Aug. 4, 1953 L. L. DREIBELBIS 2,647,364

PULSE JET ENGINE WITH SPONTANEOUSLY IGNITABLE FUEL AND OXIDIZER

Filed Sept. 10, 1948 2 Sheets-Sheet 1

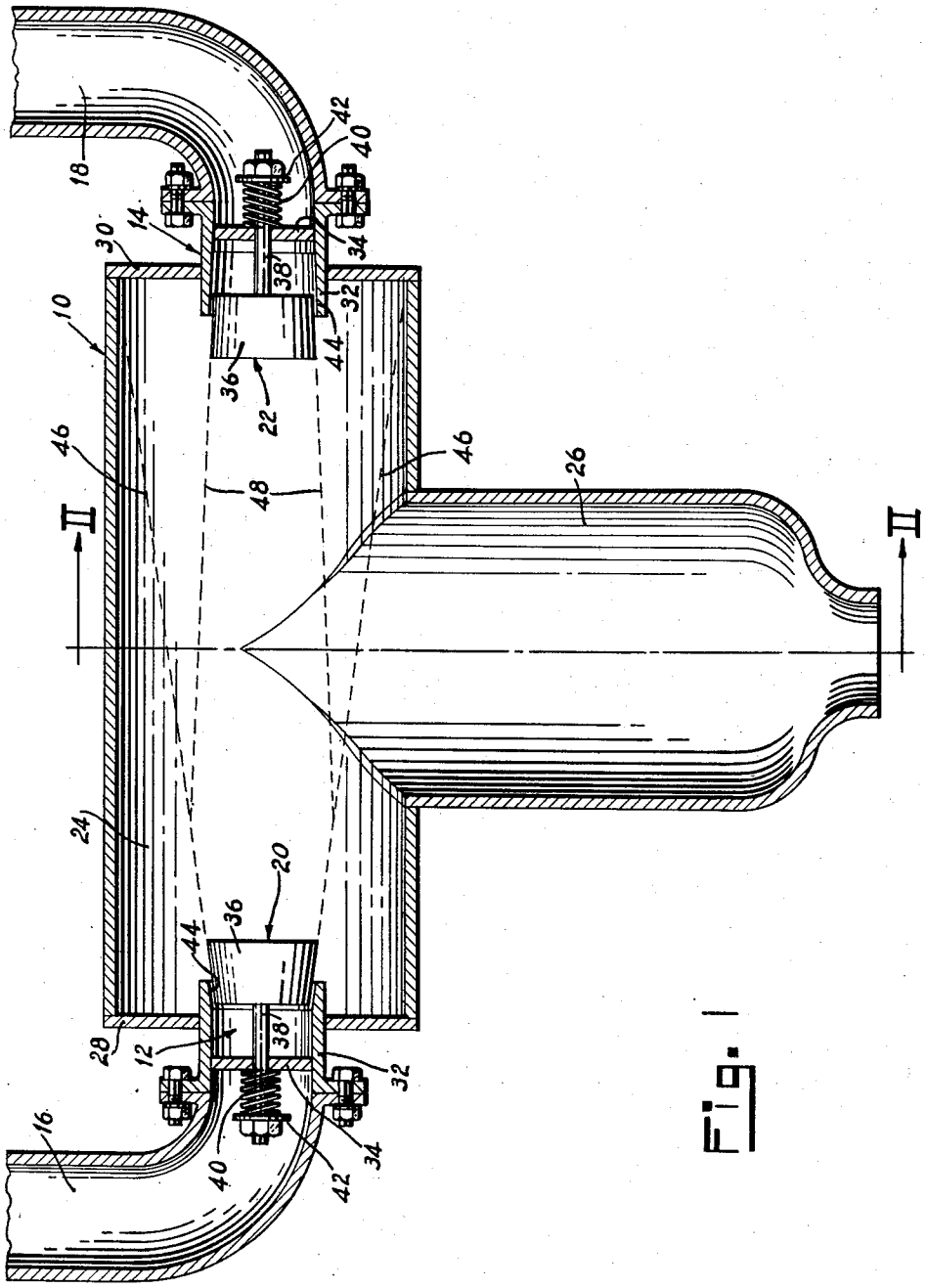


Fig. 1

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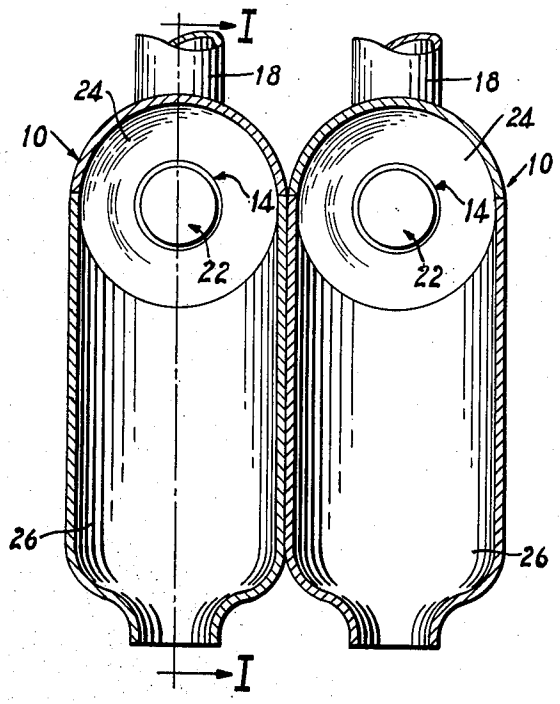


Fig. 2

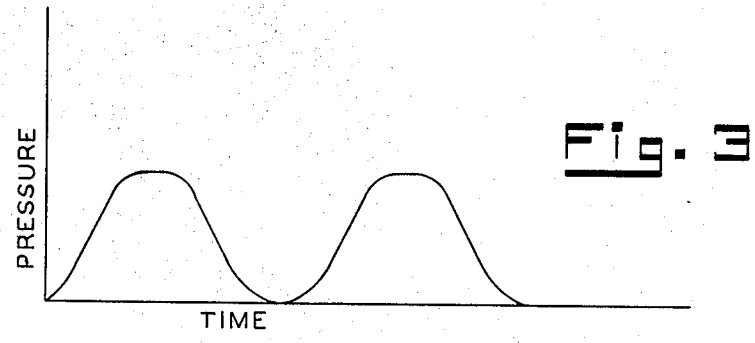


Fig. 3

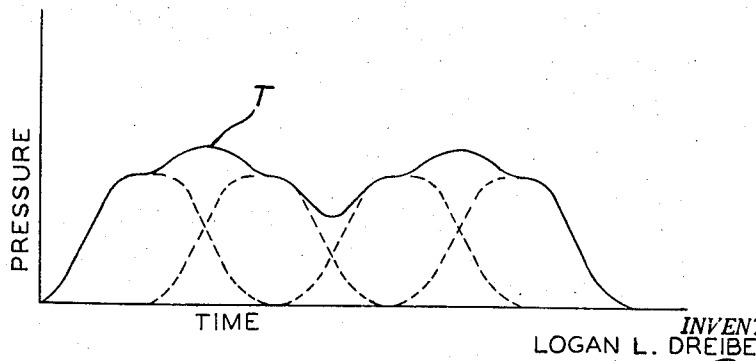


Fig. 4

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PULSE JET ENGINE WITH SPONTANEOUSLY IGNITABLE FUEL AND OXIDIZER

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3 Claims. (Cl. 60—35.6)

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The present invention relates to jet propulsion and more particularly to a jet motor adapted to operate on an impulsing cycle.

An object of the present invention is to provide a jet motor adapted to substantially fill a predetermined portion of its combustion chamber with fuel and oxidizer before said fuel and oxidizer start to react.

Another object of the present invention is to provide a jet motor of relatively small size capable of generating a large thrust.

Another object of the present invention is to provide a jet motor operating on an impulsing cycle wherein the vibration heretofore inherent in such a motor is greatly reduced.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the apparatus possessing the construction, combination of elements and arrangement of parts which are exemplified in the following detailed disclosure, and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings wherein:

Fig. 1 is a somewhat diagrammatic sectional plan view taken along the line I—I of Fig. 2, and showing a jet motor constructed in accordance with the present invention;

Fig. 2 is a sectional elevation taken along the line II—II of Fig. 1;

Fig. 3 is a curve illustrating the manner in which the pressure in one chamber will fluctuate with time as the cycle repeats; and

Fig. 4 is a curve illustrating the manner in which the pressure in two chambers will fluctuate with time as the two cycles alternate and repeat.

Figs. 1 and 2 disclose a jet motor comprising a pair of combustion chambers 10, a pair of injectors 12 and 14 located in each chamber 10 and adapted to inject liquid fuel components into said chambers, a pair of conduits 16 and 18 connected to injectors 12 and 14 respectively to supply them with said fuel components, and a pair of spring pressed valves 20 carried by injectors 12 and 14 respectively.

Inasmuch as the two combustion chambers 10 are substantially identical only one will be described in detail. However, corresponding parts in the drawing have been identified by identical numerals, and it will be understood that the description of one chamber applies equally well to both of them.

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Each combustion chamber 10 is T-shaped and has a generally cylindrical combustion portion 24 forming the top or head of the T, and a generally cylindrical exhaust portion 26 forming the stem of the T. Exhaust portion 26 is joined to the mid-point of combustion portion 24, and the interiors of portions 24 and 26 are in communication with each other. The ends of combustion portion 24 are closed by end plates 28 and 30. Injectors 12 and 14 are carried by end plates 28 and 30 respectively, and are centrally located thereon so that each of them injects its respective liquid propellant component generally axially of combustion portion 24 in a manner to be subsequently described more fully.

The propellant components preferably employed in the jet motor of the present invention are of the type which are spontaneously combustible upon coming in contact with each other, as for example, an acid type oxidant, and furfural alcohol. It is desirable, in order to obtain the maximum amount of thrust from a combustion chamber of any given size, to place as large a charge of propellant as is consistent with the design bursting strength of combustion portion 24 in said portion 24 before combustion starts and generates a pressure in chamber 10 which will close injectors 12 and 14 and prevent any more propellant from entering combustion portion 24 during that particular cycle. Injectors 12 and 14 are so constructed, and so arranged in combustion portion 24, that each of them can introduce a relatively large charge of propellant component, each charge being of correct volume, into said combustion portion 24 before said components react with each other.

Injector 12 comprises a hollow cylindrical nozzle 32 having a valve supporting spider 34 located interiorly thereof. A valve 20, comprising a valve stem 38 slidably journaled in spider 34, and a tapered valve head 36 carried by said valve stem 38, is mounted in nozzle 32 and adapted to open into combustion portion 24. A spring 40 mounted on valve stem 38, engages spider 34, and washer 42 carried by valve stem 38, to normally hold valve head 36 seated against tapered surface 44 to close nozzle 32. Injector 14 is substantially identical to injector 12 except for the degree of taper of its valve head 36 and tapered surface 44.

Injectors 12 and 14 may be connected to conduits 16 and 18 respectively by any desired means. A conventional bolt and flange connection is disclosed in the drawing. Conduits 16 and 18 are connected to sources of supply of fluid propellant components, as for example, conduit 16 may be

attached to a pump, or other means, adapted to supply an acid type oxidant under pressure, and conduit 18 may be attached to a pump, or other means, adapted to supply furfural alcohol under pressure. The resistance of springs 40 is such that when the pressure in chamber 10 is low, as when said chamber has substantially completed the exhaust portion of one cycle, the pressure of the fuel components will simultaneously open valves 20 and permit said components to enter combustion portion 24 of chamber 10. As soon as the propellant starts to burn the pressure immediately rises in chamber 10 and causes valves 20 to close and remain closed until the pressure in said chamber 10 is again reduced.

The tapered surface 44 of injector 12 and the taper of valve head 36 makes such an angle with the center line of combustion portion 24 that the liquid propellant component supplied by conduit 16 is injected into said combustion portion 24 in the form of a relatively widely diverging cone, indicated by dotted lines 46, that approaches the cylindrical wall of combustion portion 24 adjacent the opposite end thereof. The tapered surface 44 of injector 14, and the taper of its valve head 36, makes such an angle with the center line of combustion portion 24 that the liquid propellant component supplied by conduit 18 is injected into said combustion portion 24 in the form of a slightly diverging cone, indicated by dotted lines 48, that contacts the propellant component cone injected by injector 12 adjacent to said injector 12. It will, therefore, be seen that a stream or cone of propellant substantially the length of combustion portion 24 is injected into said combustion portion 24 by each of the two injectors before said streams or cones contact each other and ignition takes place. It is thus possible to introduce substantially twice the volume of propellant into chamber 10 that would be possible if both injectors injected identical cones of propellant. This larger volume results in rapid combustion of the propellant components and very high thrust in proportion to the size of the jet motor.

The frequency of the cycles of each combustion chamber 10 of the jet motor of the present invention is a function of the distance between injectors 12 and 14, the size and shape of combustion portion 24 and the ignition lag of the propellant combination used. Increasing the size of chamber 10 will decrease the frequency, and locating injectors 12 and 14 closer together will increase the frequency but will reduce the thrust of each cycle because of the smaller charge injected.

Fig. 3 is a curve that illustrates the manner in which the pressure in one chamber 10 will fluctuate as the cycle repeats itself. Inasmuch as the frequency is quite high, the rapid building up of a pressure in combustion portion 24 and the rapid exhausting of that pressure through exhaust portion 26, to obtain and utilize a thrust from said pressure, results in an intense vibration. The present invention contemplates the use of the above described chambers 10, placed side by side, as illustrated in Fig. 2, and rigidly fastened in that side by side relationship, as by welding or riveting or any other suitable means. The two chambers in their side by side relationship fire alternately by reason of the coupling provided by the alternate exhaust gas compression waves from each chamber 10. The alternate firing of two combustion chambers results in a total pressure fluctuation considerably less than the pressure fluctuation of one chamber firing alone. The pressure fluctuation of two alternately firing chambers is shown by solid line T in Fig. 4, where the curves shown in dotted line represent alternate pressure fluctuations similar to those shown in Fig. 3. It will thus be apparent to those skilled in the art that a jet motor having two combustion chambers firing alternately will have a total vibration that is much less than the vibration of a similar motor having only one chamber.

Since certain changes may be made in the above apparatus without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In a jet motor, utilizing a plurality of fluid propellant components which ignite spontaneously upon contact with each other to obtain a propulsive thrust from the resulting combustion the combination of a T-shaped combustion chamber having a combustion portion and an exhaust portion midway thereof and normal thereto, an injector in one side of said combustion portion, a normally closed spring loaded valve with a frusto-conical head associated with said injector and serving as a closure therefore and adapted to open into said combustion portion when the pressure in said injector exceeds the pressure in said combustion portion, said injector being adapted to inject a fluid propellant component into and substantially across said combustion portion in the shape of a diverging cone when said valve is open, a second injector in the opposite side of said combustion portion, said second injector being located across said combustion portion and opposite said first mentioned injector, a normally closed spring loaded valve with a frusto-conical head associated with said second injector and serving as a closure therefore and adapted to open into said combustion portion at substantially the same time that said first mentioned valve opens, said frusto-conical heads having different half angles, said second mentioned injector being adapted to inject a second fluid propellant component substantially across said combustion portion and inside of said diverging cone when said valves are open, whereby said second propellant component first contacts said first mentioned propellant component adjacent said first mentioned injector.

2. In a jet propulsion device adapted to employ a liquid propellant made up of a plurality of components which ignite spontaneously upon contact with each other, the combination of a combustion chamber including a closed ended, elongated combustion section and an exhaust section opening into said combustion section intermediate the ends thereof, said exhaust section having an outlet opening of fixed cross section throughout the operating cycle of the propulsion device, substantially unrestricted conduit means opening into the opposed ends of said combustion section adapted to supply said components to said combustion section for spontaneous ignition therein, and valve means in the combustion section ends of said conduit means biased to shut off flow out of said ends when the pressure in said combustion section approaches the pressure in said conduit means, said valve means including shaped surfaces differentially inclined relative to the longitudinal axis of said combustion section forming

the components supplied into said combustion section into diverging cones of different slopes intersecting adjacent one end of said combustion section.

3. In a jet propulsion device adapted to employ a liquid propellant made up of a plurality of components which ignite spontaneously upon contact with each other, the combination of a T-shaped chamber having a combustion section and an exhaust section midway thereof and normal thereto, said exhaust section provided with an outlet opening of fixed cross section throughout the operation cycle of the propulsion device, means at each end of said combustion section for intermittently admitting the components of the liquid propellant into said combustion section, each of said component admitting means including a substantially unrestricted conduit opening into said combustion section and a valve controlling the flow out of said conduit, said valve biased to close said conduit when the pressure in said combustion chamber approaches the pressure in said conduit, said component admitting means being in opposed relation whereby said components impinge each other as they are admitted into said combustion chamber.

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