, abrasive, or fleecy in nature in a homogeneous mixture over long periods of time and at a uniform concentration.

These and other objects and advantages of the invention will be evident or will be pointed out in connection with the following detailed description of a preferred embodiment of the invention shown in the accompanying drawings.

In the drawings,

FIG. 1 is a schematic showing of a high-pressure fuel line for supplying fuel to a test rig having the improved mechanism associated therewith for introducing contamination into the fuel; and

FIG. 2 is another view of the same mechanism with its control valves in a different position.

Referring first to FIG. 1, clean fuel is supplied from the test rig pump (not shown) at high pressure through fuel line 10 to the device under test. A pressure orifice, herein a valve 12, is provided in line 10 for the purpose of providing a difference in fuel pressure upstream and downstream of the valve. Fuel is bled off upstream of the valve 12 and flows through conduit 14, shut-off valve 15, needle valve 15a and conduit 20 to accumulator 16, or through conduit 22 to accumulator 18, as determined by the position of a two-position, 4-way valve 24. Valve 24 is solenoid operated and is controlled by a timer 25 which effects energization of the solenoid of valve 24 at predetermined intervals to position the valve alternately in the full-line and dotted-line positions shown in FIG. 1 of the drawings. When in the full-line position of FIG. 1, fuel from conduit 14 is supplied through conduit 20 to accumulator 16; when in the dotted-line position, fuel from conduit 14 is supplied through conduit 22 to accumulator 18. When valve 24 is in the full-line position, accumulator 18 is connected through conduit 22 and

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valve 24 to conduit 23 and similarly when valve 24 is in the dotted-line position, accumulator 16 is connected through conduit 20 and valve 24 to conduit 23, for a purpose which will subsequently appear.

Accumulators 16 and 18 include internal flexible bags 26 and 28 respectively, which are alternately filled with contaminated fuel, and cylinders 26a and 28a which enclose these bags. As high pressure fuel is alternately supplied to cylinders 26a and 28a of the accumulators by valve 24, the contaminated fuel in bags 26 and 28 is discharged through conduits 30 and 32 and check valves 34 and 36 respectively into conduit 38 leading to the test inlet 40. This is made possible because the pumping pressure supplied to the accumulators by valve 24 from conduit 14 is higher than the pressure in conduit 10 downstream of valve 12.

The contaminates are mixed with clean fuel in either one of two tanks A and B which are accessible at the top to permit easy introduction of the contaminating material. These tanks are charged with contaminates alternately. The tank which does not contain a slurry of fuel and contaminates is initially empty but is filled with clean fuel discharged from cylinders 26a and 28a from conduit 23 while the other tank is being emptied of its contaminated fuel. A mixing device 42 is provided for each tank which constantly agitates its contents.

A low pressure slurry pump 44 delivers slurry from the slurry containing tank which, in FIG. 1, is tank B. A two-position, three-way, manual valve 46 supplies the inlet of pump 44 with slurry from tanks B and A through conduits 48 and 50, respectively. Pump 44 is a low pressure, rubber liner type pump which has a discharge pressure of about 20 p.s.i. and at this pressure is capable of handling the slurry indefinitely. The normal contamination elements used are iron oxide, silica sand, Arizona road dust, cotton linters, crude naphthenic acid and salt water.

In the position of the valves shown in FIG. 1, the slurry is continuously circulated by pump 44 through conduit 52, 4-way valve 54, conduit 56, tank B, conduit 48 and 3-way valve 46 back to the pump inlet. This continuous circulation of the slurry in tank B, together with the agitation of the mixing device 42 in the tank insures a homogeneous mixture of the liquids and solids in the tank at all times. Similarly, when tank A is the slurry containing tank (FIG. 2), slurry is supplied to the inlet of pump 44 through conduit 50 and valve 46 and is returned through conduit 52, 4-way valve 54 and conduit 64 to tank A.

During the time accumulator 16 is pumping slurry from bag 26 into fuel inlet 40 (FIG. 1), a fluid connection is established by valve 24 between cylinder 28a of accumulator 18 and tank A through conduit 22, solenoid valve 24, conduit 23, manual valve 54 and conduit 64 which permits the clean fuel in cylinder 28a of accumulator 18 to be discharged into tank A under the pressure of the slurry pumped into bag 28 by pump 44 through conduits 52, 66, check valve 68 and conduit 32. When solenoid valve 24 is actuated into its alternative position and accumulator 18 is pumping slurry, a similar connection is provided from cylinder 26a of accumulator 16 through conduit 20, valve 24, conduit 23, manual valve 54 and conduit 64 to tank A.

When the slurry in tank B nears exhaustion, a batch of contaminates is added to the clean fuel in tank A and, when this has been well mixed, the manual valves 54 and 46 are moved to their FIG. 2 positions. Slurry pump 44 now constantly circulates the slurry in tank A and supplies slurry from this tank alternately to accumulator bags 26 and 28 whenever solenoid valve 24 is not admitting high-pressure fuel to one of these accumulators.

In describing the operation of the mechanism, reference is first made to FIG. 1 which shows the manual valves 46 and 54 in the positions which they occupy when tank B is the slurry containing tank and tank A is being used to collect clean fuel discharged from accumulators 16 and 18 during refilling of the bags 26 and 28 with slurry by pump 44. Slurry discharged from pump 44 flows continuously through conduit 52, 4-way valve 54, conduit 56, tank B, conduit 48 and 3-way valve 46 back to pump 44. Slurry is also supplied under relatively low pressure from conduit 52 through conduit 66, check valve 68 and conduit 32 to the accumulator bag 28 and alternately from conduit 52 through conduit 60, check valve 62 and conduit 30 to accumulator bag 26. Since, in FIG. 1, solenoid valve 24 is, at the moment, supplying high pressure fuel to accumulator 16, this flow of low pressure slurry to bag 26 will cease because the cylinder 26a of accumulator 16 will be subjected to high-pressure, clean fuel from conduit 14 and will be discharging slurry from bag 26 at high pressure through conduit 30, check valve 34 and conduit 38 to test inlet 40. Cylinder 28a of accumulator 18 at this time will be connected through conduit 22, valve 24, conduit 23, valve 54 and conduit 64 with tank A and slurry will flow through conduit 66, check valve 68 and conduit 32 into bag 28 of accumulator 18, forcing clean fuel from cylinder 28a of this accumulator into tank A.

When valve 24 moves into its alternative position, high pressure fuel will enter cylinder 28a of accumulator 18, forcing the slurry in bag 28 into fuel inlet 40. The clean fuel in cylinder 26a of accumulator 16 will be returned to tank A through conduit 20, valve 24, conduit 23, valve 54 and conduit 64 by reason of the pressure of the slurry which will now enter bag 26 under pressure from pump 44.

It will thus be clear that, in the FIG. 1 position of manual valves 54 and 46, whenever solenoid valve 24 moves into a position to supply high pressure fuel from conduit 14 to the cylinder of one accumulator, slurry is supplied by pump 44 to the bag of the other accumulator. As a result, the bag of one accumulator is always pumping slurry into fuel inlet 40 while the bag of the other accumulator is being filled with slurry from tank B by pump 44. Also, as the supply of slurry in tank B is gradually being depleted, clean fuel in an equal volume is being accumulated in tank A. When the slurry in tank B is nearly exhausted, a batch of contaminants is added to tank A in which they are thoroughly mixed with the fuel therein by agitator 42. The manual valves 54 and 46 are then moved to their FIG. 2 positions.

In the FIG. 2 positions of the valves 46 and 54, tank A is the slurry containing tank and tank B is the initially empty tank into which clean fuel is deposited as the slurry in tank A is discharged. In the FIG. 2 positions of the manual valves, pump 44 is supplied with slurry from tank A through conduit 50 and valve 46 and discharges through conduit 52, valve 54 and conduit 64 back into tank A, thus maintaining a continuous circulation of the slurry in tank A. At the same time slurry is supplied by pump 44 either through conduits 52 and 60, check valve 62 and conduit 30 to bag 26 of accumulator 16, or alternately to conduit 66, check valve 68 and conduit 32 to bag 28 of accumulator 18.

In the FIG. 2 position of manual valves 54 and 46, valve 24 functions as in FIG. 1, alternately supplying high pressure fuel to the cylinders of accumulators 16 and 18 and, when either of these is not being supplied with fuel, connecting it to conduit 23 from which the fuel is directed by valve 54 into tank B.

It will be noted that the presence of check valve 34 prevents the high pressure fuel in conduit 38 from flowing into the low pressure pump circuit including conduits 30 and 60 when bag 26a of accumulator 16 is filling with slurry. Check valve 36 fulfills a similar function in connection with accumulator 18. Also check valves 62 and 68 prevent the accumulators 16 and 18 from discharging back into the slurry pump circuit when accumulators 16 and

18 are pumping slurry at high pressure through conduits 30 and 32, respectively.

It will be evident that as a result of this invention, mechanism has been provided for continuously introducing a homogeneous mixture of contaminants and fuel into a device under test at a predetermined concentration so that the effects of the contaminating materials on the device being tested can be determined with accuracy.

It will also be evident that as a result of this invention, means has been provided which are capable of pumping contaminants of all kinds including acids, corrosive materials and fleecy materials continuously and for long periods of time without pump failure.

It will be further evident that the mechanism of this invention provides for uninterrupted flow of contaminated fuel into the test. Thus while one tank is supplying slurry to the accumulators, the clean fuel which is used to pump the slurry is being collected in an amount equal to the slurry pumped in a second tank, so a new batch of slurry can be prepared when needed and no interruption in the feed of slurry to the test occurs.

While only a single embodiment of the invention has been disclosed herein it will be understood that many changes in the construction and arrangement of the various elements of the mechanism are possible without exceeding the scope of the invention as defined in the accompanying claims.

I claim:

1. Mechanism for introducing contamination into a high pressure fuel line comprising a pressure reducing orifice in said line, two accumulators, each having an outer cylinder and an inner expansible bag, conduit means connecting each bag to said fuel line downstream of said orifice, a check valve between each bag and said fuel line preventing the flow of high pressure fuel from said line into said bags, conduit means including a two-position valve for alternately connecting the cylinders of said accumulators with said fuel line upstream of said orifice, means including a timer for operating said valve between its two positions, a first tank adapted to contain a slurry of fuel and contaminants, a slurry pump having an inlet and an outlet, conduit means connecting said pump inlet and said pump outlet to said slurry tank, conduit means connecting said pump outlet to the interiors of said bags, check valves in the conduit means between said pump outlet and each bag preventing slurry from flowing back toward said pump, a second tank, and conduit means including manually operative valve means for disconnecting said first tank and connecting said second tank to said pump inlet and said pump outlet.

2. The mechanism of claim 1 in which said two-position valve is a 4-way valve which also alternately connects said accumulator cylinders to a vent conduit, the cylinder which is not connected to said high pressure fuel line being connected to said vent conduit.

3. The mechanism of claim 2 in which both said first and second tanks have conduit means connecting them with said vent conduit, and said manual valve means also effects the connection of the tank not connected in the slurry pump circuit to said vent conduit.

4. Mechanism for introducing contamination into a high pressure fuel line comprising a pressure reducing orifice in said line, two accumulators, each having a cylinder and a bag in said cylinder, conduit means connecting each bag with said fuel line downstream of said orifice, a check valve between each bag and said fuel line preventing flow of high pressure fuel from said fuel line into said bags, conduit means including a two-position valve for alternately connecting the cylinders of said accumulators with said fuel line upstream of said orifice, means including a timer for operating said valve between its two positions, means for supplying a slurry of fuel and contaminants to either one of said bags whenever said valve is in position to supply high pressure fuel to the cylinder of the other accumulator including a tank containing

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slurry, a relatively low pressure pump for constantly circulating slurry through said tank, conduit means connecting the pump outlet with said bags, and check valves for preventing slurry discharged from said bags at high pressure from flowing back into said pump outlet.

5. Mechanism for introducing contamination into a high pressure fuel line in a continuous manner comprising a pressure reducing orifice in said line, two accumulators, each having a cylinder and a bag within said cylinder, conduit means connecting each bag with said fuel line downstream of said orifice, a check valve between each bag and said fuel line preventing flow of high pressure fuel from said fuel line into said bags, conduit means including a two-position valve for alternately connecting said cylinders with said fuel line upstream of said orifice, means including a timer for operating said valve between its two positions, and means for supplying a slurry of fuel and contaminants to the bag of each accumulator whenever high pressure fuel is not being supplied to its cylinder by said valve including a tank containing slurry, a relatively low pressure pump, conduit means connecting the inlet of said pump to said tank, conduit means connecting the outlet of said pump with each of said bags for supplying slurry to said bags whenever the cylinder associated therewith is disconnected by said valve from said high pressure fuel line, and check valves in said conduit means between said bags and said pump for preventing slurry from returning to said pump.

6. The combination claimed in claim 5 in which the two-position valve controlling the flow of high pressure fuel to said cylinders is a 4-way valve and provides a vent connection for each cylinder whenever the valve is supplying fuel under pressure to the cylinder of the other accumulator.

7. The combination claimed in claim 6 in which two tanks are provided, one of which is initially full of slurry and the other of which is initially empty, and conduit means connecting the empty tank to said vent connection, whereby clean fuel vented from the cylinder of either accumulator which is not pumping is collected in the other tank.

8. The combination claimed in claim 7 in which conduit means is provided including two manually operative valves by which either tank can be made the slurry-containing tank and the other the fuel-collecting tank and by which the pump inlet and discharge may be connected to whichever tank contains the slurry.

9. In a mechanism for introducing contamination into a high pressure fuel line, the combination of a pressure reducing orifice in said line, two accumulators, each having an outer cylinder and an inner expansible bag, means including a two-position valve for alternately connecting said cylinders with said fuel line upstream of said orifice, said valve also having means for connecting the cylinder which is not connected to said high pressure line to a vent conduit, and means for alternately introducing a slurry of contaminants and fuel into said bags whenever the cylinder of either is connected to said vent conduit comprising a tank containing slurry, a relatively low pressure pump for continuously circulating slurry through said tank, conduit means connecting the discharge from said pump with the interior of said bags, conduit means connecting the interior of said bags with said fuel line downstream of said orifice, and check valves in said conduit means between said pump and said bags for permitting flow therein only from said low pressure pump to said bags.

10. The combination claimed in claim 9 in which a second tank is provided in which clean fuel from said cylinders is collected when they are connected to said vent conduit.

11. The combination claimed in claim 10 in which conduit means is provided including two manually operative two-position valves by which said pump can be con-

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nected to circulate slurry through either tank and the other is connected to said vent conduit.

12. Mechanism for introducing contamination into a high pressure fuel line in a continuous manner comprising a pressure reducing orifice in said line, two accumulators, each having a cylinder and a flexible bag within said cylinder, conduit means connecting each of said bags to said fuel line downstream of said orifice, conduit means including a two-position solenoid operated valve for alternately connecting said cylinders with said fuel line upstream of said orifice, a timer for operating said solenoid valve, two tanks, one of which contains a slurry of fuel and contaminants and the other of which contains clean fuel, a low pressure pump having inlet and outlet conduits, a manually operative valve for connecting said inlet conduit to either one or the other of said tanks, a second manually operative valve for connecting said outlet conduit to one or the other of said tanks, whereby said pump continuously circulates the slurry in the slurry-containing tank, conduit means connecting said slurry pump outlet with the bag in each of said accumulators, and check valves between said pump circuit and each of said bags for preventing slurry from flowing back into said pump outlet.

13. Mechanism for introducing contamination into a high pressure fuel line in a continuous and uniform manner comprising a pressure reducing orifice in said line, two accumulators, each having a cylinder and a bag within said cylinder, conduit means connecting each bag with said fuel line downstream of said orifice, conduit means including a two-position valve for alternately connecting said cylinders with said fuel line upstream of said orifice, means including a timer for operating said valve between its two positions, and means for supplying a slurry of fuel and contaminants to the bag of each accumulator whenever high pressure fuel is not being supplied to its cylinder by said valve including a tank containing the slurry, a pump, conduit means connecting the inlet of said pump to said tank, conduit means connecting the outlet of said pump with each of said bags for supplying slurry to said bags whenever the cylinder associated therewith is disconnected by said valve from said high pressure fuel line, and check valves in said conduit means between said bags and said pump for preventing slurry from returning to said pump.

14. The combination claimed in claim 13 in which the two-position valve controlling the flow of high pressure fuel to said cylinders is a 4-way valve and provides a vent connection for each cylinder whenever the valve is supplying fuel under pressure to the cylinder of the other accumulator.

15. The combination claimed in claim 14 in which two tanks are provided, one of which is initially full of slurry and the other of which is initially empty, and conduit means connecting the empty tank to said vent connection, whereby clean fuel from the cylinder of the accumulator which is not pumping is collected in said other tank.

16. Mechanism for introducing contamination into a high pressure fuel line in a continuous manner comprising a pressure reducing orifice in said line, two accumulators, each having a cylinder and an expansible bag within said cylinder, conduit means connecting each of said bags to said fuel line downstream of said orifice, check valves in said conduit means for preventing high pressure fuel from flowing back into said bags, conduit means including a 4-way two-position valve for alternately connecting the cylinders of said accumulators with said fuel line upstream of said orifice, said valve also having means for connecting said valve to said high pressure fuel line to a vent conduit, means including a timer for operating said valve between its two positions, and means for supplying a slurry of fuel and contaminants to either of said bags whenever its cylinder is connected by said valve to said vent conduit

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comprising two tanks, either one of which is initially full of slurry and the other of which is initially empty, a low pressure pump having an inlet and an outlet, conduit means including a manual 4-way two-position valve for connecting said pump outlet to the slurry-containing tank and for connecting the other tank to said vent conduit, conduit means including a manual 3-way two-position valve for connecting said pump inlet to whichever is the slurry-containing tank, whereby the slurry in the slurry-containing tank is continuously circulated by said pump,

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and conduit means connecting said pump outlet to said accumulator bags having check valves therein for preventing slurry discharged from said bags under pressure in said cylinders from flowing back into the pump circuit.

No references cited.

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