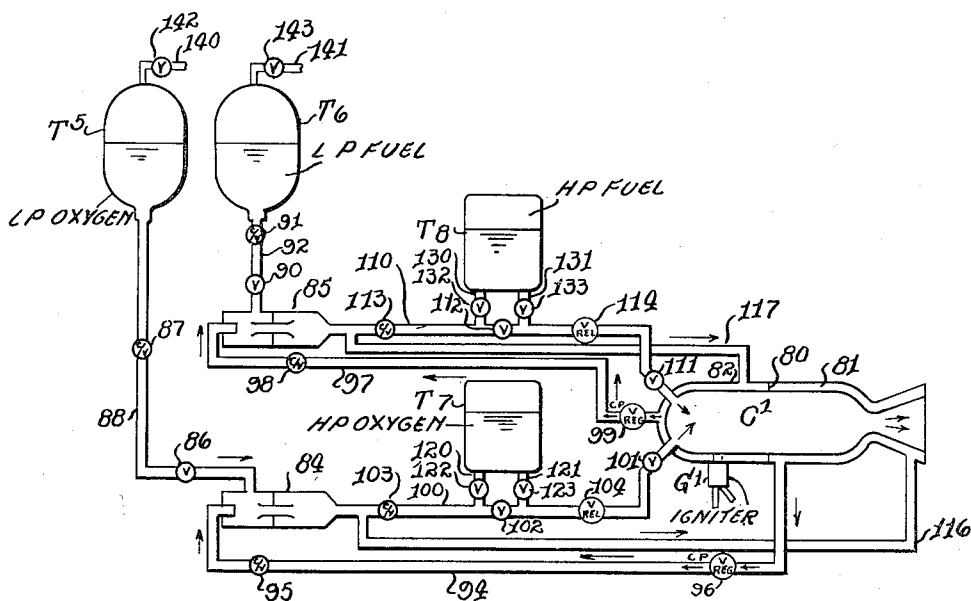


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FEEDING APPARATUS, INCLUDING INJECTORS ADAPTED  
TO SUPPLY COMBUSTION LIQUIDS UNDER  
PRESSURE TO A COMBUSTION CHAMBER  
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## UNITED STATES PATENT OFFICE

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## FEEDING APPARATUS, INCLUDING INJECTORS ADAPTED TO SUPPLY COMBUSTION LIQUIDS UNDER PRESSURE TO A COMBUSTION CHAMBER

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2 Claims. (Cl. 60—39.14)

1

This invention relates to apparatus for feeding liquid combustion elements, such as gasoline and liquid oxygen, to a chamber in which combustion is to be maintained, and is a division of prior application Serial No. 536,558 filed May 20, 1944, now Patent No. 2,558,483 dated June 26, 1951. Such combustion chambers are commonly provided with rearwardly-open discharge nozzles and have particular utility in rocket apparatus and in other jet-propelled mechanisms.

It is the general object of this invention to provide feeding apparatus involving the use of injectors in such manner that the apparatus is capable of generating much higher feeding pressures than are maintained in the storage or supply tanks.

In the preferred form, the injectors are operated by vapors of the liquid fuel and of the liquid oxygen which are evolved in separate combustion chamber jacket spaces.

The invention further relates to arrangements and combinations of parts which will be hereinafter described and more particularly pointed out in the appended claims.

A preferred form of the invention is shown in the drawing, in which the figure is a diagrammatic elevation of the improved feeding apparatus.

Referring to the drawing, a preferred construction is shown in which vapors or gases from the combustion elements are utilized to operate the injectors.

A combustion chamber C1 has a jacket divided by an annular partition 80 into jacket spaces 81 and 82. Storage tanks T5 and T6 are provided for liquid oxygen and for gasoline or other liquid fuel. Injectors are shown at 84 and 85, and each injector may comprise a cylindrical outer casing having an inner transverse partition in which a draft or Venturi tube is mounted.

A shut-off valve 86 and a check valve 87 are provided in a feed pipe 88 which connects the tank T5 to the injector 84, and a similar shut-off valve 90 and check valve 91 are provided in a feed pipe 92 which connects the tank T6 to the injector 85. A pipe 94 connects the jacket space 81 with the injector 84 and is provided with a check valve 95 and with a pressure control or regulating valve 96. The jacket space 82 is similarly connected by a pipe 97 to the injector 85 and is provided with a check valve 98 and with a pressure control or regulating valve 99.

The discharge or outlet end of the injector 84 is connected by a pipe 100 to the combustion chamber C1 and is provided with shut-off valves

2

101 and 102, a check valve 103 and a pressure-responsive relief valve 104. The discharge end of the injector 85 is similarly connected to the combustion chamber C1 by a pipe 110 having shut-off valves 111 and 112, a check valve 113 and a pressure-responsive relief valve 114.

A pipe 116 connects the discharge end of the injector 84 to the jacket space 81 and a similar pipe 117 connects the injector 85 to the jacket space 82.

For quick starting purposes, a tank T7 is connected by pipes 120 and 121 to the pipe 100 previously described and these branch pipes are provided with shut-off valves 122 and 123. The tank T7 contains a supply of liquid oxygen and is preferably under relatively high pressure. A similar tank T8 for fuel under pressure is connected by pipes 130 and 131 to the pipe 110 previously described and these pipes are provided with shut-off valves 132 and 133. A flame-type of igniter G1 is provided for the chamber C1 and this igniter may be of the construction shown in Goddard Patent No. 2,090,039. Filler pipes 140 and 141 are provided for the tanks T5 and T6 and are equipped with shut-off valves 142 and 143.

The apparatus shown in the drawing may be operated either with or without making use of the pressure tanks T7 and T8. The operation without using the tanks T7 and T8 will first be described.

It is desirable that a certain amount of liquid and gaseous oxygen be present in the jacket space 81 and that a similar amount of liquid or gaseous fuel or gasoline be presented in the jacket space 82. The flame igniter G1 is then started and the heat of the flame is sufficient to produce more gases or vapors in the jacket spaces 81 and 82.

The oxygen vapor in the space 81 will then flow through the pipe 94, regulating valve 96 and check valve 95 to the injector 84 and thence through the pipe 100 and its several valves to the chamber C1, assuming that the valves 101 and 102 have been opened and that the valves 122 and 123 are closed. If the valve 86 is then opened, liquid oxygen will flow through the pipe 88 to the injector 84.

Similarly, gasoline vapor will flow through the pipe 97 and valves 98 and 99 to the injector 85 and thence through the pipe 110 to the combustion chamber C1, and liquid gasoline will flow to the injector 85 as soon as the valve 90 is opened.

The Venturi action of the injectors 84 and 85 quickly steps up the liquid pressures from the

relatively low storage tank pressures to substantially higher pressures such as 100 lbs. per square inch, and the liquids under the increased pressures are delivered through the pipes 100 and 110 and check valves 103 and 113 to the combustion chamber C1.

The resultant mixture of oxygen and gasoline in the chamber C1 will then be ignited by the flame from the igniter G1 and increasing amounts of gaseous oxygen and gasoline will be delivered from the jacket spaces 81 and 82. The regulating valves 96 and 99 control the rate of flow of these gases to the injectors and thus prevent the injection of undesired amounts of liquid oxygen and gasoline to the chamber C1.

The oxygen and gasoline in the jacket spaces 81 and 82 are continuously replenished through the connections 116 and 117. The check valves 103 and 113 are set to open at the high pressures developed by the injectors but not at the relatively low pressure in the tanks T5 and T6. The check valves 95 and 93 prevent reverse flow in the pipes 94 and 97.

The pressure relief valves 104 and 114 are provided to prevent bursting of the pipes 100 and 110, should evaporation produce dangerous pressure in either of these pipes after the valves 101 and 111 have been closed to discontinue operations.

The pressure tanks T7 and T8 constitute auxiliary starting equipment which may be used should occasion require. These tanks may be filled with liquid at high pressure by temporarily closing the valves 102 and 123 for the tank T7 and opening the valve 122 when the apparatus is in operation. This will cause the liquid oxygen which is under high pressure in the pipe 100 to enter the tank T7 and to compress any gas or vapor in the top of the tank to any desired pressure, which pressure may then be retained by closing the valve 122. A similar procedure may be used to fill the tank T8 with gasoline under high pressure. By thereafter opening the valve 123 for the tank T7, liquid oxygen under high pressure may be fed direct to the chamber C1, and similarly by opening the valve 133 for the tank T8, gasoline under high pressure may be fed direct to the chamber C1. It is thus possible to start combustion in the chamber C1 very quickly and without waiting for the injectors 84 and 85 to become operative.

Improved and simplified means is thus provided by which liquid combustion elements may be fed to a combustion chamber under high pressures developed in the feeding apparatus itself and without requiring auxiliary pumps or other similar apparatus.

Having thus described the invention and the advantages thereof, it will be understood that the invention is not to be limited to the details herein disclosed, otherwise than as set forth in the claims, but what is claimed is:

1. In a combustion apparatus comprising a

combustion chamber and low pressure storage tanks for liquid fuel and liquid oxygen, in combination, injectors operative to feed said liquid fuel and liquid oxygen from said tanks to said combustion chamber at relatively higher pressures, and means to render said injectors operative, said means including two separate jacket spaces about said combustion chamber and connections through which each jacket space receives a portion of one of said liquids and delivers the vapor thereof to the corresponding injector under pressure and thereby renders said injector operative to feed its liquid to said combustion chamber at substantially more than storage tank pressure, together with separate high pressure storage tanks connected between each injector and the combustion chamber, and means to render said high pressure tanks selectively and immediately operative to inject the corresponding liquid to said chamber.

2. In a combustion apparatus comprising a combustion chamber and low pressure storage tanks for liquid fuel and liquid oxygen, in combination, injectors operative to feed said liquid fuel and liquid oxygen from said tanks to said combustion chamber at relatively higher pressures, and means to render said injectors operative, said means including two separate jacket spaces about said combustion chamber and connections through which each jacket space receives a portion of one of said liquids and delivers the vapor thereof to the corresponding injector under pressure and thereby renders said injector operative to feed its liquid to said combustion chamber at substantially more than storage tank pressure, together with separate high pressure storage tanks connected between each injector and the combustion chamber, means to render said high pressure tanks selectively and immediately operative to inject the corresponding liquid to said chamber, and a separate pressure-relief valve in the connection between each high pressure storage tank and the combustion chamber to protect the apparatus from excessive pressures developed by evaporation in said connections.

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*Robert H. Goddard, Deceased.*

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