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# FLAME THROWER

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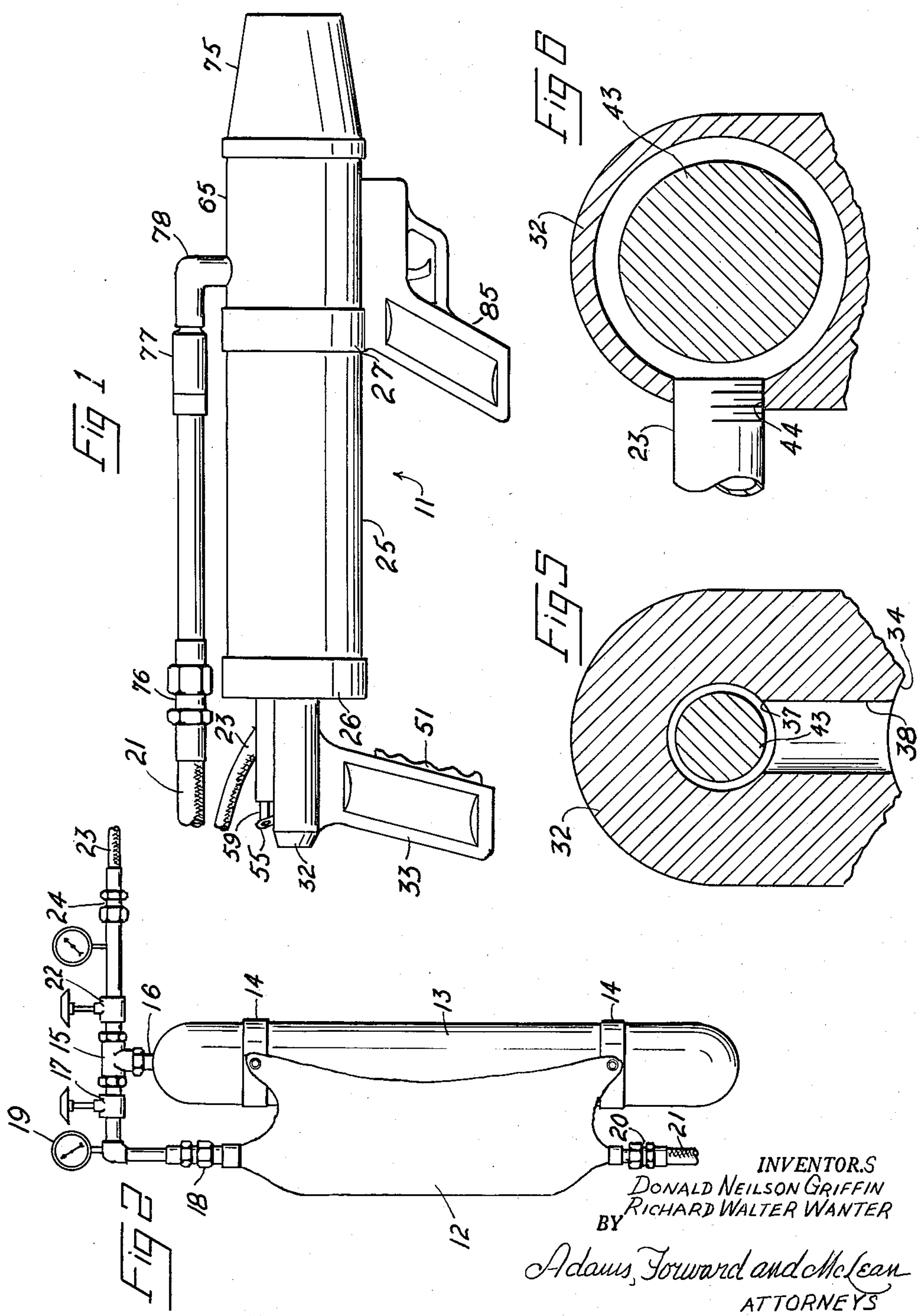


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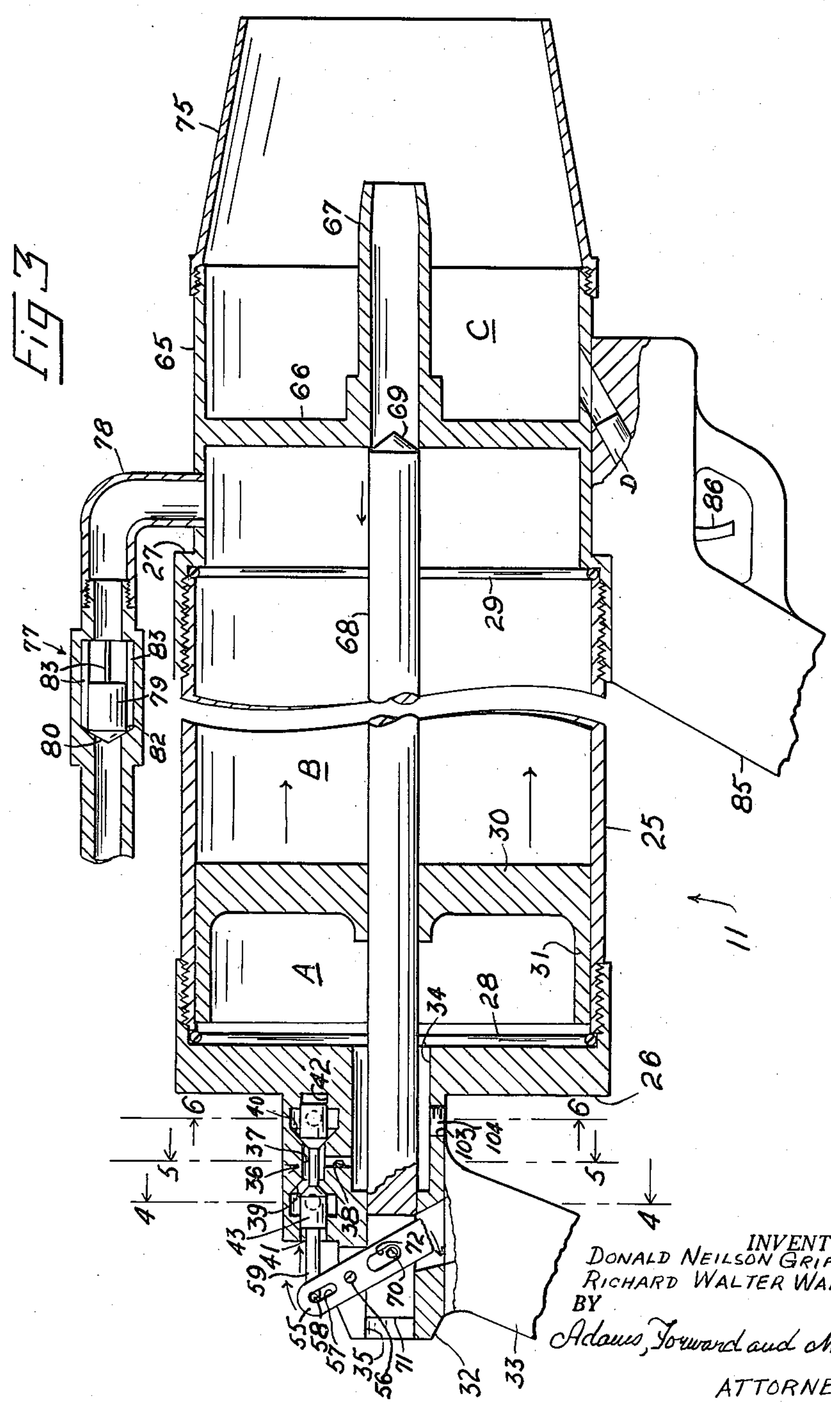


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Fig 4

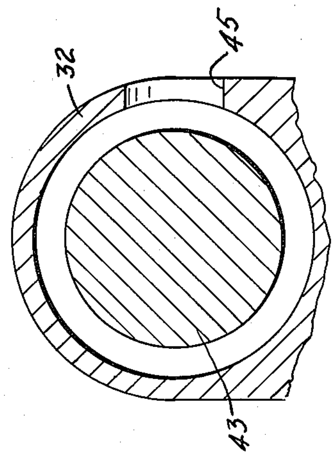



Fig 7

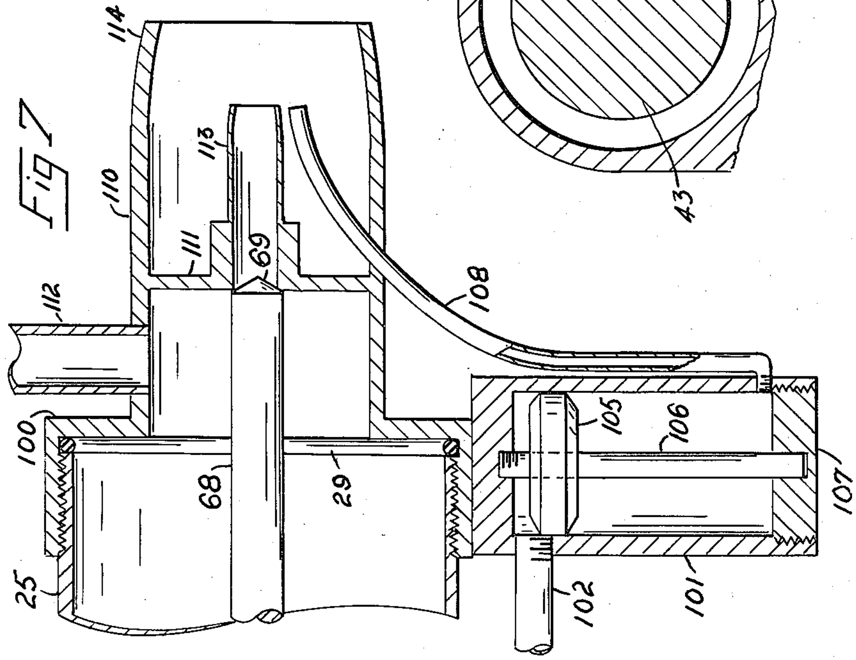
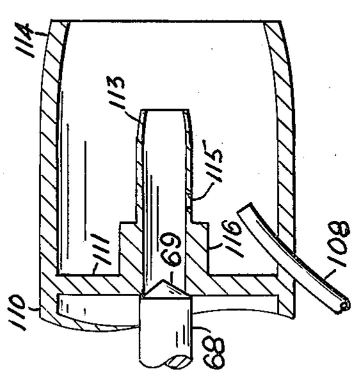



Fig 8





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# FLAME THROWER

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7 Claims. (Cl. 158—28)

This invention relates to armaments and in particular provides a fuel projector for flame throwers.

Flame throwers of conventional design employ high pressure gas to feed relatively thick, liquid fuel from storage tanks through piping and valving to project the fuel through a discharge nozzle. As a consequence in portable flame throwers a substantial portion of the equipment weight is devoted to the high pressure fuel tank and fuel lines thus limiting the total fuel which can be transported to a relatively small quantity.

It is a principal object of this invention to provide a fuel projector having separate feed and propulsion functions such that relatively low pressure propulsion is required to feed the fuel to the projector and full application of the high pressure gas in the fuel tank and fuel feed lines is avoided. Thus the fuel tank and fuel lines can be made lighter since they need withstand only relatively low pressure on the order of 10 to 50 p.s.i. rather than high projection pressures of about 300 p.s.i heretofore required. The fuel tank can even be a flexible baldder or the like instead of the conventional rigid metal tank.

Ultimately therefore, it is an important object of this invention either to reduce the size and weight of auxiliary equipment which must be carried with the flame thrower or to make available more space and weight which can be devoted to fuel storage, or a combination of both.

Another advantage of the employment of high pressure fuel projection and low pressure fuel feed which ultimately aids in reducing size and weight of the equipment is that the separate propulsion system lends itself to the employment of a liquid or solid propellant gas generator which requires less space than bottled gas conventionally used.

These and other objects and advantages of the invention are essentially obtained by a fuel projection unit which includes a fuel receiver having a reciprocable piston such that low pressure fuel feed through a check valve into the receiver at one side of the piston can be employed to load the piston. Projection is accomplished by opening a discharge nozzle on the same side of the piston and admitting high pressure propellant gas to the other side of the piston to drive the fuel from the receiver through the discharge nozzle at a high velocity.

For a more complete understanding of the practical application of the principles of the invention reference is made to the appended drawings in which:

Figure 1 is an elevational view of a fuel projector constructed in accordance with the invention;

Figure 2 is an elevational view of a suitable arrangement fuel and gas tanks for operating the projector shown in Figure 1;

Figure 3 is a vertical sectional view of the fuel projector shown in Figure 1;

Figure 4 is an enlarged cross-section taken at line 4—4 in Figure 3;

Figure 5 is an enlarged cross-section taken at line 5—5 in Figure 3;



Figure 6 is an enlarged cross-section taken at line 6—6 in Figure 3;

Figure 7 is a fragmentary section similar to Figure 3 showing an arrangement for employing a chemical igniter; and

Figure 8 is a fragmentary section similar to Figure 7 illustrating a different manner of introducing the chemical igniter to the fuel rod.

Referring to Figures 1–6 there is shown a flame thrower including a fuel projector 11, a fuel tank 12 and a high pressure gas tank 13. Preferably fuel tank 12 is a large, flexible bladder strapped on gas tank 13 as indicated by reference numerals 14 (see Figure 2). In a conventional manner tanks 12 and 13 can be provided with suspenders such that tanks 12 and 13 can be carried on the back of an operator.

Gas tank 13 is provided with a T-connection 15 at its outlet 16. On one side T-connection 15 is connected through a pressure regulating valve 17 to a fitting 18 on the upper end of fuel tank 12. A gauge 19 is provided to indicate the pressure on fuel tank 12. At its lower end tank 12 is provided with an outlet fitting 20 which is connected to a flexible fuel conduit 21. The other side of T-connection 15 is provided with a pressure regulating valve 22 in turn connected to flexible high pressure gas conduit 23. A gauge 24 is provided to indicate the gas pressure in conduit 23.

Referring more particularly to Figures 3–6 projector 11 includes a fuel and propellant receiver having the form of a cylindrical barrel 25 threadedly received at its ends by a rear end cap 26 and a forward end cap 27. Suitable O-ring gaskets 28 and 29 are employed at opposite ends of barriel 25 to assure fluid-tight seal between end caps 26 and 27 and barrel 25. A piston 30 having a cylindrical skirt 31 extending rearwardly from its outer edge is slidably positioned in contact with the inner walls of barrel 25 such that it can be reciprocated lengthwise within barrel 25. The outer surface of skirt 31 should be in fluid-tight contact with the inner walls of barrel 25. This can be achieved by the employment of resilient sealing gasket or the like where necessary.

Rear end cap 26 is provided with a rearward projection 32 from which depends a pistol grip handle 33. Internally projection 32 is provided with a cylindrical bore 34 opening into the chamber A defined in barrel 25 between end cap 26 and the rear face of piston 30. Bore 34 at its rear end opens into a bore 35 of narrower diameter which extends through the end of projection 32. Bores 35 and 34 are axially aligned with barrel 25.

Located in projection 32 above bore 34 is a two way valve 36 which includes a central bore 37 which communicates with bore 34 by means of a short vertical passage 38. At its opposite ends bore 37 is flared to form conical valve seats 39 and 40 facing each other. Beyond these are valve guide passages 41 and 42 respectively, which receive opposite cylindrical ends of a valve element 43 having a reduced central portion passing freely through bore 37 and having conical valve faces facing inwardly near its cylindrical ends. The length of the reduced central portion of valve element 43 is such that only one conical valve face can be seated at a time, one on valve seat 39 or one on valve seat 40. A port 44 opens into the space behind forward valve seat 40 and is connected to the end of flexible gas conduit 23 to communicate the interior of valve 36 with high pressure gas tank 13. A similar port 45 opening externally of projection 32 is provided in the space behind rear valve seat 39 to vent the interior of valve 36. Thus, it will be seen that when valve element 43 is withdrawn rearward, rear chamber A in barrel 25 is vented to the atmosphere but when valve element 43 is reciprocated forward, chamber A is closed to the atmosphere but communicated with high pressure gas tank **13**.

Pistol grip handle **33** is provided with a finger grip piece **51** which is reciprocable rearwardly from a spring biased forward position. A lever **55** which extends transversely through bore **34** is pivotally secured to projection **32** by means of a pin **56**. At its upper end lever **55** is provided with an elongated hole **57** which receives a pin **58** mounted on the end of a shaft **59** the other end of which is secured to valve element **43**. At its lower end lever **55** extends into a slot in finger piece **51** where it is loosely received. Thus when handle **33** is grasped and finger piece **51** is squeezed lever **55** oscillates clock-wise about pin **56** and moves valve element **43** from a position at which it is seated on seat **40**, venting chamber A, to a position at which it is seated on seat **39** communicating chamber A with high pressure tank **13**.

Forward end cap **27** carries a large cylindrical forward extension **65** which is centrally divided by a transverse partition **66**. Thus the rearward face of partition **66** and the forward face of piston **30** define a chamber B in barrel **25** and end cap extension **65**. Partition **66** is provided with a central bore and forwardly of chamber B is provided with a central extension leading from such bore forming a nozzle **67** open at the forward end and communicating at its rear end with chamber B.

A valve rod **68** having a conical forward valve tip **69** which seats at the opening of nozzle **67** into chamber B extends centrally through chambers A and B and bore **34**, and is slidably received at its rear end **71** in fluid-tight contact in bore **35**. Piston **30** is provided with a central boss having a central bore extending through piston **30** which slidably receives valve rod **68** in fluid-tight contact. The end **71** of rod **68** remote from its conical tip **69** and residing in bore **35** is slotted to receive lever **55**. A pin **70** affixed at its ends in opposite sides of slotted end **71** of rod **68** is freely received by lever **55** in an elongated opening **72**. Thus when finger piece **51** is depressed chamber A is not only communicated with high pressure tank **13** but valve rod **68** is reciprocated rearwardly to unseat its conical valve end **69** and communicate chamber B with nozzle **67**.

A truncated conical wind shield **75** is threadedly received at its larger end on the forward portion of extension **65**, enclosing nozzle **67**. Flexible fuel conduit **21** by means of coupling **76** is connected through a check valve **77** and elbow **78** to the interior of cylindrical extension **65** rearwardly of partition **66**. Check valve **77** is provided with a valve element **79** having a tapered face **80** at one end. Element **79** is positioned in the body of check valve **77** with its tapered face directed toward flexible conduit **21**, and a conical valve seat **82** is provided to receive tapered face **80** and close the valve. Suitable vanes **83** are provided to receive valve element **79** allowing only axial movement of element **79**. Thus when chamber A is vented, and hence valve **79** seated, fuel in tank **12** can flow through conduit **21** and check valve **77** to chamber B, but, when high pressure propellant gas is admitted to chamber A driving piston **30** forward, the pressure placed thereby on liquid fuel in chamber B closes check valve **77**.

The flame thrower shown in Figures 1–6 is completed by a forward pistol grip handle **85** which depends from end cap **27** and extension **65** and which is provided with a trigger **86** operably connected to a conventional pyrotechnic igniter which discharges a cartridge D into the chamber C defined in the annular space between nozzle **67** and extension **65** forward of partition **66**.

In operation air is stored in container **13** under high pressure and gasoline thickened with a suitable thickening agent, such as napalm, is placed in tank **12**. When it is desired to employ the flame thrower, valve **22** is opened to let high pressure air flow through conduit **23**. Desirably a pressure of 300 p.s.i. is employed. Valve **17** is similarly opened to pressure the fuel in tank **12**. Preferably 10 to 50 p.s.i. pressure is employed. As long as finger piece **51** remains undepressed the fuel in conduit **21** passes through check valve **77** and elbow **78** filling chamber B and forcing piston **30** to its rearward position. Air in chamber A is expelled by the rearward movement of piston **30** through vent **45**.



To fire the flame thrower trigger **86** is first squeezed to discharge an ignition cartridge D into chamber C. Immediately thereafter finger grip piece **51** is squeezed moving valve element **43** to communicate chamber A with high pressure conduit **23**. The high pressure gas entering chamber A drives piston **30** moving the fuel in chamber B forward closing check valve **77**. Since the finger piece **51** action also opens valve **69** the liquid fuel is driven through nozzle **67** and windshield **75** where it is ignited by the cartridge discharged into chamber C and is thrown from the device as a flaming rod. Releasing finger piece **51** cuts off valve **69** stopping the throw of flaming liquid fuel and at the same time closes communication between chamber A and high pressure gas tank **13**. Chamber A is also vented to the atmosphere, and the low pressure in tank **12** thereupon drives more fuel through conduit **21** and check valve **77** to refill chamber B driving piston **30** rearwardly.

While the operation of the invention has been described above with reference to use of conventional fuels and a bottled propellant gas it is evident that a solid propellant gas generator can readily be substituted for tank **13** with evident advantages in size and weight of equipment which must be transported.

In addition it is contemplated that further size reduction can be achieved using fuels of greater densities. Of particular advantages are hypergollic rocket fuels which are available in densities as high as 1.1 grams per cc. as compared with the 0.75 gram per cc. density of gasoline thickened with napalm. The advantages of a denser fuel are not only reduction in size of fuel tanks and volume of pressurizing gas, but in reduction of the volumetric flow rate of fuel which will permit reduction in size of piping or valving or otherwise permit lowering further the pressure required to feed the thickened fuel from the fuel tank to the gun. One hypergollic compound having excellent ignition characteristics is triethyltrithiophosphite which has a freezing point of −65° F. and a density of 1.1 grams per cc.

The hypergollic rocket fuels ignite spontaneously upon contact with an oxidizer. Accordingly, in order to incorporate their use in the flame thrower of this invention, provision is made, as shown in Figures 7 and 8, for ignition employing a fluid oxidizer or catalyst in place of the conventional pyrotechnic igniter. A suitable igniter fluid is $N_2O_4$ which is stable and safe for field handling. If necessary catalysts can be added to either the fuel or the oxidizer to promote ignition.

Referring specifically to Figure 7 there is shown a modification of the flame thrower of Figures 1–6 which is provided with an end cap **100** on the forward end of barrel **25**. Depending from end cap **100** is a cylindrical stub **101** which at its upper end is connected by means of a conduit **102** with bore **34**. Referring for the moment to Figure 3, it will be observed that on the underside of projection **32** there is provided a small vertical port **103** which in the modification of Figures 1–6 is closed by a plug **104**. In the present modification plug **104** is removed and conduit **102** is connected to bore **103** thus communicating the interior of the upper end of cylinder **101** with the interior of bore **34**. A piston **105** is positioned in cylinder **101** with its peripheral edges in sliding contact with the inner walls of cylinder **101**. Piston **105** is slidably mounted on a guide shaft **106** which is received in the upper end of cylinder **101**. The lower end of cylinder **101** is closed by a plug **107** which is provided with a central vertical aperture slidably receiving guide shaft **106**. Immediately above plug **107** cylinder

101 is provided with an outlet port which receives one end of an eduction tube 108.

It will be noted that end cap 100, like end cap 27, is provided with a forwardly extending hollow extension 110 which is divided along its length by a vertical partition 111 having a central opening in which conical valve tip 69 seats. The diameter of extension 110, however, is smaller than that of extension 65 which it replaces. An elbow 112 is employed to connect the interior of that portion of hollow extension 110 located between partition 111 and barrel 25 with check valve 77. Partition 111 is provided with a forwardly extended nozzle 113 leading from the opening in partition 111 which seats conical valve tip 69. Hollow extension 110 forwardly of partition 111 encloses nozzle 113 and serves as a windshield 114 for nozzle 113. Eduction tube 108 is carried externally of cylinder 101 along the forward side thereof up through an opening in the windshield 114 portion of extension 110 and terminates at its upper end immediately below the forward opening of nozzle 113.

Operation of the device of Figure 7 is much the same as the device shown in Figures 1–6 except that in loading the flame thrower plug 107 is removed while projector 11 is in an inverted position and cylinder 101 is filled with liquid oxidizer. Plug 107 is then reinserted and the device reverted to its normal position. It will be thus evident that piston 105 is raised in cylinder 101 with the oxidizer located in cylinder 101 beneath it and in communication with eduction tube 108.

When it is desired to fire the device finger piece 51 is depressed as before. This not only communicates chamber A with the high pressure gas source, but also through bore 103 and conduit 102 communicates the upper end of cylinder 101 with the high pressure gas source to drive piston 105 downwardly and force the liquid oxidizer through eduction tube 108 into the fuel rod issuing from nozzle 113 thereby igniting the fuel rod as it issues from windshield 114. Desirably the capacity of cylinder 101 for liquid oxidizer is adjusted to the capacity of storage tank 12 in order that one filling of each will last the same length of time in operation.

Figure 8 shows an alternate mode of igniting hypergollic fuel with liquid oxidizer. In Figure 8 the device is the same as in Figure 7 except that eduction tube 108 is terminated within the space in windshield portion 114 of projector 110 near the base 116 of nozzle 113, and nozzle 113 is provided with a port 115 near its base 116 and adjacent the opening of eduction tube 108. In this arrangement when the device is operated to project fuel from nozzle 113 a small side stream of fuel is forced through port 115 directly into the stream of oxidizer from eduction tube 108 producing a pilot flame within windshield 114 which carries forward and ignites the main fuel rod as it issues from nozzle 113.

We claim:

1. A liquid fuel projector for a flame thrower having a high pressure propellant gas source and a low pressure liquid fuel supply, which includes a hollow receiver, a piston slidably mounted in said receiver for reciprocation therein dividing the interior of said receiver into a fuel receiving zone located on one side of said piston and a propellant gas receiving zone located on the opposite side of said piston, a discharge outlet from said receiver connected to said fuel receiving zone, first conduit means interconnecting said low pressure liquid fuel supply and said fuel receiving zone for feeding fuel from said supply to said receiving zone, second conduit means interconnecting said high pressure propellant gas supply and said propellant gas receiving zone, first valve means having an open position and a closed position for opening and closing communication between said fuel receiving zone and said discharge outlet, second valve means having an open position and a closed position for opening and closing communication between said second conduit means and said propellant gas receiving zone, and a movable control element connected to said first valve means and connected to said second valve means, said movable control element having a normal position holding said first and second valve means in said closed positions thereof and having an actuated position holding said first and second valve means in said open positions thereof.

2. A liquid fuel projector according to claim 1 which further includes check valve means in said first conduit means to permit flow therethrough only in a direction from said supply to said fuel receiving zone.

3. A liquid fuel projector according to claim 1 which further comprises third valve means for venting said propellant gas receiving zone, said third valve means having a closed position and having a second position venting said propellant gas receiving zone, said control element being connected to said third valve means holding said third valve means in said second position thereof in said normal position of said control element and holding said third valve means in said closed position thereof in said actuated position of said control element.

4. A liquid fuel projector according to claim 1 which further comprises a liquid igniter receiver, eduction means connected to said liquid igniter receiver and terminating adjacent said discharge outlet, means for propelling liquid igniter retained in said liquid igniter receiver through said eduction tube operably connected to said control means for actuation thereby when said control means is actuated to open said first and second valve means.

5. A liquid fuel projector according to claim 4 in which said eduction tube terminates adjacent the outlet end of said discharge outlet.

6. A liquid fuel projector according to claim 4 in which said eduction tube terminates adjacent the base of said discharge outlet and in which said discharge outlet further includes a port adjacent the base thereof and the terminal end of said eduction tube.

7. A liquid fuel projector for a flame thrower having a high pressure propellant gas source and a low pressure liquid fuel supply which includes a closed hollow receiver, a piston transversely positioned and slidably mounted in said receiver for reciprocation lengthwise therein and dividing the interior thereof into a fuel receiving zone located on one side of said piston and a propellant gas receiving zone located on the opposite side of said piston, a discharge outlet from said receiver, a port in said receiver positioned at the end thereof on the fuel receiving zone side of said piston communicating with said discharge outlet and said fuel receiving zone, said port including means defining a valve seat thereabout facing said fuel receiving zone, a valve rod positioned lengthwise in said receiver slidably extending through said piston in fluid-tight contact therewith and reciprocable lengthwise in said receiver between a first position at which one end of said valve rod is seated on said valve seat closing said port and a second position at which said end is withdrawn into said fuel receiving zone opening said port, the other end of said valve rod slidably extending in fluid-tight contact through the end of said receiver on the propellant gas receiving side of said piston, first conduit means connected to said receiver communicating with said fuel receiving zone for inter-connecting said low pressure fuel supply and said fuel receiving zone and including a check valve to permit flow through said conduit only in a direction from said supply to said fuel receiving zone, a two-way valve mounted on said receiver adjacent the end thereof on the propellant gas receiving side of said piston having an outlet port leading into said propellant gas receiving zone and having a first inlet port and a second inlet port leading to the exterior of said receiver and operable between a first position at which said first inlet port and said outlet port are inter-connected and a second position at which said second inlet port and said outlet port are inter-connected,

second conduit means connected to said second inlet port of said two-way valve communicating with said propellant gas receiving zone for inter-connecting said propellant gas source and said propellant gas receiving zone, and a common control device operably connected to said valve rod and said two-way valve having a normal position holding said valve rod and said two-way valve in their respective first positions and actuable to change said valve rod and said two-way valve to their respective second positions simultaneously.

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