Oct. 12, 1943. W. C. GRAHAM 2,331,388

FLAME THROWING EQUIPMENT

Filed March 21, 1942 2 Sheets-Sheet 1

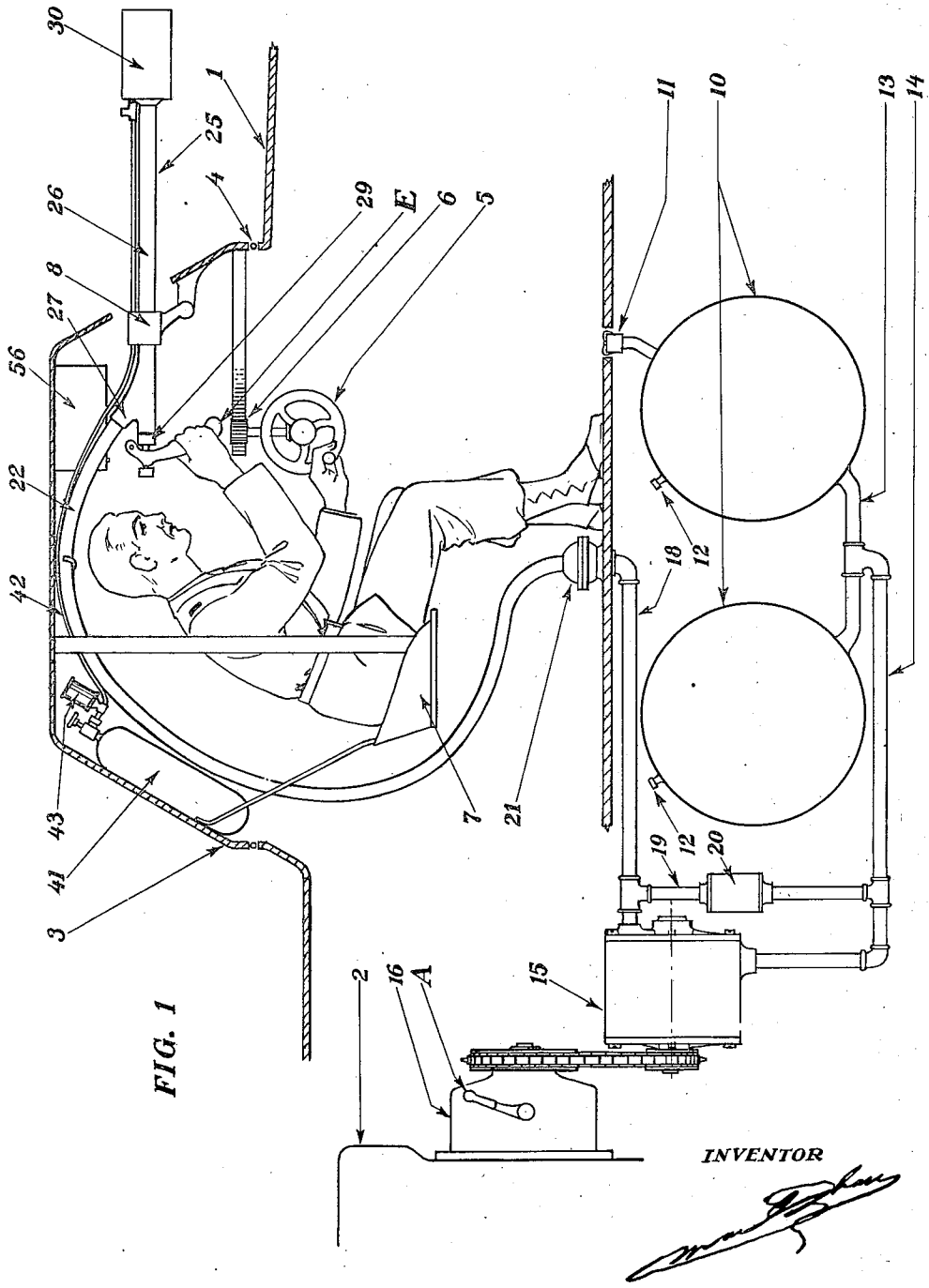

FIG. 1

INVENTOR

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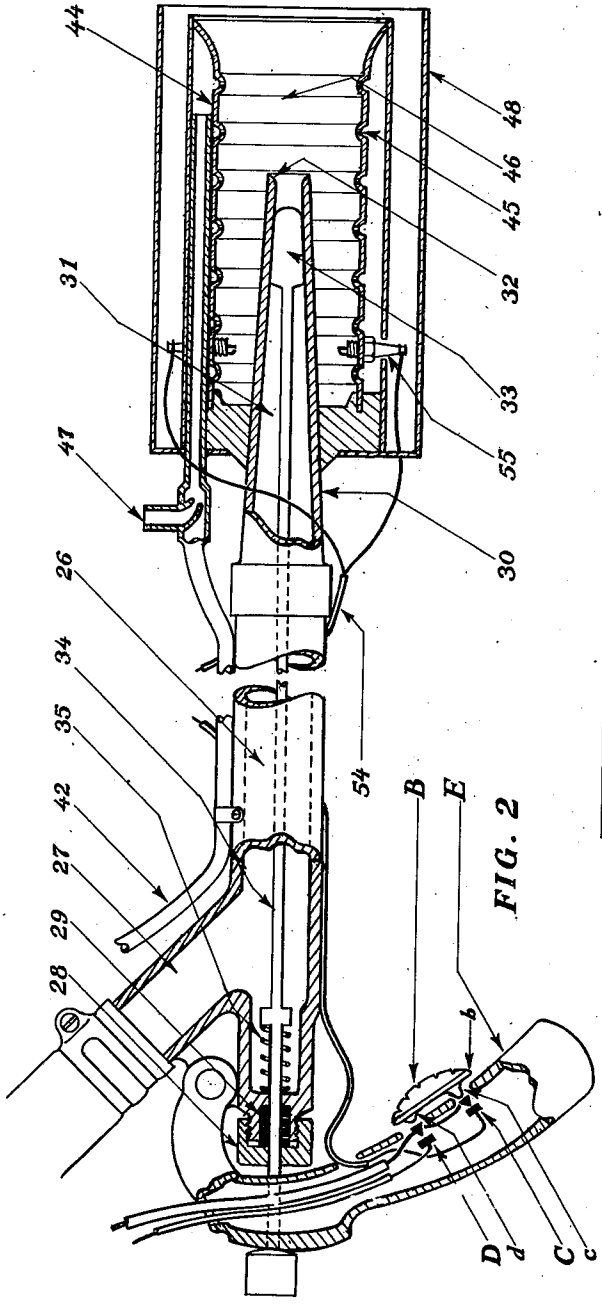

FIG. 2

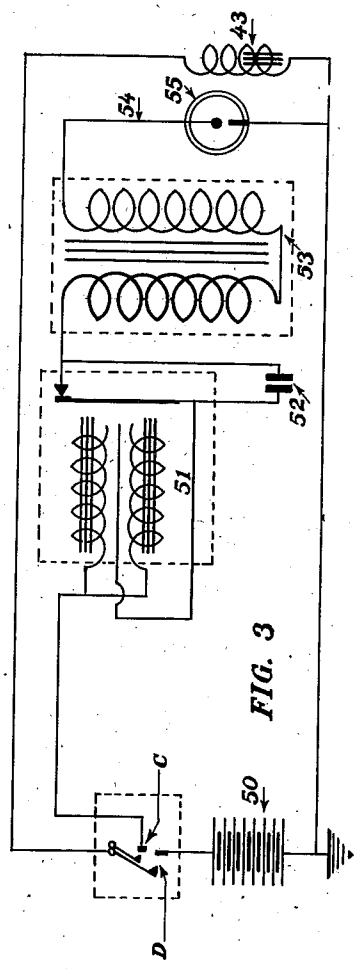

FIG. 3

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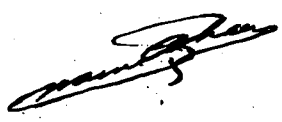

Patented Oct. 12, 1943

2,331,388

UNITED STATES PATENT OFFICE

2,331,388

FLAME THROWING EQUIPMENT

Warren C. Graham, New York, N. Y., assignor to First Bank and Trust Company, Perth Amboy, N. J., and Reconstruction Finance Corporation, New York, N. Y., a corporation of the United States

Application March 21, 1942, Serial No. 435,595

8 Claims. (Cl. 158—28)

This invention relates to flame throwers as used in warfare, and more particularly to flame throwing equipment for tanks and other combat vehicles.

This application is a continuation-in-part of my copending applications for U. S. Letters Patent Serial Nos. 432,443 and 435,015, respectively.

It is an object of this invention to provide flame throwing equipment for tanks and the like having an improved ignition system.

It is a further object of the present invention to provide flame throwing equipment for tanks and the like having an improved fuel ejection system.

It is still another object of this invention to provide flame throwing equipment for tanks and the like having an improved control system.

It is a still further object of this invention to provide flame throwing equipment for tanks and the like facilitating firing in any and all directions.

It is still another object of the invention to provide flame throwing equipment for tanks and the like equally well adapted for use in existing tanks as for installation in tanks under construction.

Other objects, and the manner in which the same are attained, will appear from the following description.

Broadly, the invention involves flame throwing equipment for tanks and other combat vehicles including ignition gas and electrical spark ignition systems yielding superior performance in any desired direction.

More specifically, the invention involves flame guns including an ignition gas system, an electrical spark ignition system; an electrical control system; a dripless fuel nozzle eliminating distortion of the fuel stream; a shield to prevent the flame from coming back upon the operator; and other features more fully described below.

In the drawings affixed to this specification and forming part thereof several embodiments of the invention are shown diagrammatically by way of example.

In the drawings,

Fig. 1 is a side view, partly in section, of part of a combat tank including flame throwing equipment;

Fig. 2 is a side view, partly in section, of the flame gun of Fig. 1;

Fig. 3 is a wiring diagram of the electrical ignition and control systems according to Fig. 1.

Referring now to the drawings, wherein like elements are designated by like symbols of reference, and first to Fig. 1, this shows the outline of a combat tank comprising, as part of its standard equipment, a body 1, an engine 2 in the rear part of the tank body, a revolving turret 3 supported on ball bearings 4 to be rotated, by means of hand wheel 5 and spur gear 6, in a complete 360° arc, a seat 7 arranged for rotation with the turret, and a swivel joint support 8 designed to mount a gun in the turret.

Two fuel tanks 10 equipped with a fill pipe closed by a cap 11, air vents 12 and a fuel pipe header 13, are arranged in the body 1. From the fuel pipe header 13, a fuel pipe 14 extends to the intake of a pump 15 which may be a pump of the rotary type. This pump is arranged in the body 1 to be driven by the engine 2 through a clutch 16 controlled by the manually operated clutch control lever A. The pump discharges fuel into the fuel discharge pipe 18, which is connected with the fuel pipe 14 by a by-pass 19 controlled by an automatic by-pass control valve 20. The fuel discharge pipe 18 terminates in the bottom part of a swivel joint 21. The top part of this swivel joint 21 is at the end of a fuel pipe 22 secured to the turret 3 for rotation therewith, and extending along the top of the turret to the flame gun 25 mounted in the gun mount 8, at least a part of fuel pipe 22 being flexible to permit movement of the flame gun in mount 8.

As best seen in Fig. 2, the flame gun 25 comprises a shaft 26 having a fuel inlet 27 and being closed, at one end, by a closure 28 including packing 29 for a purpose to be described below. The other end of shaft 26 carries the fuel nozzle 30.

The fuel nozzle 30 includes, in its interior, a converging part 31 and a short diverging orifice 32, forming a venturi. A tapered plug 33 is arranged in the converging part to control the passage of fuel through the venturi, this plug being mounted on a rod 34 passing through the packing 29 and out of the shaft 26 to the fuel control lever E to which it is secured for longitudinal displacement thereby. Normally, the plug 33 is pressed against its seat in the venturi by a spring 35. The position of the plug 33 when in open position may be adjusted to suit prevailing requirements, and to yield optimum performance. For best results, the converging part of the venturi should converge at an angle of approximately 30°. The interior of the nozzle should be highly polished for maximum efficiency.

The fuel nozzle is one of the most important elements of any flame throwing unit as its design is instrumental in determining the distance the flame is thrown. One of the purposes of a noz-

zle is to reduce the passage of fuel from the size of the supply pipe down to a sufficiently narrow orifice so that a given amount of fuel may be ejected without being exposed to any distortion. For, if any eddy currents are set up in the fuel stream during the passage from the supply pipe to the nozzle orifice, the fuel stream is distorted and in this condition, does not carry as far as an undistorted stream discharged from a nozzle eliminating distortion. Another important consideration is the type of equipment on which the fuel nozzle is to be employed. Evidently, any drippage that may occur in other types of equipment without harmful effects, should be eliminated in the case of combat tank equipment, where the results of drippage might be very undesirable.

The provision, in the fuel nozzle according to this invention, of a venturi of the type described completely eliminates the occurrence of any eddy currents in the fuel stream, and thus assures undistorted fuel ejection and, consequently, effectiveness of the flame throwing equipment over a materially greater distance than was heretofore obtainable. Moreover, the provision of the adjustable plug in front of the venturi restriction, permits control of the fuel while it passes through the nozzle, and an immediately effective shut-off of the fuel when ejection is to be terminated, thus eliminating any harmful drippage from the nozzle.

Existing flame throwers, in the main, employ either one of two types of ignition. Most of the flame throwers used today in Europe employ a fine resistance wire heated up for ignition purposes. This resistance wire type of ignition system suffers from the disadvantage that after it has been used once, oil is deposited on the wire to form a film or coating thereon. The next time the ignition is operated, this film or coating must first be burned off before effective ignition occurs, this removal of the oil deposit requiring as much as one minute. The fact that the operator is required to wait for the film to burn off the resistance wire before ignition occurs, and this for a considerable period of time, renders the use of flame throwing equipment of this type undesirable and even dangerous. Other flame throwers like the French type employ an improvised cigarette lighter for ignition purposes. This lighter cannot be relied upon at all times, particularly not if there is a strong wind. This lighter would prove unreliable to the extreme, if not inoperative, in connection with equipment contemplated for use on combat tanks and the like, as presently disclosed, where the draft caused by the advance of the vehicle would be apt to prevent ignition of this type from functioning.

The present invention utilizes the ignition system disclosed in my aforementioned copending applications for U. S. Letters Patent which assures immediate and reliable ignition at all times and under any conditions, and which, if adapted to prevailing requirements as described below, is as effective a part of combat tank equipment as it is in connection with other types of flame throwers. This ignition system operates on the electric spark principle and comprises ignition gas and electrical ignition equipment.

As shown in Figs. 1 and 2, the ignition gas equipment comprises an ignition gas cylinder 41 containing an ignition gas such as butane, for example, under pressure, such as a pressure of about from 1800 to 2000 lbs. per square inch, and an ignition gas pipe 42 controlled by the ignition gas control solenoid valve 43 and extending from the gas cylinder 41, along the shaft 26 of the flame gun, to the jacket 44 where it opens to admit ignition gas, through holes 45, into the gas chamber 46 surrounding the fuel nozzle 30. Part at least of the ignition gas supply conduit 42 is made flexible to permit movement of the flame gun 25 in its mount 8. An air intake 47 is provided to assist in the formation of a combustible mixture which is ignited at the spark plugs, as described below.

The jacket 44 enclosing the gas chamber 46 is, in turn, surrounded by a tube-shaped shield 48 which is spaced from the jacket and closed at the end facing the vehicle, to prevent a back draft when the tank is moving against the wind and to prevent the flame from coming back upon the occupants of the vehicle.

The ignition gas control solenoid valve 43 is adapted to reduce the pressure of the gas from the variable gas cylinder pressure to a constant working pressure, and, preferably, is of the type of the trigger valve disclosed in my aforenoted copending application for U. S. Letters Patent Serial No. 432,443, comprising two interconnected valves, one controlling the passage of the gas from the inlet, through a narrow, pressure reducing, bore, to the outlet of the valve, while the other seals the stem of the valve during such passage of the gas.

Fig. 3 shows the electrical equipment, including the electrical ignition system and the electrical control of the ignition gas system, both operating on the battery 50.

The electrical ignition system comprises a primary circuit including an interrupter or buzzer 51; a condenser 52 associated with the interrupter; the primary windings of a high-tension transformer 53 producing, for example, from 10,000 to 12,000 volts; and a push-button type switch C controlling the spark generation. The secondary circuit of the electrical ignition system comprises the secondary windings of the high tension transformer 53, the high-tension ignition wire 54 and two spark plugs 55, also seen in Fig. 2.

The electrical control of the ignition gas system includes, apart from the battery 50 and the ignition gas control solenoid valve 43, a push-button type switch D.

The bulk of this electrical equipment is contained in the box 56 mounted in the turret, as shown in Fig. 1. The push-buttons C and D are arranged on the fuel control lever E as seen in Fig. 2.

As further shown in Fig. 2, an ignition master control lever B may be arranged on the fuel control lever E whereby to operate both push-buttons but so that C is pressed down first, and D is pressed down only thereafter, to assure that sparks are being generated prior to release of the ignition gas. This control B is similar to the safety trigger disclosed in my aforenoted copending application for U. S. Letters Patent Serial No. 432,443 and comprises a lever part *b* arranged, for rocking motion, on the fuel control lever E, and two pins *c* and *d* projecting, opposite the push-buttons C and D, from the lever part *b*, pin *c* being longer or projecting more than pin *d* so that, when the lever part *b* is pressed down, push-button C, controlling the electric spark generation, is pressed down first, while push-button D, controlling the ignition gas supply is pressed down only afterward when it makes contact with the shorter pin *d*.

If desired, a safety lock as disclosed in my copending application for U. S. Letters Patent Serial No. 432,443 may be incorporated in the ignition master control lever B.

The provision of the ignition gas system, the electrical ignition system and the electrical ignition gas control system in the turret eliminates the need for any sliding contacts as all these systems rotate with the turret. The arrangement of the ignition master control lever on the fuel control lever concentrates control of the entire equipment in one place where, once the clutch control is operated to prepare the unit for firing, all controls may be actuated easily with one hand, the other being free to rotate the turret in any desired direction.

The operation of the flame throwing equipment according to Figs. 1, 2 and 3 is as follows: The fuel tanks 10 are filled through the fill pipe after removal of cap 11, air escaping through the vents 12. When preparing for battle, the operator actuates the hand lever A to throw in the clutch 16. The pump 15 now idles, the fuel discharged into the fuel pipe 18 being returned to the fuel pipe 14 through the automatic by-pass valve 20 which is adjusted to remain open until the fuel is discharged through the fuel nozzle 30 in the flame gun.

When ready to open fire, the operator depresses the ignition master control lever B so as to first actuate, through push-button C, the spark ignition, and only thereafter, through push-button D, the ignition gas control solenoid valve 43, releasing ignition gas, through the ignition gas pipe 42, into the jacket 44, where the ignition gas mixes with air entering through the air intake 47 to form a combustible gas mixture which, through holes 45, enters the gas chamber 46 to be ignited at the spark plugs 55.

Now, the fuel control lever E is pulled back so as to remove the plug 33 from its seat in the fuel nozzle venturi. This results in the automatic closing of the by-pass regulating valve 20, and in the passage of fuel through the fuel pipe 22 into the flame gun where it is discharged from the fuel nozzle 30 to be ignited, by contact with the flaming ignition gas-air mixture, at some distance from the flame gun. The ignition master control lever B is then released. When shots are fired at intervals, levers B and E are operated intermittently.

To terminate operation permanently, lever E is permitted to be retracted by the spring 35 whereby plug 33 closes the venturi in the fuel nozzle so as to prevent any drippage of fuel from the nozzle. Disengagement of the clutch by operation of hand lever A finally renders the flame throwing equipment inoperative.

The ignition gas preferred in connection with the present invention is butane, but any other highly inflammable gas such as hydrogen, acetylene or propane, for example, may be used.

A wide range of fuel may be used in the flame throwing equipment according to this invention. Preferably the fuel oil should contain high volatile fractions to assist the ignition of the fuel, and low volatile fractions to provide slow burning and range.

The electrical or remote control system controlling the ignition gas control valve 43 may be extended to control any or all remaining control members. Similarly, this system may be omitted and valve 43 may be manually controlled if desired.

The flame throwing equipment according to this invention offers numerous advantages.

The gas and electrical spark ignition is a material improvement over the resistance or cigarette lighter type of ignition systems in being far more reliable, quicker acting and safer than these old systems. The introduction of air into the gas jacket aids in providing a sufficiently rich mixture. The electrical ignition gas control, and the master ignition control are effective means of providing an immediate supply of ignition gas when needed and of assuring operation of the electrical ignition and the ignition gas system one after the other and in this order so sparks are being generated prior to release of the ignition gas. The shield surrounding the gas chamber prevents the flame from coming back upon the occupants of the vehicle.

Evidently, various features of the invention may be used individually instead of combined, according to prevailing requirements. While of particular utility in connection with combat tanks and the like, the invention may be applied to other, and in particular, stationary installations such as pill boxes and other strong points and fortifications.

I wish it to be understood that I do not desire to be limited to the exact details of design and construction shown and described as various modifications within the scope of the appended claims will readily suggest themselves to a person skilled in the art.

I claim:

1. A flame gun, particularly adapted for use in armored tanks, comprising in combination, a flame gun barrel, a nozzle for discharging a stream of fuel under pressure at the end of said barrel, an ignition gas system including a gas chamber surrounding and spaced from said nozzle, said gas chamber being provided with openings to establish communication between said chamber and the space around the nozzle, and an electric spark ignition system including electrodes extending through said chamber and into the space between the nozzle and the chamber.

2. A flame gun, particularly adapted for use in armored tanks, comprising in combination, a flame gun barrel, a nozzle for discharging a stream of fuel under pressure at the end of said barrel, an ignition gas system including a gas chamber surrounding and spaced from said nozzle and extending materially beyond the discharge end of said nozzle, said gas chamber being provided with openings to establish communication between said chamber and the space around the nozzle, and an electric spark ignition system including electrodes extending through said chamber and into the space between the nozzle and the chamber.

3. A flame gun, particularly adapted for use in armored tanks, comprising in combination, a flame gun barrel, a nozzle for discharging a stream of fuel under pressure at the end of said barrel, an ignition gas system including a gas chamber surrounding and spaced from said nozzle and extending materially beyond the discharge end of said nozzle, said gas chamber being provided with openings to establish communication between said chamber and the space around the nozzle, and an electric spark ignition system including electrodes arranged rearwardly of said discharge end of the nozzle and extending through said chamber and into the space between the nozzle and the chamber.

4. A flame gun, particularly adapted for use

in armored tanks, comprising in combination, a flame gun barrel, a nozzle for discharging a stream of fuel under pressure at the end of said barrel, an ignition gas system including a gas chamber surrounding and spaced from said nozzle, said gas chamber being provided with openings to establish communication between said chamber and the space around the nozzle, a shield surrounding said chamber in spaced relation thereto but sealed with respect thereto at the end facing the operator, and an electric spark ignition system including electrodes extending through said chamber and into the space between the nozzle and the chamber.

5. A flame gun, particularly adapted for use in armored tanks, comprising in combination, a flame gun barrel, a nozzle for discharging a stream of fuel under pressure, at the end of said barrel, an ignition gas system including a gas chamber surrounding and spaced from said nozzle, and extending materially beyond the discharge end of said nozzle, said gas chamber being provided with openings to establish communication between said chamber and the space around the nozzle, an ignition gas pipe leading into said gas chamber and an air inlet tube extending into said pipe outside said gas chamber, and an electric spark ignition system including electrodes extending through said chamber and into the space between the nozzle and the chamber.

6. A flame gun, particularly adapted for use in armored tanks, comprising in combination, a flame gun barrel, a nozzle for discharging a stream of fuel under pressure at the end of said barrel, said nozzle comprising a long converging part and a short diverging orifice, means for controlling the discharge from said nozzle arranged in close proximity to said orifice whereby to prevent dripping, an ignition gas system including a gas chamber surrounding and spaced from said nozzle and extending materially beyond said orifice, said gas chamber being provided with openings to establish communication between said chamber and the space around the nozzle, and an electric spark ignition system including electrodes extending through said chamber and into the space between the nozzle and the chamber.

7. A flame gun, particularly adapted for use in armored tanks, comprising in combination, a flame gun barrel, a nozzle for discharging a stream of fuel under pressure at the end of said barrel, said nozzle comprising a diverging orifice and means for controlling the discharge from the nozzle arranged in close proximity to said orifice whereby to prevent dripping, a nozzle control lever for operating said discharge control means, an ignition gas system including a gas chamber surrounding and spaced from said nozzle, said gas chamber being provided with openings to establish communication between said chamber and the space around the nozzle, an electric spark ignition system including electrodes extending through said chamber and into the space between the nozzle and the chamber, and ignition gas and electric spark control means, including means mounted on said nozzle control lever and adapted to first operate said electric spark ignition system, and only thereafter said ignition gas system.

8. A flame gun, particularly adapted for use in armored tanks, comprising in combination, a flame gun barrel, a nozzle for discharging a stream of fuel under pressure at the end of said barrel, said nozzle comprising a diverging orifice and means for controlling the discharge from the nozzle arranged in close proximity to said orifice whereby to prevent dripping, a nozzle control lever for operating said discharge control means, an ignition gas system including a gas chamber surrounding and spaced from said nozzle, said gas chamber being provided with openings to establish communication between said chamber and the space around the nozzle, an electric spark ignition system including electrodes extending through said chamber and into the space between the nozzle and the chamber, ignition gas and electric spark control means including means mounted on said nozzle control lever for first operating said electric spark ignition system, and only thereafter said ignition gas system, and means for locking said operating means except during operation of the flame gun.

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