United States Patent

Bondi

[15] **3,692,041**

[45] **Sept. 19, 1972**

[54] **VARIABLE FLOW DISTRIBUTOR**

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[73] Assignee: **General Electric Company**

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[21] Appl. No.: **103,600**

[52] **U.S. Cl.** **137/238,** 137/246.12, 137/625.47

[51] **Int. Cl.**.....**F16k 5/22**

[58] **Field of Search.**137/237, 238, 240, 246, 246.11, 137/246.12, 246.22

[56] **References Cited**

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[57] **ABSTRACT**

A variable flow distributor for disbursing contaminated fluids through a plurality of metering orifices, wherein the metering area of each orifice is uniformly regulated by offsetting the coaxial alignment of a pair of holes through adjacent movable partitions, such that seizure of the moving partitions from contaminants entering the area therebetween is prevented by the introduction of highly filtered fluid from conduit means which surround each orifice.

4 Claims, 3 Drawing Figures

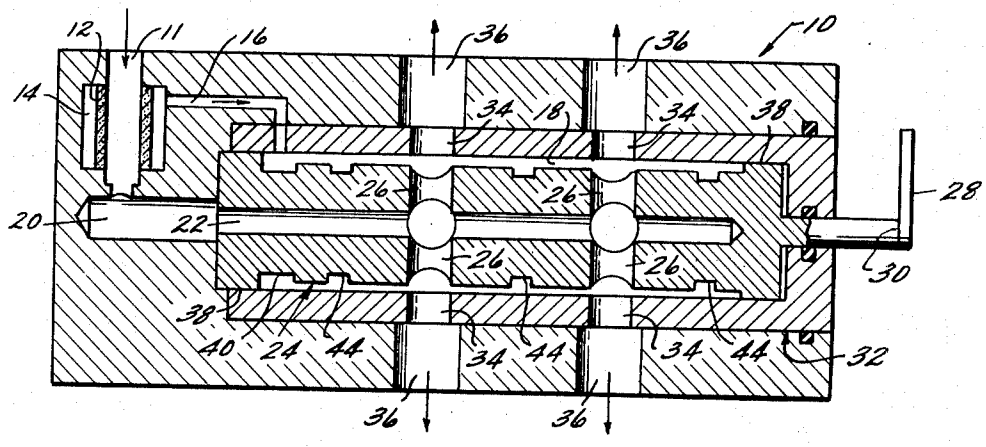


Fig 1

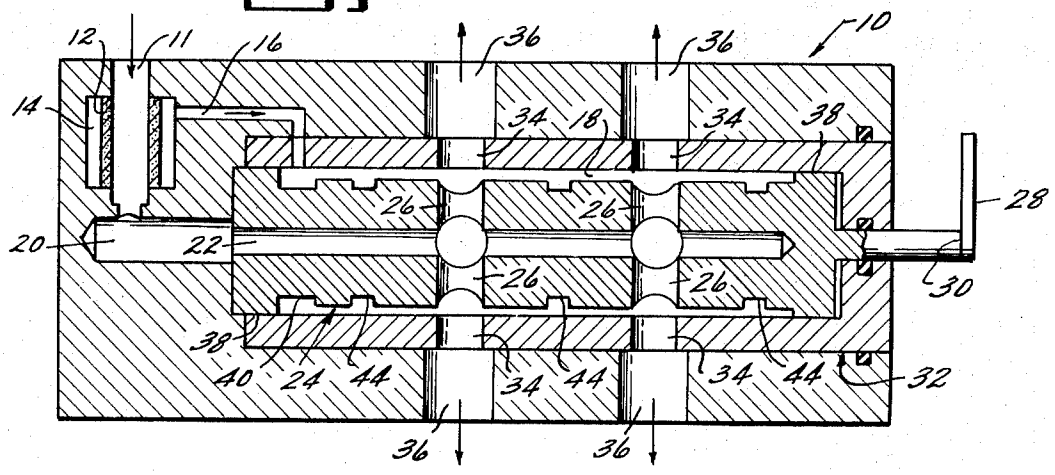


Fig 2

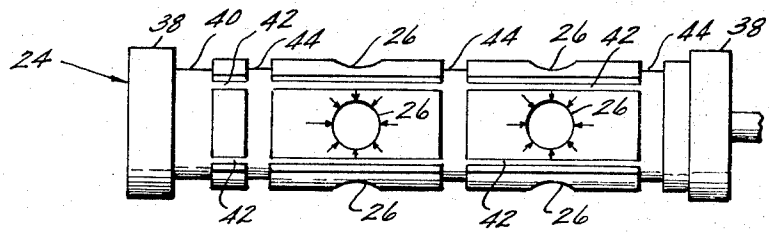
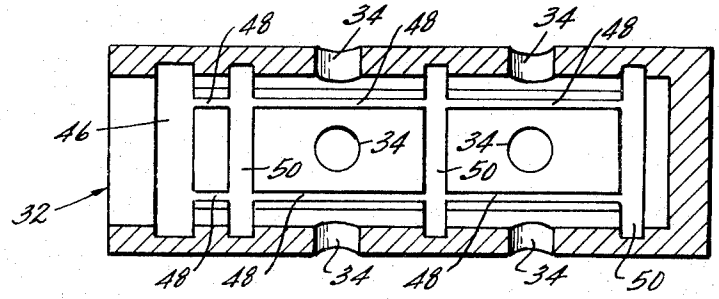


Fig 3



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VARIABLE FLOWDISTRIBUTOR

The invention herein described was made in the course of or under a contract or subcontract thereunder with the Department of the Navy.

BACKGROUND OF THE INVENTION

Generally this invention relates to a variable flow distributor and more particularly to a variable flow distributor wherein a contaminated fluid is metered through a plurality of metering orifices without substantial risk of contaminating particles causing the moving members to stick or seize.

The present invention has particular application in the fuel control systems of jet engines wherein it is important to feed equal amounts of fuel to a multiple of burners in the engine, and wherein the fuel must be carefully regulated so that flow to each burner starts simultaneously and is kept at various uniform flow ratios.

The equal distribution of fuel to jet engine burners may be accomplished by flowing fuel through a chamber such that the output flow is diverted through a series of metering orifices all of which may be adjusted simultaneously, allowing the same uniform rate of flow through each orifice. A simple yet highly effective metering orifice may be formed by two opposing walls, wherein each wall contains a hole of predetermined size and one partition is adapted to slide over the surface of the opposing partition such that the two holes cooperate to form a metering orifice. The metering orifice may be fully opened by sliding one of the walls into the position required for coaxial alignment of the holes, or alternatively the metering orifice may be closed by fully offsetting the holes from each other with all ranges of orifice opening existing therebetween.

In a practical fuel distribution system for jet engines, however, the fuel is normally contaminated by undesirable particles. These contaminants tend to lodge between the moving walls of the fuel control system causing sticking and seizure of such members. Seizure and wear could be prevented by filtering all of the fuel undergoing distribution; however, this would prevent high flow rates since a filter small enough to remove the smallest contaminants would impose high pressure drops upon the system.

An alternate solution would be to remove a negligible amount of finely filtered wash fuel from the main flow path at a point upstream of the flow distributor, and introduce it between the slidable walls which define the metering orifices. The present state of the art relative to such systems however has not provided for a uniform flow of wash fuel across the circumferential edge of each orifice. Unless such a uniform flow is provided, contaminants will still have a tendency to lodge between the moving surfaces which define the metering orifice, and if spaced apart metering orifices are incorporated within the same moving members, a further tendency will exist for contaminated fuel to flow between metering orifices.

Therefore, it is an object of this invention to provide a variable flow distributor having the capability of channeling contaminated fuel through a plurality of metered orifices without sticking or seizure of the moving members.

It is also an object of this invention to provide a variable fuel flow distributor having a plurality of metering orifices wherein possible contamination paths between the orifices are eliminated.

SUMMARY

A variable flow distributor is provided in accordance with this invention for uniformly disbursing fluids such as jet engine fuel that may have contaminating matter therein.

The variable flow distributor of this invention includes a plurality of metering orifices formed by a first wall member having a plurality of holes therethrough, through which the flow of contaminated fuel is directed. A second wall member overlies the first wall member and includes a plurality of holes for alignment with the holes of the first wall member such that the holes of the first wall member cooperate with the holes of the second wall member to form a plurality of metering orifices. Actuating means are provided for offsetting the coaxial alignment of the holes of the first and second wall members, thereby further restricting the flow of contaminated fuel through each metering orifice.

Highly filtered wash fuel is provided for keeping the area between the wall members free of contaminants, thereby preventing binding or seizing. A bypass located upstream of the flow distributor filters a portion of the contaminated fuel and conducts it to the opposing surfaces of the wall members. Grooves contained in either opposing wall surface or in both surfaces direct a uniform flow of filtered fuel around each metering orifice, such that there is a substantially uniform flow of filtered fuel from the grooves towards the central axis of each metering orifice and across the entire circumferential edge of each hole which cooperates to form a metering orifice, thereby eliminating any possibility of contaminants lodging between the moving members.

The first wall member could comprise a hollow spool with a plurality of radially and longitudinally spaced apart holes therethrough, with the flow of unfiltered fuel directed into the hollow center and out through the holes in the side thereof. The second wall member would be a hollow sleeve closely fitted around the outer diameter of the spool and having a plurality of radially and longitudinally spaced apart holes therethrough for alignment with the holes of the spool. The variable flow distributor may be actuated by either rotating the spool about its longitudinal axis or sliding the spool along its longitudinal axis, thereby offsetting the coaxial alignment of the holes forming the metering orifices and restricting flow therethrough.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 shows a cross-sectional view of the preferred variable flow distributor of this invention.

FIG. 2 shows a side view of the spool of FIG. 1 with its reticulated surface contour.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a cross-sectional view of a typical embodiment of a flow distributor as may be incorporated in the fuel system of a gas turbine aircraft engine. Aircraft gas turbines are designed to burn various hydrocarbons ranging in grade from kerosene to high

octane gasolines, and these fuels may be contaminated by gritilike impurities, such as rust and dirt. Contaminated fuel enters the hollow cylindrical housing **10** of the variable flow distributor through the inlet port **11**. A fine filter **12** is mounted in the inlet port and there is a chamber **14** surrounding the filter. A portion of the fuel from the inlet port passes through the filter and chamber **14** through passageway **16** into cylindrical chamber **18**.

Meanwhile the remainder of the unfiltered fuel flows through passageway **20** and into the hollow central portion **22** of the rotatably operated spool **24**. The flow of contaminated fuel is then equally distributed through the radially and axially spaced apart holes **26** located in the side of spool **24**.

Spool **24** may be mechanically rotated about its axis through rod **28** which is pinned at **30** to the spool **24** to actuate the same. The actuating means for the rod **28** are not shown, but in a typical gas turbine engine may include a manually operated linkage interconnected with various types of low force automatic actuators for temperature, pressure and speed connections.

Hollow cylindrical sleeve **32** includes radially and axially spaced apart output holes **34** through the side thereof. The output holes **26** through the spool **24** cooperate with the opposing output holes through sleeve **32** to form metering orifices. The flow of contaminated fuel through the metering orifices is controlled by actuating means which arcuately rotate rod **28**. When the metering orifices are fully opened, the output holes **26** of the spool are radially and axially aligned with the output holes **34** of the sleeve. Arcuately rotating rod **28**, causes spool **24** to rotate about its central axis offsetting the radial alignment of the output holes **26** of the spool with the output holes **34** of the sleeve, thereby simultaneously restricting the flow of contaminated fuel through each metering orifice. The distributed output fuel is discharged through output ports **36** in housing **10**.

The rubbing surfaces of the spool **24** and the sleeve **32** are provided with a finely filtered flow of washing fuel through passage **16**. FIG. **2** illustrates the contour of the outside surface of spool **24**, and further shows one configuration for the arrangement of an **8** hole spool for uniformly distributing fuel to **8** burners. The spool alternatively could contain any number of holes depending on the number of burners serviced by the flow distributor.

The areas at the circumferential edges **38** at both ends of spool **24** are highly machined for a close tolerance fit with the inner diameter of sleeve **32**, thereby acting as a seal between the highly filtered wash fuel and contaminated fuel. A small portion of wash fuel, however, does flow in the finite space between the circumferential edges **38** and the inner surface of sleeve **32**, cleaning the rubbing surfaces and preventing seizure of the moving parts.

Highly filtered wash fluid exits from passage **16** into annular groove **40** on spool **24**. Annular groove **40** uniformly distributes the filtered wash fuel to the longitudinal grooves **42** which are further intersected by additional annular grooves **44**. The longitudinal and annular grooves surround each hole **26** on the surface of spool **24** so as to define a reticulated surface contour thereby insuring a uniform flow of filtered wash fuel around each hole. Holes **26** on the spool, cooperating with holes **34** on the sleeve to form the metering orifices, effect reductions in the pressure of fuel flowing therethrough. The reduced pressure at the metering orifices causes filtered wash fuel to uniformly flow from the surrounding annular and longitudinal grooves toward the metering orifices and back into the unfiltered flow of fuel. The filtered wash fuel flows between the close fitting surfaces of the spool and sleeve maintaining the flow pattern as illustrated by the arrows of FIG. **2**, thereby keeping the surfaces washed or bathed free of any grit-like impurities that may be present in the main flow path through the metering orifices. The filtered wash fuel prevents wear and possible seizure of the spool **24** and sleeve **32**.

The annular and longitudinal grooves around each metering orifice effect a substantial improvement over prior art systems by insuring a uniform flow of filtered wash fuel over the circumferential edges of all the holes that define the metering orifices. If the flow of filtered wash fuel over the entire circumferential edge of each hole was not uniform, grit or impurities from the contaminated fuel could lodge between the closely fitted surfaces at those areas along the circumferential edges where filtered wash flow is reduced or lacking, thereby causing sticking or seizure. The annular and longitudinal grooves around each orifice also isolate the orifices from each other eliminating any possible contamination paths between the orifices. The grooves further insure that the filtered wash fuel is uniformly distributed to each metering orifice, no matter how far the metering orifice may be from the inlet passage **16**.

FIG. **3** shows a cross-sectional view of sleeve **32** embodying an alternate scheme for incorporating the grooves into the inside surface of sleeve **32**. Highly filtered wash fluid would exit form passage **16** into annular groove **46** on the inside surface of the sleeve. Annular groove **46** uniformly distributes the filtered wash fuel to the longitudinal grooves **48** which are further intersected by additional annular grooves **50**. The longitudinal and annular grooves surround each hole **34** on the inside surface of sleeve **32** so as to define a reticulated surface contour thereby insuring a uniform flow of filtered wash fuel around each hole. Sleeve **32** as shown in FIG. **3** could be used in combination with the spool of FIG. **2** wherein the longitudinal and annular grooves of the spool and sleeve would be aligned in substantially opposing relation.

Alternatively, it should be understood that the cylindrical spool **24** could be actuated by axially sliding the spool along its central axis, which also would simultaneously offset the opposing holes and uniformly restrict flow through each metering orifice.

The preferred embodiment of the invention has been described fully as applied to an aircraft gas turbine fuel system because the invention was conceived in an effort to overcome failures in such systems that were experienced as a result of impurities in the fuel. It should be obvious that the invention may be applied to any type of fluid transfer system wherein minute particulate matter is present in the fluid being transferred, and wherein it is desirable to protect the variable flow distributor from the particulate matter.

What is claimed is:

1. A variable flow distributor for uniformly dispersing fluids that may have contaminated matter therein comprising a housing;

inlet means for conducting the field into the housing;

a hollow sleeve disposed within the housing and having a plurality of radially and longitudinally spaced apart holes therethrough;

a hollow spool movably disposed within the hollow sleeve and having a plurality of radially and longitudinally spaced apart holes therethrough for cooperation with the holes of the sleeve to form variable metering orifices such that fluid may be directed into the hollow center of the spool and out through the metering orifices;

bypass means upstream of the housing for filtering a portion of the fluid and channeling the filtered fluid to between the opposing surfaces of the sleeve and spool;

conduit means as defined by the contour of the opposing surfaces of the sleeve and spool for receiving the filtered fluid and directing a uniform and continuous flow of filtered fluid entirely around each orifice independent of the metered orifice opening such that there is a substantially uniform and continuous flow of filtered fluid from the conduit means towards the central axis of each metering orifice and across the entire circumferential edge of each hole which cooperates to form a metering orifice for all variable metered orifices between full open and closed; and

outlet means for conducting the fluid from each metering orifice.

2. The variable flow distributor of claim 1 wherein the conduit means includes a series of intersecting grooves in the opposing surface of the sleeve, with the grooves so arranged as to completely surround each hole of the sleeve thereby forming a reticulated surface contour.

3. The variable flow distributor of claim 1 wherein the conduit means includes a series of intersecting grooves in the opposing surface of the spool, with the grooves so arranged as to completely surround each hole of the spool thereby forming a reticulated surface contour.

4. The variable flow distributor of claim 1 including actuator means having a rod for rotating the spool about its axis.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,692,041 Dated September 19, 1972

Inventor(s) Pasquale Columbo Bondi

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 4, "field" should read -- fluid -- .
Column 6, line 22, "actuator" should read -- actuating -- .

Signed and sealed this 1st day of May 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

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* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.