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J. P. LONGWELL

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FUEL PRESSURING SYSTEM FOR SUPERSONIC RAM-JET

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FIG. 1.

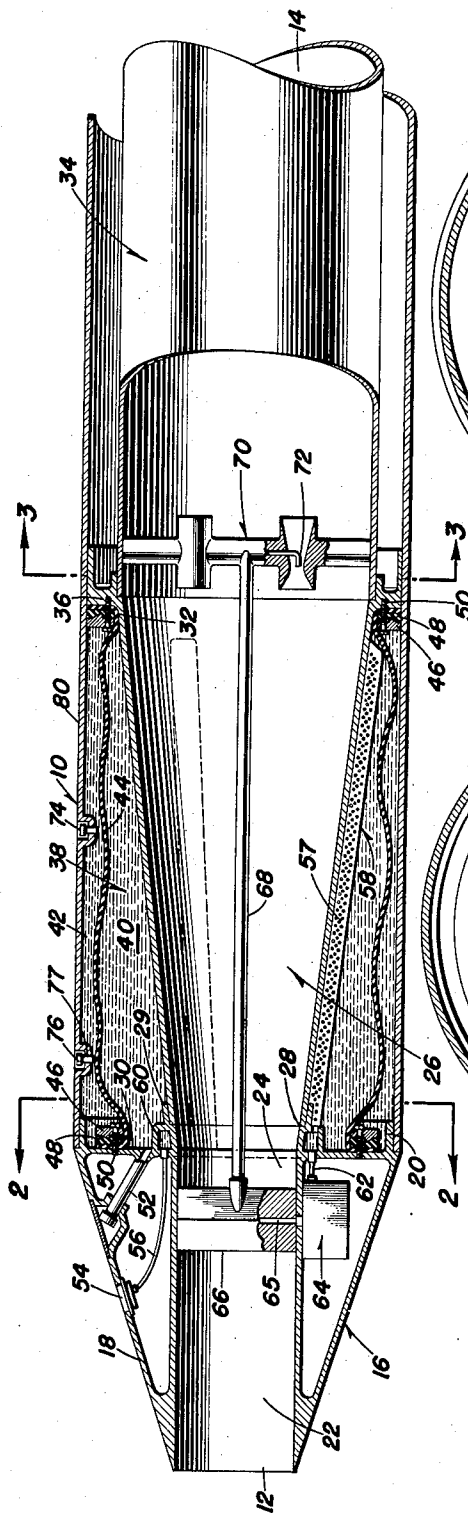
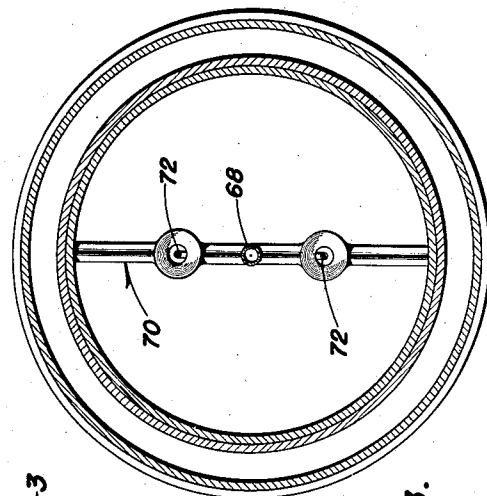


FIG. 3.

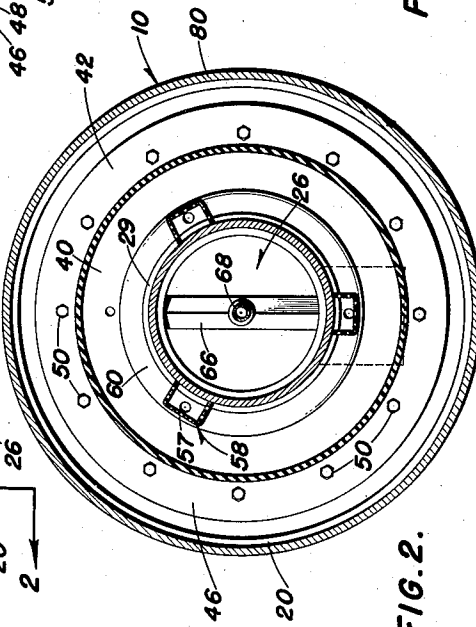


FIG. 2.

INVENTOR.
JOHN P. LONGWELL
BY *G. W. O'Brien*

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FUEL PRESSURING SYSTEM FOR SUPERSONIC RAM-JET

John P. Longwell, Scotch Plains, N. J., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Navy

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9 Claims. (Cl. 60—39.48)

This invention relates generally to aerial missiles, and, in particular, to an improved pressurized fuel system for ram-jet engines and to a method for feeding fuel into the combustion chambers thereof.

In the past, considerable difficulty has been encountered with conventional fuel systems in supplying the desired quantity of fuel at the proper pressure to the combustion chamber of a ram-jet engine. In addition, the conventional fuel systems that are now used with this type of engine are bulky and are quite expensive to install.

It has now been found that it is highly desirable as well as necessary to operate a ram-jet engine with a compact fuel pressure system as well as with a light source of fuel pressure.

It is the principal object of this invention, therefore, to provide a pressurized fuel system that is compact and one which gives a source of fuel at low pressure.

Another main object of the invention is to provide a pressurized fuel system that is suitable for use with either sub-sonic, sonic, or super-sonic ram-jet engines.

It is another object of the invention to provide a pressurized fuel system in which the vapor pressure of a volatile liquid is used as a source of pressure for forcing fuel into ram-jet combustors.

As a further object, the invention provides an improved fuel feeding means which make use of air temperature present during the flight of the aerial missile through the atmosphere, with the result that smooth, uniform fuel feeding will be assured.

And another object of the invention is to provide a pressurized fuel system for a ram-jet engine which is simple in design, economical to manufacture and install, reliable and efficient in operation.

Briefly, the present invention relates to the use of the vapor pressure of a volatile liquid as a source of pressure for forcing fuel into the combustion chamber of a ram-jet engine. For super-sonic ram-jets, volatile liquids, such as propane, have proved to be quite suitable for this purpose. The fuel, in a typical ram-jet engine, is contained in an annular cavity in the body of the unit. Propane is placed in a second annular cavity adjacent the fuel cavity and is separated therefrom by means of a collapsible wall. The annular cavity for the propane is so located that it has a portion of its surface in contact with the air from which the heat necessary for evaporation of the propane is transferred. As the liquid propane vaporizes, the developed propane gases exert pressure on the collapsible wall and force the liquid fuel from the annular cavity through suitable piping into the combustion chamber of the ram-jet. The collapsible wall is also utilized to prevent mixing of the fuel and the propane, and also to prevent propane vapors from entering the fuel outlet as the ram-jet goes through various maneuvers.

These and other objects of the invention will be apparent from the following description and claims, taken in connection with the accompanying drawings, forming a part of this application, and in which:

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Fig. 1 is a fragmentary view partially in elevation of a ram-jet engine;

Fig. 2 is a cross-section on line 2—2 of Fig. 1, and;

Fig. 3 is a cross-section on line 3—3 of Fig. 1.

Referring now to the drawings for a more detailed description of the invention, there is shown in Fig. 1 the tubular body of a ram-jet engine or motor, which is indicated generally by reference numeral 10. This ram-jet engine is generally a part of an aerial missile or the like, but is not necessarily limited to this particular use. This body 10 is formed of heavy gauge sheet metal and is open at both ends, indicated generally by numerals 12 and 14.

The forward end of the body 10 is partially enclosed by a nose assembly section, indicated generally by 16, which includes a nose or ogive 18 of metal or plastic, and an annular metal flange 20 for attaching the outer portion of ogive assembly 16 to the tubular body 10.

The ogive or nose assembly section 16 is formed with a central passage 22, and has its rear end 24 communicating with a frusto-conical diffuser section 26. This diffuser section 26 has its forward end 28 in engagement with an extension 29 from an annular flange or wall 30, which defines the rear wall of nose or ogive assembly 16, and which is also used as the forward wall of diffuser section 26. The rear end 32 of diffuser section 26 is attached to the tailpipe section 34 and tubular body 10 by means of another annular flange 36. This annular flange defines the rear wall of the diffuser section 26.

Annular walls or flanges 30 and 36, together with the tubular body 10 and the wall of diffuser section 26 thus define an annular chamber or cavity, indicated generally by reference numeral 38.

This annular cavity or chamber 38 is divided into two sections 40 and 42 by means of an annular collapsible wall 44, for example, made up of rubber or neoprene or the like, having its ends fastened, in an appropriate manner, to walls 30 and 36. For example, the ends of the rubber wall 44 can be attached to flanges or walls 30 and 36 by means of an aluminum ring 46 and a rubber sealing ring 48 which are maintained in position by means of bolts 50 passing through these rings and walls 30 and 36. Collapsible wall 44 is arranged in chamber 38 such that its overall length is greater than the length of chamber 38 in order to prevent tearing.

It is to be observed that the volume of chamber cavity section 40 is much larger than the volume of chamber section 42, approximately the ratio of four (4) to one (1), i. e., four cubic feet of liquid fuel to one cubic foot of liquid propane.

Liquid fuel for operating the ram-jet engine is stored in chamber section 40, while in chamber section 42 there is placed a volatile liquid for pressurizing the liquid fuel contained in chamber section 42. This arrangement is to be described more fully presently.

Liquid fuel is placed in chamber section 40 through an entrance passage 52, which is generally located in the ogive assembly section 16. A pressure gage 54 in communication with fuel chamber section 40 through passage 56 is utilized to determine the pressure therein.

The liquid fuel, under pressure, is forced through a series of perforations 57 in metal channel members 58 to a small annular manifold 60, and thence through passageway 62 to a meter arrangement, indicated generally by reference numeral 64. From metering arrangement 64, the metered fuel flows through a passageway 65 in strut arrangement 66, and passageway 68 to fuel nozzle arrangement 70 where the fuel is injected into the air stream through a series of nozzles 72. After mixture of the air and fuel, the fuel is ignited further downstream in the combustion chamber by means of a

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remote controlled igniter arrangement or the like (all of which are not shown in the drawings).

The liquid propane is introduced into chamber section 42 through an inlet 74, which generally has a relief valve located therein for reducing the liquid pressure in section 42 to the desired amount. A safety or pop-off valve 76 is also located in the tubular wall 10 to relieve the gas pressure in chamber section 42 in the event that it becomes too high when the liquid fuel is introduced into chamber section 40.

As previously pointed out, the vapor pressure of propane is used as a source of fuel injection pressure, although other types of volatile liquids could be readily utilized in place of propane.

The manner of placing the liquid propane in chamber section 42, and the method of using the vapor pressure of the propane to supply fuel to the system will now be described.

Chamber section 40 is then filled with liquid fuel, such as heptane. After fuel chamber section 40 is filled, the safety valve 76 can be removed from tubular body 10 leaving an open vent 77. Let it be assumed that approximately four cubic feet of heptane is placed in fuel chamber 40, leaving approximately one cubic foot of free space or volume in chamber section 42 for the liquid propane.

A supply tank (not shown), containing liquid propane, is then connected to inlet 74 of chamber section 42 by means of copper tubing or the like (also not shown). The propane in the supply tank is first cooled by permitting it to flow out of the supply tank and through chamber section 42 as a gas, the propane supply tank being placed in an upright condition. The collection of frost on the tank indicates when this has gone far enough. The supply tank is then laid down or inverted to the point where liquid propane is flowing into chamber section 42 at a moderate rate. This rapidly cools the unit in the vicinity of chamber section 42, and the flow of liquid is continued for a period of five to ten minutes. The propane flow is then increased until propane in vaporized form is flowing from vent 77. The propane flow is then shut off, the copper tubing is then removed from inlet opening 74 as quickly as possible, and inlet opening 74 and vent exit 77 are then capped. The cooling procedures are necessary in order to reduce the pressure once the chamber section 42 is sealed and also to assure that a sufficient supply of propane will be sealed in chamber section 42.

The operation of the fuel system will now be described. The aerial missile, which includes the arrangement described so far, and to which there is attached a launching carriage arrangement, is launched by means of the carriage arrangement from a platform or the like (not shown). At a certain point along the trajectory of the aerial missile, the launching carriage will separate from the aerial missile and the ram-jet engine will then furnish the source of power for the aerial missile.

As the aerial missile moves through the atmosphere, heat will be introduced through the walls of tubular body 10 of the missile which is subjected at its outer surface 80 to air stagnated at the velocity of flight. The heat that is transferred through the walls causes the liquid propane in chamber section 42 to evaporate and thus the vapor pressure generated is used to exert pressure against the collapsible wall 44, and the latter, in turn, exerts pressure on the liquid fuel contained in chamber section 40. The liquid fuel is forced through the perforations 57 in channel members 58 to the annular manifold 60. From the manifold 60, the fuel is fed through passageway 62 to meter 64, thence through passageways 65 and 68 to the fuel nozzle arrangement 70 where the fuel is injected through nozzles 72 into the air stream which passes through central passage 22 and diffuser section 26. The mixture is then ignited by a remote controlled igniter or the like located further

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downstream in the combustion chamber of the tailpipe section 34 of the aerial missile. After ignition of the fuel mixture, the products of combustion will be ejected through a nozzle located at the exit of tailpipe section 34 at a sufficiently higher velocity than at entrance of the air into chamber passage or throat 22 to provide the necessary thrust for driving the aerial missile through the air at sub-sonic, sonic or supersonic speeds.

In a general manner, while there has been, in the above description, disclosed what is deemed to be a practical and efficient embodiment of the invention, it should be well understood that the invention is not to be limited thereto as there might be changes made in the arrangement, disposition and form of the parts and the steps of the method without departing from the principle and spirit of the present invention as comprehended within the scope of the appended claims.

What is claimed is:

1. In combination, a projectile body having an outer wall and an inner wall in the form of an elongated tubular duct, a diffuser in said duct, a compressible wall located between said inner and outer walls, anchoring means for said compressible wall, a first chamber having fuel therein and defined by the wall of said diffuser and said compressible wall, said outer wall and said compressible wall defining a second chamber, nozzle means connected with said first chamber and located within said duct, and vapor pressure producing means in said second chamber and adjacent said compressible wall for compressing said wall and forcing fuel through said nozzle means into said duct.

2. In combination, a projectile body having an outer wall and an inner wall in the form of an elongated tubular duct, a diffuser in said duct, a compressible wall between said inner and outer walls, anchoring means for said compressible wall, a fuel source in an annular fuel chamber defined by said inner and compressible walls, nozzle means connected with said fuel chamber and located within said tubular duct, and vapor pressure producing means adjacent said compressible wall for compressing said wall and forcing fuel through said nozzle means into said duct.

3. An arrangement as set forth in claim 2, wherein said compressible wall and said outer wall define a second annular chamber for containing said vapor pressure means.

4. An arrangement as set forth in claim 3, wherein said vapor pressure producing means consists of a volatile liquid which is vaporized by heat transferred from the air surrounding said projectile through said outer wall of said projectile to said volatile liquid while said projectile is in flight, whereby upon vaporization of said volatile liquid the gases produced by the vaporization exert pressure against said compressible wall to force fuel from said fuel chamber through said nozzle means to said duct.

5. A pressurized fuel system for a ram-jet engine having a body with an outer wall and an inner wall in the form of an elongated tubular duct, and a diffuser in said inner wall, comprising, a collapsible wall in spaced relationship with a portion of the wall of said diffuser and with said outer wall of said body, means for anchoring the edges of said collapsible wall to said portion of said wall of said diffuser, wherein said collapsible wall, the portion of said wall of said diffuser and said anchoring means define a fuel chamber, nozzle means in said duct and communicating with said fuel chamber, and vapor pressure producing means adjacent said collapsible wall for compressing said collapsible wall and forcing fuel from said fuel chamber through said nozzle means into said duct.

6. An arrangement as set forth in claim 5, wherein said collapsible wall and a portion of said outer wall of said body define a second annular chamber for containing said vapor pressure producing means.

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7. An arrangement as set forth in claim 6, wherein said vapor pressure producing means consists of a volatile liquid which is vaporized by heat transferred from the stagnated air surrounding said ram-jet engine through said outer wall of said portion of said elongated tubular body to said volatile liquid while said projectile is in flight, whereby upon vaporization of said volatile liquid the gases produced by the vaporization exert pressure against said compressible wall to force liquid fuel from said fuel chamber through said nozzle means to said duct.

8. An arrangement as set forth in claim 7, wherein said volatile liquid is propane.

9. In an aerial missile including a ram-jet engine having a body with an outer wall and an inner wall in the form of an elongated tubular duct, a diffuser and a combustor in said duct, a compressible wall, anchoring means for said compressible wall, a fuel source having a fuel chamber defined by the wall of said diffuser and said compressible wall, and nozzle means connected with

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said chamber and communicating with said duct; the combination with vapor pressure producing means adjacent said compressible wall, said vapor pressure producing means consisting of a volatile liquid which is vaporized by heat transferred to said volatile liquid from stagnated air adjacent said body, whereby upon vaporization of said volatile liquid the gases produced by vaporization exert pressure against said compressible wall to force liquid from said fuel chamber through said nozzle means to said combustor in said duct.

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