

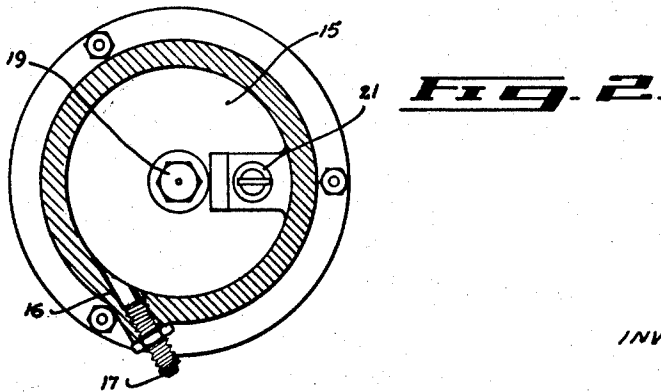
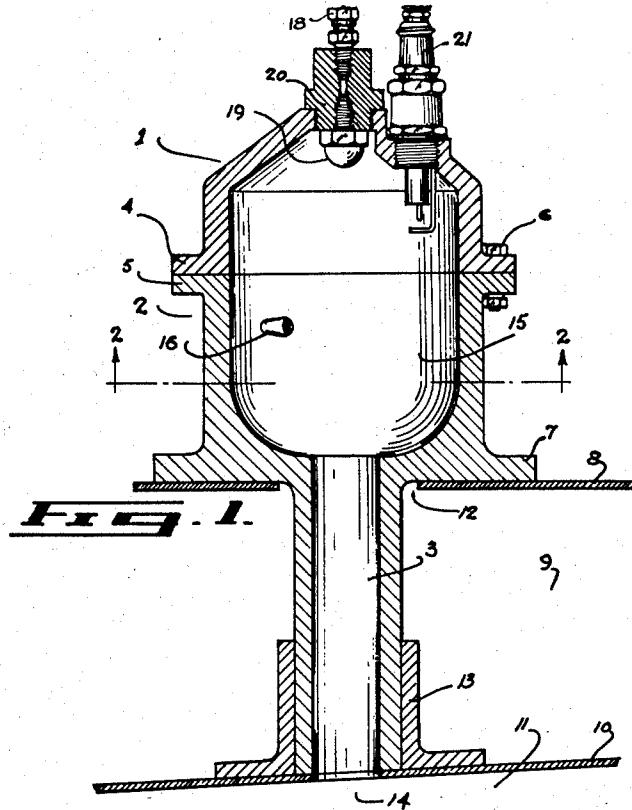
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PULSATING TORCH IGNITER

2,847,826

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2 Sheets-Sheet 1



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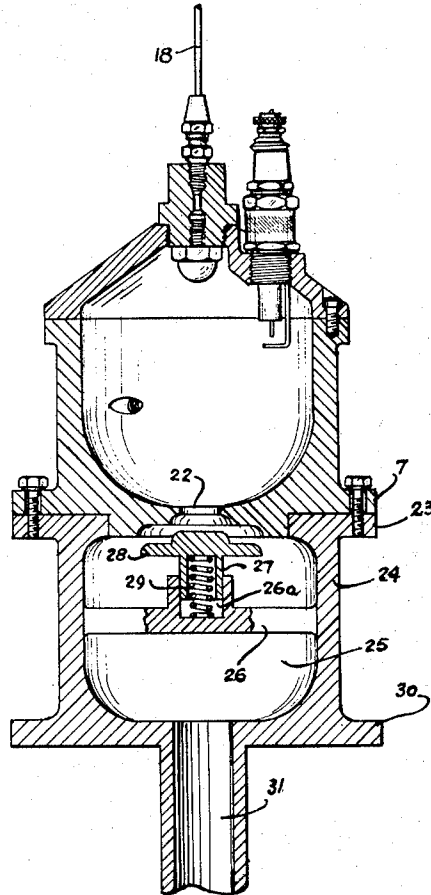


Fig. 3.

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PULSATING TORCH IGNITER

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1 Claim. (Cl. 60—39.82)

This invention relates to the ignition of main combustion chambers, more particularly those using non-volatile fuels by which, in this specification, is meant those fuels having an initial boiling point of 150° F. or above by the A. S. T. M. method, e. g. the petroleum fractions including kerosene and crude oils.

The invention is particularly concerned with the ignition of the main combustion chambers of jet propulsion engines and the description will be mainly directed to this aspect. It is to be realised however that the invention is also applicable to the ignition of other main combustion chambers, for example those of marine and other heavy boilers, those of rocket motors, and those burning difficultly ignitable fuels such as coal dust, peat, and residual fuels from the distillation of petroleum.

With present methods, difficulty is found in effecting efficient ignition of the main combustion chambers of jet propulsion engines, especially when using high air velocities through the main combustion chamber, when using wide main combustion chambers, or when, in the case of aircraft engines, operating at high altitudes. A common method of ignition is by the use of a so-called "torch igniter" which is a much smaller combustion chamber located in the wall of the main combustion chamber and adapted to direct a continuous flame into the main combustion chamber to ignite the main fuel charge therein. Great difficulty has been found in giving this ignition flame sufficient pressure to achieve efficient penetration of the main combustion chamber, especially under the conditions outlined above.

It is the object of the present invention to overcome these difficulties.

Surprisingly, it has been found that, if a rich charge in the torch igniter chamber is given a rotary motion and a continuous spark is provided in the torch igniter chamber, intermittent explosions are obtained. This produces a pulsating flame of greatly improved penetration as compared with the flame produced by the common igniters used up to the present. It is not quite clear why the igniter should operate in this fashion even though the sparking plug or other igniting device is continuously sparking or operating, but it is thought that the rotary motion of the fuel mixtures causes such an arrangement and disposition of the ingredients of the fuel mixture that intermittent explosions take place rather than a continuous combustion.

According to the invention, therefore, a method for igniting the charge in a main combustion chamber comprises continuously feeding to a torch igniter chamber oxygen and an atomised liquid fuel, said liquid fuel being in excess of the stoichiometrical proportion for the complete combustion of said fuel, effecting a rotary motion of the mixture in said igniter chamber, providing a substantially continuous sparking within said igniter chamber, and passing the pulsating flame from the resultant intermittent explosions to said main combustion chamber to ignite the charge therein. The oxygen will of course normally be provided in the form of air.

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It is preferable that the torch igniter chamber is substantially cylindrical in order to facilitate the rotary motion of the igniter charge. The most suitable method for effecting this rotary motion is to introduce the oxygen at a fine angle to the wall of the torch igniter chamber. Thus in the case of a substantially cylindrical chamber, the air inlet is preferably substantially tangential to the substantially cylindrical side wall of the chamber. Alternatively, this rotary motion could be obtained by introducing the oxygen into the torch igniter chamber between inclined vanes.

A suitable form of igniter according to the present invention comprises a generally cylindrical torch igniter chamber, an oxygen inlet pipe extending into said igniter chamber substantially tangentially to the side wall of said igniter chamber, a liquid fuel inlet atomizer connected to said igniter chamber, an igniting device in said igniter chamber, and an outlet aperture in the wall of said igniter chamber, said outlet aperture having a cross-sectional area substantially smaller than the lateral cross-sectional area of said igniter chamber and being adapted for connection to a main combustion chamber. The restricted outlet aperture is normally required for efficient penetration.

At the reduced pressure of high altitudes, it is difficult to build up sufficient pressure of the fuel mixture before explosion. To overcome this difficulty, there may be disposed between the combustion chamber of the torch igniter and the main combustion chamber a spring-loaded valve whose spring-loading is sufficient to enable the build up of pressure but weak enough to be forced open on explosion taking place. In the preferred form of the invention, this valve controls the afore-mentioned outlet aperture and, between this aperture and the main combustion chamber, there is disposed an intermediate chamber which in turn is connected to the main combustion chamber via a second aperture. The purpose of this intermediate chamber and second aperture is to concentrate the flame in the desired direction after being dispersed in passing round the head of the said-loaded valve.

It is desirable that the afore-mentioned valve on the outlet aperture of the torch igniter chamber should open wide and operate rapidly in order to avoid the possibility of extinguishing the flame at this point. Valves having these properties are well known in the art.

An embodiment of the said preferred form of the invention is illustrated in the accompanying drawings, in which:

Figure 1 is a sectional elevation of a torch igniter in operative position,

Figure 2 is a cross-sectional view on line 2—2 of Figure 1,

Figure 3 is a sectional elevation of a modified torch igniter for high altitudes.

As shown in Figures 1 and 2, the torch igniter consists of two main parts, an upper part 1 and a lower part 2 formed with a cylindrical tube 3. The parts 1 and 2 are formed respectively with peripheral flanges 4 and 5 which are secured together by bolts 6. The lower part 2 is also formed with a peripheral flange 7 which is secured by bolts (not shown) to the outer casing 8 of an air space 9 surrounding the wall 10 of the main combustion chamber 11 of a jet propulsion engine (not shown). The tube 3 extends through an aperture 12 in the outer casing 8 and is secured by means of an angle bar 13 in alignment with an aperture 14 in the wall 10.

The parts 1 and 2 together embrace a torch igniter chamber 15 connected by the tube 3 to the main combustion chamber 11. Air is fed to the chamber 15 via a tangential air inlet 16 which is formed in the part 2 and to which an air pipe connection 17 is secured. Liquid fuel is fed to the chamber via a fuel inlet pipe 18 and a

spray nozzle 19 which is mounted in an adapter 20 secured in the part 1. Also secured in the part 1 is a spark plug 21.

Figure 3 shows a modified form of torch igniter for use at high altitudes and omits details of the engine to which the igniter is to be secured. Apart from certain differences of shape, all parts of the igniter shown in Figures 1 and 2 are duplicated in Figure 3 except that the cylindrical tube 3 is replaced by a shaped aperture 22. The flange 7 is connected, not to the casing 8, but to a peripheral flange 23 of an outer casing 24 of an intermediate chamber 25. A cross bar 26 is provided across the inside of the chamber 25 and formed with a cylindrical cavity 26a in the centre. Slidably fitted within the cavity 26a is a cylindrical sleeve 27 carrying a valve head 28 shaped to seat in the aperture 22. A compression spring 29 is located within the sleeve 27 and acts between the underside of the valve head 28 and the base of the cavity 26a. The case of the casing 24 is formed with a peripheral flange 30, for bolting to the casing 8 in the same manner as flange 7 in Figure 1, and a cylindrical tube 31 for securing to the wall 10 in the same manner as tube 3 in Figure 1.

As regards the measurements of both forms of igniter illustrated, the maximum diameter of the chamber 15 is three inches, the diameter of the tube 3 is one inch, and the minimum diameter of the aperture 22 is one inch. The spark plug 21 is so located that the spark occurs about a half inch from the wall of the chamber 15. The liquid fuel spray nozzle 19 is a "Monarch" 3 G. P. H. swirl jet and the air pipe connection 17 has an internal diameter of 0.18". The spring 29 is of such strength that the valve head 28 will not open until the pressure in the chamber 15 exceeds 14 p. s. i. above atmospheric pressure.

In the operation of the device shown in Figures 1 and 2, the air and liquid fuel are introduced at the requisite pressures and the spark plug 21 is continuously operated. The tangential entrance of the air ensures a rotary motion to the fuel mixture in the chamber 15 and it is found that intermittent explosions take place which force a pulsating flame down the tube 3 and into the main combustion chamber 11. The main fuel mixture is introduced into the main combustion chamber 11 and efficient and positive ignition is effected right across his chamber.

In Figure 3, the valve arrangement serves to enable sufficient pressure of the unexploded fuel mixture to be built up between explosions in spite of the adverse effects of the rarefied atmosphere at high altitudes. As the pressure in the chamber 15 rises above 14 p. s. i. on explosion taking place, the valve head 28 opens and the flame is forced down the aperture 22. On passing round the valve head 28, the flame tends to disperse outwardly on all sides of the head 28. The intermediate chamber 25 serves to concentrate the dispersed flame and re-direct it down the tube 31 and into the main combustion chamber 11.

With the dimensions as specified and using kerosene as the liquid fuel, the device operated satisfactorily with a fuel pressure of 5 to 100 p. s. i. gauge in the fuel inlet pipe 18 and an air pressure of 0.08 to 8.0 p. s. i. gauge at the inlet to the air pipe connection 17.

Under these conditions, the resulting frequency of pulsation fell within the range of 6 to 0.6 per second. While the device functioned satisfactorily over the range of pressures given above, it is not intended that it need be limited to these pressures, provided that the proportion of kerosene or other liquid fuel is maintained above the stoichiometrical proportion for the complete combustion of the fuel in air.

It is found that the frequency of pulsation can be varied by moving the spark plug 21 towards or away from the wall of the chamber 15. The frequency increases the nearer the plug 21 is moved towards this wall and for normal purposes the plug 21 will be appreciably spaced from this wall.

I claim:

A pulsating torch igniter comprising a generally cylindrical torch igniter chamber, an oxygen inlet pipe extending into said igniter chamber substantially tangentially to the side wall of said igniter chamber, a liquid fuel inlet atomizer connected to said igniter chamber, an igniting device in said igniter chamber, an outlet aperture in the wall of said igniting chamber, said outlet aperture having a cross-sectional area substantially smaller than the lateral cross-sectional area of said igniter chamber and connecting said igniter chamber to an intermediate chamber, a loaded valve controlling gaseous flow through said aperture from said igniter chamber to said intermediate chamber, and an outlet aperture in the wall of said intermediate chamber, said second-mentioned outlet aperture having a cross-sectional area substantially smaller than the lateral cross-sectional area of said intermediate chamber and being adapted for connection to a main combustion chamber.

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