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NASA Case No. LEW-14,846-2

PRINT FIG. 1

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Serial No.: 709,907

Filed Date: 5/31/91

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(NASA-CRS #LEW-14846-2) METHOD OF INJECTING
 FLUID PROPELLANTS INTO A ROCKET COMBUSTION
 CHAMBER Patent Application (NASA) 911
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AWARDS ABSTRACT

**METHOD OF INJECTING FLUID PROPELLANTS
INTO A ROCKET COMBUSTION CHAMBER**

A rocket injector is provided with multiple sets of manifolds for supplying propellants to injector elements. Sensors transmit the temperatures of the propellants to a suitable controller which is operably connected to valves between these manifolds and propellant storage tanks.

Additional valves are opened to furnish propellants to more of the manifolds when cryogenic propellant temperatures are sensed. Only a portion of the valves are opened to furnish propellants to some of the manifolds when lower temperatures are sensed.

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Employer: NASA Lewis Res. Ctr.
Serial No.: 709,907
Filing Date: 5/31/91

**METHOD OF INJECTING FLUID PROPELLANTS
INTO A ROCKET COMBUSTION CHAMBER**

Origin of the Invention

5 The invention described herein was made by an employee of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

Related Application

10 This application is a division of application serial No. 443,523 which was filed on November 30, 1989.

Technical Field

15 This invention is concerned with an improved method of injecting fluid propellants into a rocket combustion chamber. The invention is particularly directed to improving the propellant temperature/pressure range of liquid rocket operations.

 Prior art procedures fail to provide for the operation of liquid rockets over an extended range of propellant inlet temperatures. Moreover, the use of conventional injectors produces unacceptable fuel and oxidizer injector pressure drop when operation over an extended range of propellant inlet temperatures is attempted. Injector pressure drop outside of the acceptable range can result in combustion chamber instability.

20 It is, therefore, an object of the present invention to improve liquid rocket operations using propellants with a wide range of propellant inlet temperatures from cryogenic to ambient.

25 A further object of the invention is to improve the operation of a liquid rocket in which a wide range of propellant inlet densities is encountered.

Background Art

30 U.S. patent No. 3,662,960 to Mitchell et al describes a rocket injector head with multiple inlets to control pressure drop. U.S. patent No. 4,081,136 to Addoms et al is concerned with multiple chamber inlets with undivided valve control for the purposes of controlling inlet pressure.

 U.S. patent No. 2,536,597 to Goddard describes a recoil operated

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feeding apparatus for a combustion chamber in which successive charges of the combustion mixture are ignited. U.S. patent No. 2,714,286 to Zucrow describes a liquid propellant injector system utilizing a plurality of
5 propellant injectors, each introducing only a small proportion of the total amount of propellant fed into the combustion chamber. U.S. patent No. 3,740,946 to Welton et al is directed to a momentum exchange throttling injector for varying propellant flow rates and consequently liquid rocket engine thrust levels over wide ranges.

10 Disclosure of the Invention

The objects of the invention are achieved by injecting fluid propellants through multiple sets of manifolds in the injector. Each set of manifolds uses a set of valves to control fluid flow through the connected injector elements to the rocket chamber. The valves are operated in
15 response to changes in propellant temperatures and pressure.

Description of the Drawing

The objects, advantages, and novel features of the invention will be more fully apparent from the following detailed description when read in connection with the accompanying drawing wherein;

20 FIG. 1 is a schematic view of a rocket injector embodying the features of the invention, and

FIG. 2 is a section view taken along the line 2-2 in FIG. 1.

Best Mode for Carrying Out the Invention

Referring now to the drawing, there is shown a rocket motor 10 in the
25 form of an annular hollow elongated enclosure. This rocket motor includes an upstream cylindrical combustion chamber 12, an adjacent downstream convergent-divergent throat section 14, and an exhaust nozzle 16. Liquid propellants are stored in tanks 18 and 20. By way of illustration, the tank 18 contains an oxidizer, such as liquid oxygen, while a fuel, such as
30 liquid hydrogen, is stored in the tank 20.

These propellants are supplied to the rocket 10 from the tanks 18 and 20 through a propellant feed system. Liquid oxidizer is supplied to the rocket 10 through a line 22 while a similar line 24 supplies liquid fuel to the rocket combustion chamber 12 through an injector 26.

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According to the present invention, the injector 26 utilizes a plural
ity of manifolds 28, 30, 32 and 34 with connected injector elements 36 and
5 38. The set of manifolds 30 and 32 uses a set of valves 40 and 42 to
control fluid flow through the connected injector elements 36 to the rocket
chamber. The set of manifolds 28 and 34 uses the set of valves 44 and 46
to control fluid flow through the connected injector elements 38. The set
of manifolds 30 and 32 with connected injector elements 36 is operated
10 parallel to the set of manifolds 28 and 34 with connected injector elements
38. Combined together they form the injector 26.

The control box 48 maintains the rocket thrust level in a predeter-
mined design range by controlling the mass flow of propellants through the
injector 26. This control box 48 is operably connected to the valves 40,
15 42, 44 and 46 which are opened and closed as needed to maintain the overall
injector pressure drop within an acceptable range dictated by rocket
combustion chamber stability criteria while admitting propellants with a
wide inlet temperature/pressure range to the injector elements. The
pressure of the liquid oxidizer is supplied to the control box 48 by a
20 pressure sensor 50 while a similar pressure sensor 52 supplies the pressure
of the fuel to this control box. The temperature of the liquid oxidizer is
supplied to the control box 48 by a temperature sensor 54 while a similar
temperature sensor 56 supplies the temperature of the fuel to the control
box.

25 In operation, if temperature sensors 54 and 56 sense cryogenic propel-
lant temperatures and communicate this information to the control box 48,
the control box sends signals via line 58 to valve 40 and via line 60 to
valve 42 to open these valves and admit these cryogenic propellants to the
manifolds 30 and 32 which are connected to injector elements 36. These
30 injector elements are designed such that their pressure drop is within an
acceptable range dictated by rocket combustion chamber stability criteria
when cryogenic propellants are admitted to the injector. If the tempera-
ture sensors 54 and 56 sense ambient propellant temperatures and communi-
cate this information to the control box 48, the control box sends signals
35 via line 58 to valve 40 and via line 60 to valve 42 to open these valves

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and admit these ambient propellants to the manifolds 30 and 32 which are connected to injector elements 36.

In addition, the control box 48 sends signals via line 62 to the valve
5 44 and via line 64 to the valve 46 to admit these ambient propellants to
the manifolds 28 and 34 connected to the injector elements 38. The ambient
propellants flow in parallel through the injector elements 36 and 38.
These injector elements are designed such that their pressure drop is
within an acceptable range dictated by rocket combustion chamber stability
10 criteria when ambient temperature propellants are admitted to the injector.
More than two parallel sets of manifolds, injector elements and valves may
be required to operate over the entire propellant temperature range of
cryogenic to ambient.

While the preferred embodiment of the rocket motor has been disclosed
15 it will be appreciated that various structural modifications may be made to
the injector without departing from the spirit of the invention or the
scope of the subjoined claims.

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ABSTRACT OF THE DISCLOSURE

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METHOD OF INJECTING FLUID PROPELLANTS
INTO A ROCKET COMBUSTION CHAMBER

10 A rocket injector is provided with multiple sets of manifolds for supplying
propellants to injector elements. Sensors transmit the temperatures of the
propellants to a suitable controller which is operably connected to valves
between these manifolds and propellant storage tanks.

15 Additional valves are opened to furnish propellants to more of the
manifolds when cryogenic propellant temperatures are sensed. Only a
portion of the valves are opened to furnish propellants to some of the
manifolds when lower temperatures are sensed.

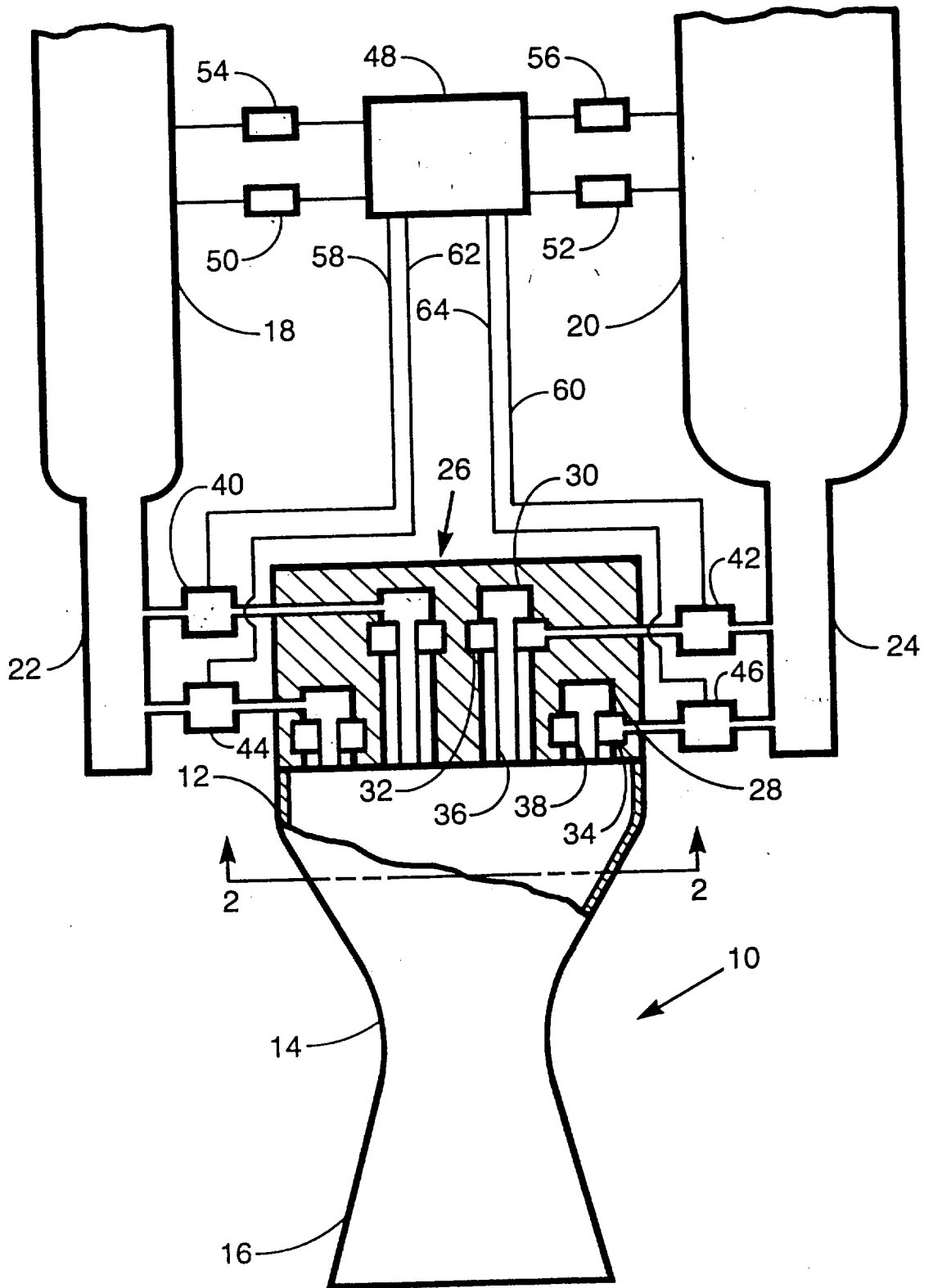


Fig. 1

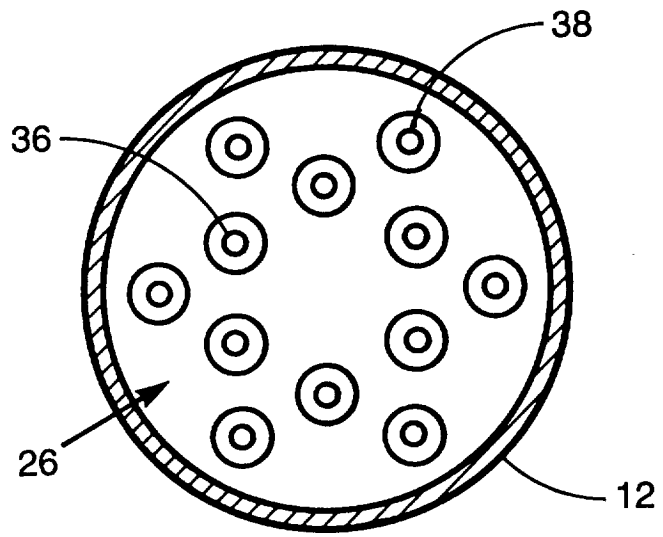


Fig. 2