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INJECTION HEAD FOR JET PROPULSION SYSTEM

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Fig. 1.

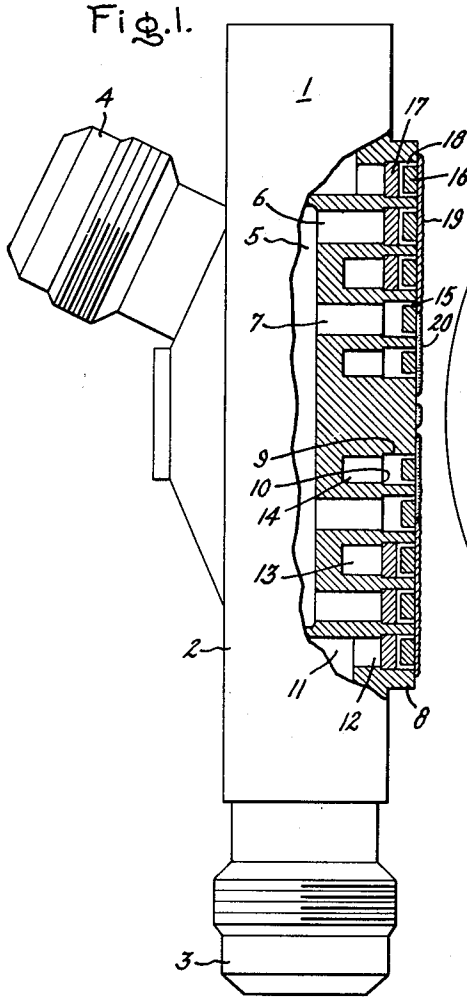


Fig. 2.

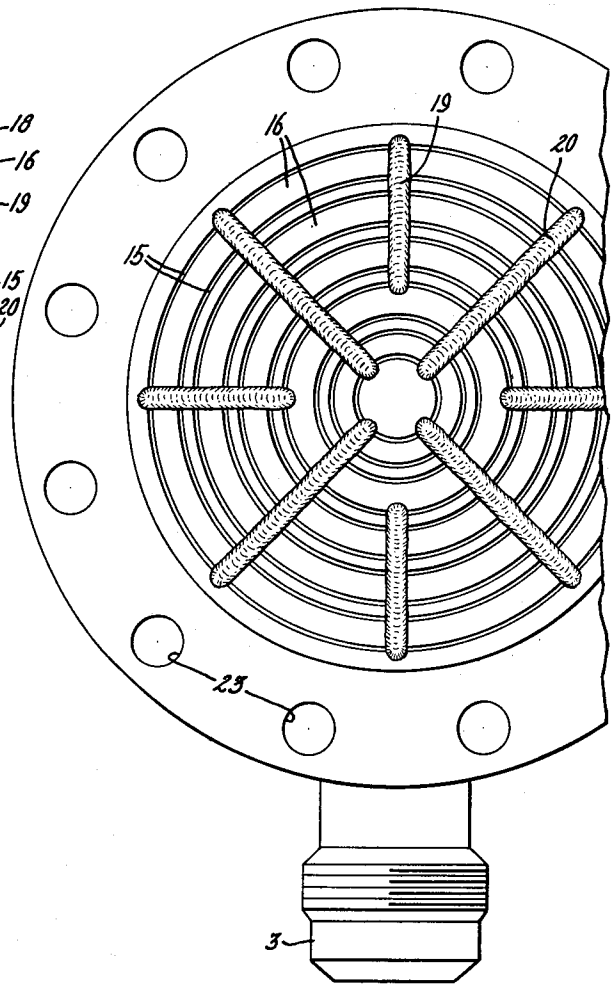
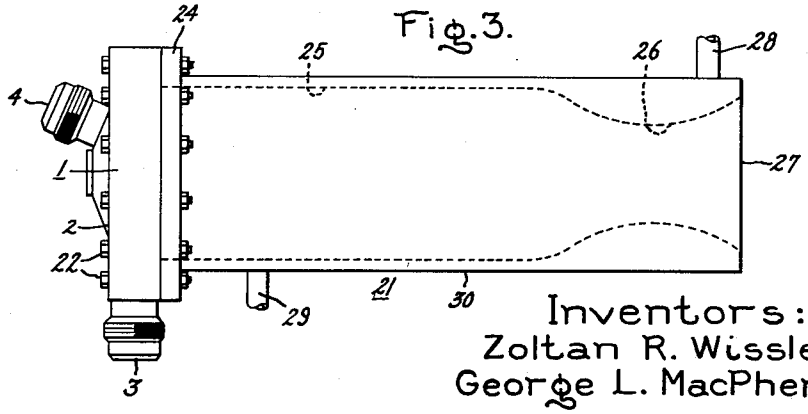


Fig. 3.



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2 Claims. (Cl. 60—39.46)

This invention relates to an injection head for fluid reactants. More particularly, it relates to a reactant injection head for jet propulsion engines.

The term "jet propulsion engine" as used herein includes all so-called reaction type motors wherein the mechanical driving thrust or force is derived from the reaction of equal and opposite forces arising between the motor body and the body of reactants attained during the conversion of the reactants into gaseous products of greater volume than that occupied by the reactants as distinguished from internal combustion engines of the reciprocating type. Devices falling within this definition and in the operation of which this invention may be employed are commonly known as rocket motors, turbo-jets, pulse-jets, and turbo-prop-jets. While the present injection head is, for the purpose of example, described herein as applied to a rocket motor, it will, of course, be realized that it may be used in any jet propulsion system.

Heretofore, fuel injection heads for jet propulsion motors burning fluid fuels or propellants have typically included a plurality of impinging or non-impinging holes arranged in a geometric pattern from which the oxidizer and combustible reactant issue into the combustion chamber for ignition.

The holes or passages for the emission of reactant from the injection head are usually made as short as possible and are backed up by a relatively larger space which serves in a sense as a temporary reservoir for the reactant. An inherent characteristic of such injection heads is the change of flow coefficient at certain pressure drops. This, in turn, results in changes in the rate of flow of fluid through the holes and into the combustor. While such interruptions are only momentary, they are constantly recurrent and in a head containing a large number of holes contribute to pulsations in the combustion process. These pulsations result in an unsteady thrust which detracts from the efficiency of the motor. More serious is the fact that the pulsations initiate vibrations in the motor which may lead to mechanical failure and destruction of the motor. The lack of steady fuel feed also may cause the burning out of the injection head due to periodic excesses of oxidizer or increased heat transfer rates.

It is an object of this invention to provide an improved injection head for jet propulsion motors.

It is another object of this invention to provide an injection head for jet propulsion motors which is characterized by a smooth, non-pulsating flow of fluid.

Another object of the invention is to provide a relatively large surface area of reactant flow per reactant volume.

A further object of the present invention is to provide a jet propulsion motor which is devoid of pulsations due to interruptions in the reactant feed through the injection head.

Other objects will become apparent from a consideration of the following description and the drawing in which Fig. 1 is an elevational view partly in cross-section of the

present injection head, Fig. 2 is a partial top plan view of the injection head, and Fig. 3 is a view of a rocket motor with the injection head in place.

It has been found that an improved non-pulsating injection head for jet propulsion motors may be very readily provided and which is characterized by ease of manufacture.

More particularly, it has been found that such an injection head may be realized by providing a plurality of slits in lieu of holes through which to inject the reactants into the combustion chamber.

The injection head slits or slots may be made in any desired geometric configuration. However, for ease of manufacture that particular arrangement or embodiment shown in the drawing is preferred.

Referring to Fig. 1, there are attached to the body portion **2** of injection head **1** inlet conduits **3** and **4** for the reactant or propellants which comprise an oxidizer and a fuel. As is well known to those skilled in the art, any of a number of oxidizers and fuels may be used in jet propulsion devices. Typical oxidizers include, among others, oxygen and hydrogen peroxide while examples of fuels are alcohol, gasoline, kerosene, and other hydrocarbon and organic and metallo-organic materials. For the purpose of the present description it will be assumed that the fuel enters through conduit **3** and the oxidizer through conduit **4**, although the reverse arrangement may also be used. Oxidizer conduit **4** terminates in a chamber or header portion **5**. Connecting with chamber or space **5** are a plurality of relatively large annular holes or slots **6** and **7** which extend from the chamber through the forward portion **8** of the injection head. The upper part of these annular holes is slightly enlarged as at **9** forming a shoulder **10**, the purpose of which will be made clear hereinafter.

Fuel conduit **3** terminates in annular space **11** which in turn leads to annular holes **12**, **13**, and **14** which are similar to holes **6** and **7** though not necessarily of the same size. Like holes **6** and **7**, the upper portions of the fuel holes are also slightly enlarged to form a shoulder such as that shown at **10**. Passage of fuel from chamber **11** to hole **12** is direct while conduits, not shown, are employed to connect the chamber with holes **13** and **14**, annular holes **6** and **7** being interrupted at a plurality of points to permit such passage.

The slit-like propellant feed holes **15** of the invention are provided by placing in the upper enlarged portion of the annular holes **6**, **7**, **12**, **13**, and **14**, ring members **16** which are so proportioned in width as to be smaller than the width of the annular holes by an amount which will provide slits or slit-like openings **15** of the desired width.

Rings **16** are supported at a plurality of points by small metal blocks **17** which rest on the shoulders **10** of the annular holes. Shims **18** which are conveniently of a U-shape which fit under and along the sides of rings **16** are used to maintain the proper spacing of ring **16** from the side of the annular hole. Blocks **17** and shims **18** are arranged under rings **16** at a sufficient number of points to provide adequate support to the rings, the shims preferably being welded, brazed, or otherwise fixed to the blocks. For convenience in manufacture of the present injection head, they are arranged radially as shown, the larger rings being supported at more points than those of smaller diameter which are by structure more rigid.

In order to hold the rings **16** in fixed-spaced relationship to the rest of the head, a welding bead such as that shown at **19** and **20** is laid or deposited over the rings, the upper exposed parts of the shims, and the head body between the rings. While welding as above has been found to be the most convenient way of assembling the parts

concerned, the rings may also be fixed in place by brazing, bolting, or any other convenient way.

It will be understood, of course, that the number of slits provided for the injection of reactants varies with the size of the injection head. As a specific example, the injection face of the head shown in the drawing having ten annular slits is about three inches in diameter. A head having a face-diameter of ten inches and used to inject alcohol and liquid oxygen, as in the above example, has about fifteen annular slits. It will also be understood that the width of the annular slits varies depending on the size of the head and the reactants used. For example, the width of the slits in the three inch diameter head shown is about 0.01 inch. The oxidizer and fuel slits may also be of different widths.

In operation fuel is fed through conduit 3 into space 11 and into annular holes 12, 13, and 14 with little or no pressure drop. From these holes the fuel is fed through slits 15 alongside rings 16, except at those limited points at which blocks 17 prevent such flow. Oxidizer is fed in a similar manner through conduit 4 into header chamber 5, thence to annular holes 6 and 7 and through slits 15. It will be noted that the only restricted passage for flow of reactant and hence the only region in which any notable pressure drop occurs is in the very short passage through the slits themselves. The reactants issue from the slits in concentric annular sheets which lend themselves to ready mixing for thorough combustion. Preferably though not mandatorily, the outer slit is used to feed fuel to shield the wall of the combustor from pure oxidizer which may cause hot spots and failure. The angle of exit of the fuel may be varied by canting the slits.

In Fig. 3 is shown a rocket motor as typical of jet propulsion motors in which the present injection head may be employed. Injection head 1 is fixed to rocket combustion chamber 21 by means of bolts 22 fitted through holes 23 in the head and in the flange 24 of the motor. The rocket motor is shown conventionally as having an inner combustor wall 25 cylindrical in its upstream portion and restricted downstream to form a throat 26 and flaring nozzle portion 27 for the issue of hot gases. Inlet conduit 28 and outlet conduit 29 are provided for the flow of coolant between liner 25 and the outer wall 30

of the motor. A rocket motor is chosen as typical of jet propulsion devices merely for purposes of illustration and not in any limiting sense, the present injector being useful in any type of reaction motor using fluid reactants.

There is provided by this invention an improved slit-type reactant injection head for jet propulsion motors which is characterized by smooth running qualities and absence of pulsations due to unsteady flow of reactants. The construction leads to ease in manufacture and results in improved combustion due to the large surface area of reactant provided per unit of reactant volume.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A reactant injection head for jet propulsion engines comprising a fuel inlet, a fuel inlet header connected to said fuel inlet, an oxidizer inlet, an oxidizer inlet header connected to said oxidizer inlet, and concentric alternate outlet means for said fuel and oxidizer connected to the respective headers, said outlet means comprising a plurality of annual apertures having rings fixed therein, said rings being in spaced relationship to said apertures to form slits.

2. A reactant injection head for jet propulsion engines comprising a fuel inlet, a fuel inlet header connected to said fuel inlet, an oxidizer inlet, an oxidizer inlet header connected to said oxidizer inlet, and concentric alternate outlet means for said fuel and oxidizer connected to the respective headers, said outlet means comprising a plurality of annular apertures, each aperture having fixed in the exit end thereof a ring supported at a plurality of points by metal blocks and held in spaced relationship to the edges of said apertures at the same points by metal shims to form annular slits in conjunction with said apertures.

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