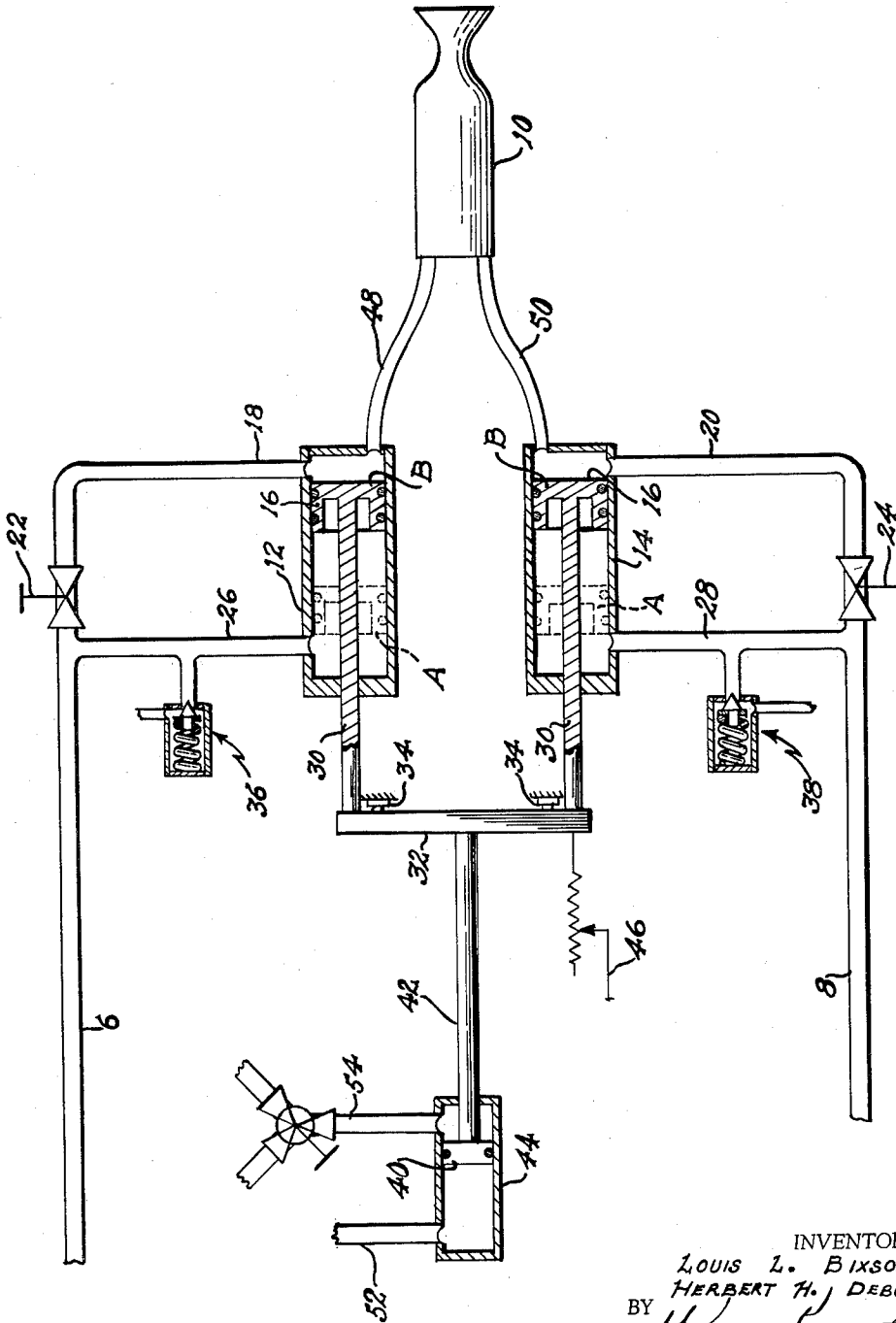


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INSTANTANEOUS AND SIMULTANEOUS PROPELLANT SHUTOFF
FOR A BIPROPELLANT FLOW SYSTEM
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INSTANTANEOUS AND SIMULTANEOUS PROPELLANT SHUTOFF FOR A BI-PROPELLANT FLOW SYSTEM

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This invention relates generally to valve systems and more particularly to one which is capable of instantaneously and simultaneously cutting off the flow of two liquids to a bipropellant engine.

The system in which this invention may be utilized comprises a jet or rocket engine having two propellants, one a fuel and the other an oxidizer. Both the fuel and oxidizer are maintained separately until forced into the combustion chamber of the engine.

Previous systems for shutting down an engine of the type heretofore described utilized valve systems which were not precise with regard to an exact time for cutoff, and also had the disadvantage of allowing a variation in the time of cutoff between the fuel and the oxidizer. This condition precludes the calculation of the chemical conversion time which is the time at which there is complete combustion of all droplets present in a combustion chamber.

Accordingly, it is an object of this invention to provide a useful device for determining the exact time of cutoff in a bipropellant fuel system.

Another object of this invention is to provide a cutoff system which is capable of instantaneously and simultaneously shutting off both propellants of a bipropellant flow system.

It is still another object of this invention to provide a cutoff system which will permit a steady state flow of propellants until the desired time of cutoff.

A further object of this invention is to provide a system which enables the determination of efficiency of fuels and engines.

A still further object of this invention is to provide a system which avoids the build-up of either fuel or LOX after a predetermined time for cutoff.

Another object of this invention is to provide a bipropellant cutoff system which has provision for water hammer relief in order to prevent spurious piston oscillations after shutoff.

Still another object of this invention is to provide a bipropellant shutoff system which is easy and economical to produce of conventional, currently available materials which lend themselves to mass production manufacturing techniques.

These and other advantages, features and objects of the invention will become more apparent from the following description taken in connection with the illustrative embodiment in the accompanying drawing, wherein the drawing is a diagrammatic representation of a preferred embodiment of the invention showing the essential elements thereof.

The system of this invention consists essentially of a pair of valves each having a cylinder or chamber containing a piston and piston rod reciprocal therein. The piston rods extend through one end of each of the cylinders and are yoked together for simultaneous operation. The other ends of the cylinders are in series with the fuel line and the LOX flow lines, respectively, to the engine. Continuous recording of the position of the pistons in the cylinders is achieved by means of a recording displacement potentiometer. The fuel and liquid oxygen are fed from the cylinders to a combustion chamber until the pistons are forced to cutoff, at which point

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the exact time of cutoff may be registered on the continuous recording displacement potentiometer.

Referring to the FIGURE, lines or conduits 6 and 8 represent sources of liquid oxygen under pressure and fuel, respectively. Each of these lines or conduits is connected to similar valve systems. Conduits 26 for precise time cutoff flow and 18 for main LOX flow are both connected with supply conduits 6 and bisect the flow therefrom. A valve 22 is provided in line 18 in order to act as a main flow valve for LOX. The corresponding components for the fuel line are precise time cutoff conduit 28, main fuel flow conduit 20 for bisecting the fuel flow and valve 24 for providing the main fuel flow control. The conduits 26, 18 and 28, 20 are connected, as shown, with cylinders 12 and 14, respectively, and conduits 48 and 50 provide the passageways from the cylinders to the combustion chamber 10 of a bipropellant engine.

Pistons 16 are located in each of the cylinders 12 and 14 and are provided with piston rods 30 which are interconnected for simultaneous operation by means of a crossbar or yoke 32. Stops 34 are provided to limit the movement of the crossbar 32, piston rods 30 and, therefore, the pistons 16. A displacement potentiometer 46 is connected to a suitable voltage supply (not shown) and with the yoke 32 in order to provide a recording of the position of the pistons and the time of cutoff. Movement of the yoke 32 is transmitted by means of a rod 42 to a piston 40 in a compensating air cylinder 44. Supply line 54 is provided proximate to one end of cylinder 44 and may be connected with a source of air pressure in order to cause movement of piston 40 and pistons 16 through elements 42, 32 and 30.

Since a precise shutoff system would have as one of its characteristics a water hammer effect, conventional hammer relief valves 36 and 38 are positioned in lines 26 and 28, respectively, in order to allow for relief of pressure surges in the system.

Assuming that steady state engine operation has been achieved with valves 22 and 24 in their open position, the shutoff sequence for taking a measurement of the chemical conversion time of the droplets present in the engine chamber at a given instant of time may be initiated. Position A, indicated by the phantom lines of the pistons 16 in their cylinders, is the position to which the pistons have been withdrawn by means of the proper application of a fluid differential force in cylinder 44 by means of applying air pressure to line 54. At this time, the cylinders 12 and 14 are charged with LOX and fuel, respectively. Main flow valves 22 and 24 for the propellants are actuated to their closing position and at the same instant air cylinder 44 is discharged by disconnecting line 54 from a source of air supply, line 52 being opened at all times. The switch over of line 54 from its supply to its discharge may be achieved by linking operation of its flow valve to the main flow valves, all of which may be of the solenoid operated type. Propellant flow then is diverted from the main flow lines 18 and 20 to the precise time cutoff flow lines 26 and 28 and the fuel pressures from the precise time cutoff lines causes movement of pistons 16 to the solid line position designated B. This movement is achieved at a steady state flow rate. Thus far the engine has received an uninterrupted flow of propellants; however, when the crossbar 32 abuts the stops 34, the pistons are instantaneously and simultaneously stopped and the displacement potentiometer 46 records the precise indication of time in order that measurements of the chemical conversion of the fuel in the chamber may be measured.

It is evident, therefore, that a simple arrangement which provides both instantaneous and simultaneous cut-

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off for the flow of bipropellant fluid to a combustion chamber and also an arrangement for the recording of the cutoff time have been devised with a minimum of complexity in the device.

Although the invention has been described with reference to a particular embodiment, it will be understood to those skilled in the art that the invention is capable of a variety of alternative embodiments within the spirit and scope of the appended claims.

What is claimed is:

1. A valve system for providing instantaneous and simultaneous propellant shutoff in a bipropellant flow system comprising a pair of cylinders, a piston arranged for reciprocating movement in each of said cylinders, a piston rod connected with each of said pistons and extending through its cylinder, means connected with said piston rods for yoking said pistons for simultaneous movement a separate source of fluid for each of said cylinders, each source having a conduit connected with one end of a cylinder, bypass lines connected between each of said source conduits and the other end of its cylinder, valve means within each of said source conduits downstream from the connection with said bypass lines for controlling fluid flow, pneumatic means connected with said means for yoking to control movement of said pistons in one direction, and conduit means connecting said one end of said cylinders with a combustion chamber.

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2. A valve system as defined in claim 1 including valve means in said bypass lines for eliminating water hammer effect.

3. A valve system for providing instantaneous and simultaneous propellant shutoff in a bipropellant flow system comprising a pair of cylinders each having a piston reciprocable therein, a piston rod connected with each of said pistons and extending through one end of its cylinder, means connected with said piston rods for yoking said pistons for simultaneous movement, a supply line connected with a source of fluid for each of said cylinders, each of said supply lines having a connection with one end of a cylinder, bypass lines connected with each of said supply lines and said other end of said cylinders, valve means in each of said supply lines downstream from said bypass lines for controlling fluid flow, pneumatic means connected with said means for yoking to control movement of said pistons in one direction and means connecting said one end of said cylinders with a combustion chamber.

4. A valve system as defined in claim 3 including spring biased valve means in each of said bypass lines for relieving pressure surges.

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