United States Patent

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[72] Inventors **Karl-Heinz Stahl**
Zum Saibling 20, 7773 Nussdorf, Bodensee;
Fritz M. Fend, Thurmayrstrasse 11, 84 Regensburg, Germany

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[73] Assignee **said Fend assignor to said Stahl**
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[33] **Germany**
[31] **P 17 57 005.7 and P 17 82 076.7**

[54] **SPRAYING APPARATUS**
10 Claims, 9 Drawing Figs.

[52] **U.S. Cl.** **239/135,** 239/129, 239/303
[51] **Int. Cl.** **B05b 1/24**
[50] **Field of Search** ..... 239/129, 135, 137, 152, 154, 304, 335, 407, 410, 411, 413, 124, 125; 251/73, 94, 624.27; 431/(no search)

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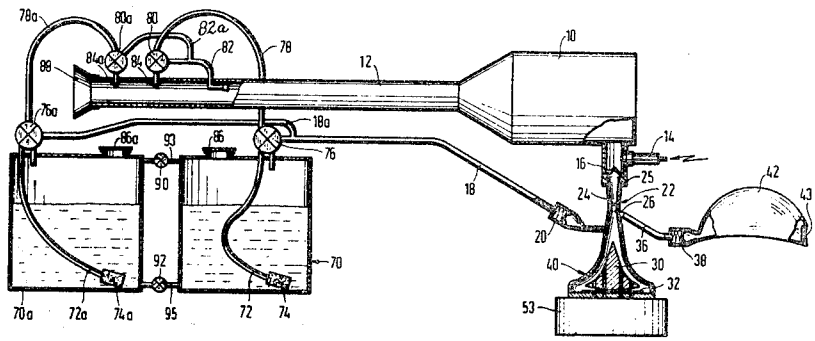
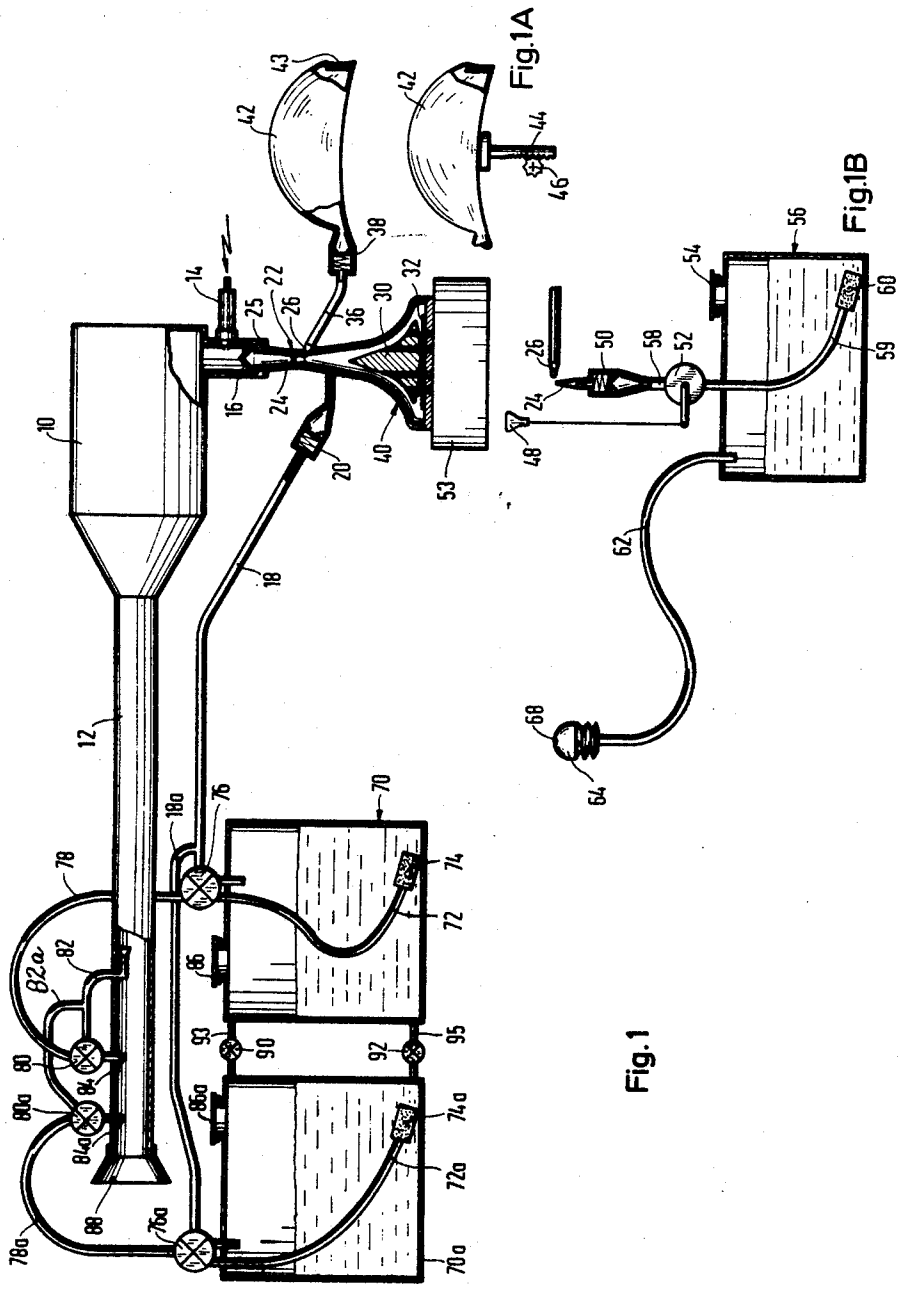
Primary Examiner—Lloyd L. King
Assistant Examiner—Edwin D. Grant
Attorney—Low & Berman

ABSTRACT: In a spraying apparatus in which a liquid is atomized in a pulsating stream of combustion gas discharged from a combustion chamber equipped with a carburetor for use of liquid fuel, a valve is interposed between the tank for the sprayed liquid and an atomizing nozzle in the exhaust pipe of the combustion chamber and is automatically closed when the pressure in the exhaust pipe is reduced below the value normally maintained by the stream of combustion gas, thus shutting off the flow of spray liquid to the hot exhaust pipe when the liquid could flow backwards into the combustion chamber or burn the operator.





INVENTORS.
Karl-Heinz Stahl
Fritz M. Fend
By: Low and Berman
AGENTS

Fig.3

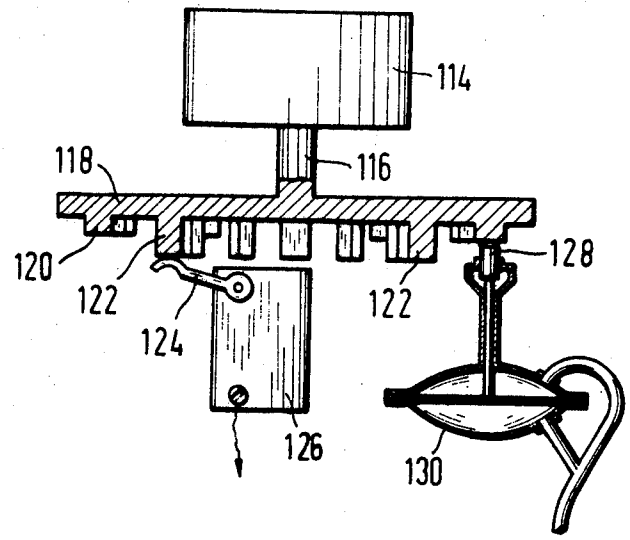


Fig.2

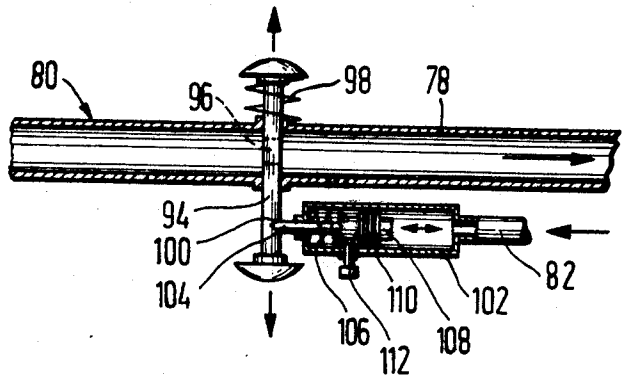
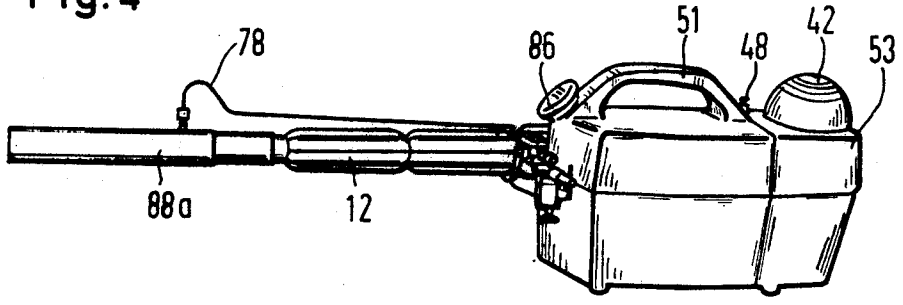


Fig.4



INVENTORS.
Karl-Heinz Stahl
Fritz M. Fend
By: Law and Berman
AGENTS

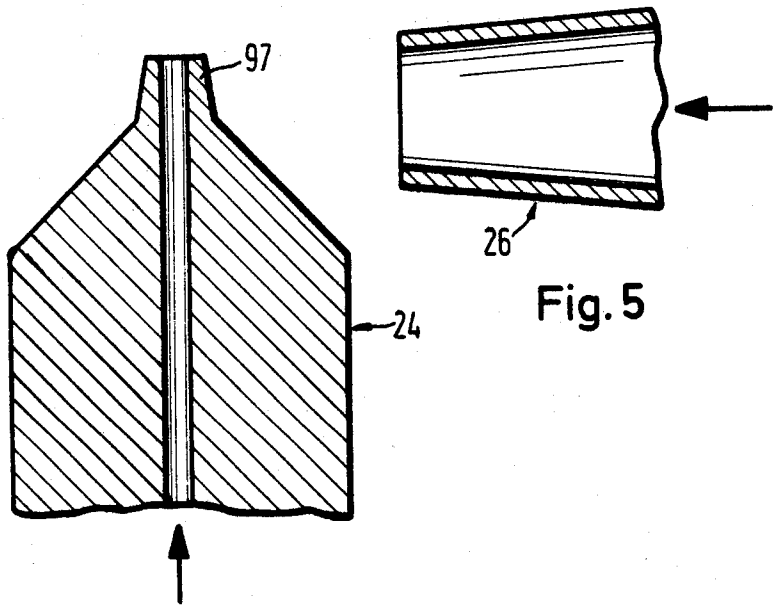


Fig. 5

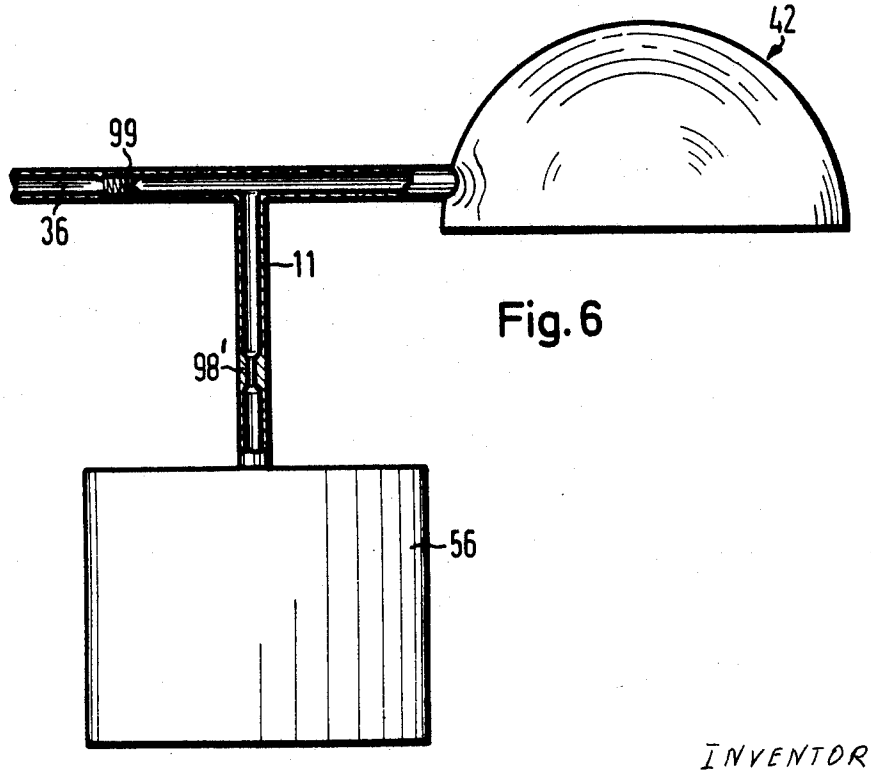


Fig. 6

INVENTORS.
Karl-Heinz Stahl
Fritz M. Fend
By: Low and Berman
AGENTS

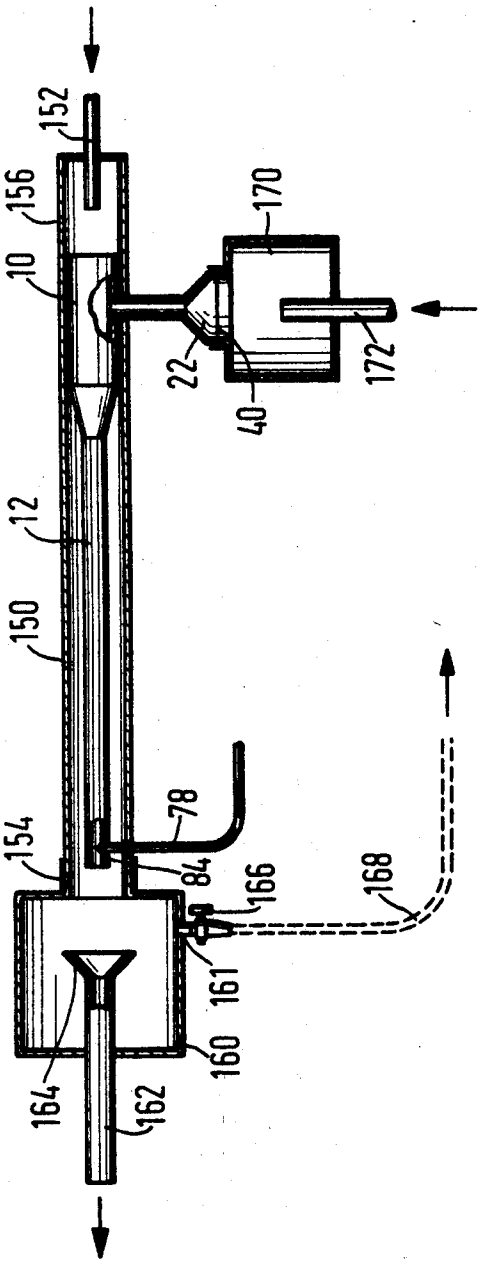


Fig. 7

INVENTORS.
Karl-Heinz Stahl
Fritz M. Fend
By: Low and Berman
AGENTS

SPRAYING APPARATUS

This invention relates to spraying apparatus, and particularly to improvements in a known type of spraying apparatus in which a liquid to be sprayed is dispersed in a pulsating stream of hot combustion gas.

Spraying apparatus of the type described is widely used in agriculture and may be employed for spraying herbicidal liquids or ignited combustible liquids in the manner of a flamethrower. The known apparatus commonly includes a combustion chamber, a carburetor connected to the same for supplying a combustible mixture of a liquid fuel with air of combustion, an ignition device for igniting the mixture, an exhaust pipe connected to the chamber for discharging the combustion gas in a stream, a source of liquid fuel for the carburetor, a tank adapted to hold the liquid to be dispersed in the combustion gas for spraying thereby, an atomizing nozzle in the exhaust pipe, a conduit connecting the tank to the nozzle, a shutoff valve in the conduit, and operating means for operating the valve. After it has been started, the known apparatus draws sequential pulses of air and corresponding small batches of fuel into the carburetor, the resulting bodies of combustible mixture are sequentially burned in the chamber, and the pulsating stream of exhaust gas atomizes the liquid to be sprayed as a fog or as a flame.

If combustion ceases in the known apparatus for any reason, the liquid to be sprayed continues to be fed to the hot exhaust pipe. It may flow from the open end of the exhaust pipe without being projected away from the operator, and thus cause injury to the operator. It may also flow back into the combustion chamber or even into the carburetor and be converted by the prevailing heat to baked-on coatings which are difficult to remove and interfere with operation of the apparatus unless removed.

It has been found that the reliability and safety of a spraying apparatus of the type described can be increased substantially by automatic operation of the valve conventionally provided between the tank for the spraying liquid and the atomizing nozzle in the exhaust pipe. A sensing mechanism senses the pressure normally generated in the exhaust pipe by the stream of combustion gas, and a closing device is connected to the sensing mechanism and responds to a reduction of the sensed pressure to a set or predetermined minimum for closing the valve.

In a preferred embodiment, the closing device includes a resilient biasing member which biases the valve toward the closed position, and a latch which may be engaged with the valve for holding the same in the open position against the force of the biasing member. The latch is connected to the sensing mechanism for releasing the engaged valve when the sensing mechanism senses the set pressure minimum.

The valve is additionally equipped for manual opening and closing. The sensing mechanism may include a cylinder communicating with the exhaust pipe, a piston exposed in the cylinder to the pressure of the combustion gas which tends to move the piston in a certain direction, and a spring which opposes such movement with a carefully chosen force. The latch is connected to the piston for movement therewith.

Other features and many of the attendant advantages of this invention will readily become apparent from the following detailed description of preferred embodiments when considered in connection with the appended drawing in which:

FIG. 1 shows the principal operating elements of a spraying apparatus of the invention in side elevation, and partly in section;

FIG. 1A shows a portion of the apparatus of FIG. 1 in a corresponding view;

FIG. 1B shows elements of the spraying apparatus not visible in FIG. 1 in elevational view, and others also shown in FIG. 1 in the disassembled condition;

FIG. 2 shows a portion of the apparatus of FIG. 1 in an enlarged sectional view;

FIG. 3 shows a modified starting mechanism for the apparatus of FIG. 1 in partly sectional elevation;

FIG. 4 shows the assembled spraying apparatus in a perspective view;

FIG. 5 shows elements of the apparatus of FIG. 1 in greatly enlarged, fragmentary plan view;

FIG. 6 shows portions of yet another starting mechanism for the apparatus of FIG. 1 in elevation, and partly in section; and

FIG. 7 illustrates a modification of the apparatus of FIG. 1 in fragmentary side-elevational section.

Referring now to the drawing in detail, and initially to FIG. 1, there are shown the principal operating elements of an apparatus of the invention for spraying an atomized liquid by means of combustion gases generated in a combustion chamber 10, and discharged from the chamber through a straight, cylindrical exhaust pipe 12. A combustible mixture of a liquid fuel and air is supplied to the chamber 10 from a carburetor 22 which is essentially a tube having a converging intake section 40 and a diverting discharge section connected to the intake nipple of the chamber 10.

A fuel nozzle 24 has its discharge orifice in the throat of the carburetor, and a nozzle 26 for starting air is located in the nozzle slightly upstream from the fuel nozzle 24 and is directed into the throat at an angle of 45° to the carburetor axis and toward the orifice of the nozzle 24, as is seen in FIG. 5. The portion of the nozzle 24 which projects into the carburetor throat tapers frustoconically at an apex angle of about 90° to a free tip 97, also tapering but at an apex angle of less than 30°. The air nozzle 26, whose bore is much wider than the capillary bore of the fuel nozzle 24 directs the stream of discharged air against both conically tapering surfaces of the nozzle 24, an arrangement which has been found to produce most effective fuel atomization under the starting conditions of the spraying apparatus.

The diverging part of the carburetor terminates in a sharply angular, circular edge 25. Liquid deposited from the fuel mixture on the walls of the carburetor is driven by the rapidly moving fluid toward the edge 25, and is dispersed in droplets in the stream as it is driven from the edge. A conical screen or grid 16 is arranged in the entrance of the intake nipple for better uniformity of the fuel mixture and for preventing backfiring from the combustion chamber into the carburetor.

The funnel-shaped intake section 40 is located behind an apertured wall of the sprayer casing 53, only schematically indicated in FIG. 1, and the air supply may be adjusted by means of a valve plate 32 mounted on a conical baffle 30 in the section 40 that can be moved toward and away from the casing wall, and fastened in the adjusted position in a manner conventional in itself, and not shown in the drawing.

As is better seen in FIG. 4, the casing 53 carries on its outer top face a rubber bulb 42. As is shown in FIG. 1, the bulb is equipped with a suction valve 43 and connected with the air nozzle 26 by an air line 36 closed by a check valve 38 unless the pressure in the bulb 42 exceeds the pressure in the carburetor. As is seen in FIG. 1A, the bottom of the bulb 42 abuts against a rack 44 which meshes with a drive pinion 46 on the operating shaft of a make-and-break ignition of the type seen in FIG. 3 at 126, but omitted from the showing of FIG. 1A. When the bulb 42 is alternatingly squeezed and expanded, the pinion 46 oscillates about its axis to supply ignition voltage to a spark plug 14 in the intake nipple of the combustion chamber 10.

Fuel is supplied to the nozzle 24 from a tank 56 through a fuel line 58 whose lower end 59 is flexible and held immersed in the fuel in the tank 56 by a weight 60. The line 58 is kept filled with liquid in the inoperative condition of the apparatus by a check valve 50, and the fuel line is controlled by a valve 52 which may be operated manually by means of a button 48. The spark plug may also be operated by a battery in the casing 53 or by house current through a nonillustrated cord.

The filling aperture of the tank 56 is normally sealed tight by a cover 54, and fuel flow to the carburetor may be started by increasing the air pressure in the tank, manually operated bellows 64 being connected to the tank 56 by a pressure line 62 which normally functions as a vent line leading to an opening 68 in the bellows 64. The opening is closed by a finger

of the operator when it is desired to raise the pressure in the tank 56.

A liquid to be atomized and sprayed by means of the combustion gases in the exhaust pipe 12 is stored in a tank 70, and withdrawn from the tank through a flexible hose 72 whose intake orifice is held near the tank bottom by a weight 74. The hose 72 is attached to a manually operated multiple-way valve 76 which may vent the top of the tank 70 during filling and connects the hose 72 to a feedline 78 under normal operating conditions when the filling aperture of the tank 70 is closed by a tight cover 86, and the vent is closed.

The feedline 78 leads through an automatic control valve 80 to an atomizing nozzle 84 in the terminal front portion of the exhaust pipe 12. A pressure sensing line 82 terminates in the pipe 12, and its open end is directed toward the combustion chamber 10. As is seen in FIG. 2, the valve 80 includes a valve slide 94 provided with buttons for manual operation and with an aperture 96 which permits fluid flow through the feedline 78 in the illustrated open position of the slide 94. A helical compression spring 98 biases the slide 94 toward the closed position, but the slide is held in the open position by a pneumatic lock which communicates with the sensing line 82 and includes a cylinder 102 from which a latch 104 projects into a notch 100 in the slide 94. The latch 104 is backed by a piston 108 exposed to the pressure transmitted by the sensing line 82, and biased to withdraw the latch 104 by a spring 106 precisely calibrated to match the normal operating pressure in the exhaust pipe 12 and interposed between the piston 108 and an end wall of the cylinder 102. Soft sealing rings 110 on the piston 108 reduce friction between the piston and the cylinder to a minimum. A pin 112 on the cylinder permits the piston to be fixed in the illustrated position and when the latch 104 is withdrawn from the slide 94.

A tank 70*a* practically identical with the tank 70 and normally sealed by a cap 86*a* is connected with a nozzle 84*a* in the exhaust pipe 12 downstream from the nozzle 84 by a hose 72*a* equipped with a weight 74*a*, a multiple-way valve 76*a*, a feedline 78*a*, and an automatic control valve 80*a* connected to the sensing line 82 by a branch line 82*a*, the arrangement being as described in more detail with reference to the tank 70.

The tanks 70, 70*a* are connected near their tops by a pipe 93 equipped with a shutoff valve 90, and near their bottoms by a pipe 95 equipped with a shutoff valve 92. When the valves 90, 92 are closed, the apparatus may be employed for simultaneously spraying two liquid components in a common carrier gas of combustion products, or the tanks may be connected to deliver the same liquid through both nozzles 84, 84*a*.

The spring 106 is chosen to withdraw the latch 104 from the notch 100, and thereby to permit the valve slide 94 to be moved into the closing position by the spring 98 when the pressure in the sensing line 82 drops to atmospheric pressure while retaining the slide in the open position under the pressure normally prevailing in the exhaust gas at the orifice of the sensing line 82. The slide 94 may be moved manually into the open position, and the locking pin 112 may be used to lock the latch 104 in or out of engagement with the notch 100.

A pressure line 18 equipped with a check valve 20 connects the converging section of the carburetor 22 near the carburetor throat with the valve 76, and further through a branch 18*a* with the valve 76*a*. The valves 76, 76*a* may be set to connect the pressure line 18 directly with the feedlines 78, 78*a* for blowing air from the carburetor through the feedlines and the attached valves and nozzles for cleaning the same. In the normal operating position of the valves 76, 76*a*, the air is forced into the top portions of the tanks 70, 70*a* to cause liquid flow to the nozzles 84, 84*a*.

The free end of the exhaust pipe 12 carries a releasably mounted, conically flaring mouthpiece 88 preferably replaced by a silencer 88*a* as shown in FIG. 4 which illustrates the assembled spraying mechanism. Most of the operating elements are covered or obscured in FIG. 4 by the casing 53 which is equipped with a molded-on carrying handle 51. The operating button 48 is located next to the handle and adjacent the bulb 42. The cover 86, through which the tank 70 may be filled, is seen near the front end of the handle 51. The sprayer is normally handheld by an operator while a flame of burning, atomized fuel, a fog of atomized weed killer solution, or the like is discharged from the open front end of the silencer 88*a*.

The apparatus shown in FIG. 1 is operated as follows after a prolonged shutdown during which the chamber 10 cools to ambient temperature.

The fuel supply valve 52 is opened, a finger is placed over the opening 68 in the bellows 64, and the bellows are squeezed to force liquid fuel from the tank 56 out of the nozzle 24. The bulb 42 is pressed to blow air from the nozzle 26 over the orifice of the nozzle 24 to atomize the discharged fuel and to generate a spark in the spark plug 14. The operation of the bellows 64 and of the bulb 42 is repeated until combustion is started and the carburetor 22 draws its own air of combustion through the converging section 40.

The apparatus thereafter operates automatically to draw fuel mixture into the hot combustion chamber and to burn it there in a series of intermittent explosions or combustion steps which generate a pulsating stream of exhaust gas, as is known in itself. When steady operation conditions are achieved in the combustion chamber 10 and the exhaust pipe 12, the valve slides 94 of the valves 80, 80*a* are pushed manually into the open position in which they are held by the associated latches 104 as long as the combustion chamber 10 operates and exhaust gas under pressure is driven against the open end of the sensing line 82.

FIG. 3 shows a modification of the starting mechanism which may replace the device shown in FIG. 1A. A starter 114 operated by a nonillustrated pull rope and return spring in a conventional manner has an output shaft 116 on which a disc 118 is coaxially mounted. The disc 118 carries two circular, concentric rows of cams 120, 122. The latter operate an actuating arm 124 of a make-and-break ignition 126 connected to the spark plug 14. The cams 120 travel over the operating rod 128 of a diaphragm pump 130 connected to the atmosphere and to the air nozzle 26 by conventional conduits and valves, not shown in detail. When the shaft 116 is turned, the pump 130 discharges pulses of air under pressure into the throat of the carburetor 22 and the spark plug 14 is energized from time to time in precise synchronization with the air blasts until spontaneous operation of the burner part of the apparatus commences.

As shown in FIG. 6, the apparatus illustrated in FIG. 1B may dispense with the bellows 64 when the bulb 42 is connected with the top of the tank 56 by an air line 11 to raise the air pressure on the fuel in the tank, and thereby to supply fuel to the nozzle 24 through the check valve 50 as the bulb 42 is alternatingly compressed and permitted to expand. A metering orifice 98' in the line 11 maintains the proper quantitative relationship between the amounts of air and fuel which are delivered to the carburetor 22 during startup. A check valve 99 is provided in the air line 36 to prevent blow-back from the carburetor throat into the bulb 42.

The modified spraying apparatus shown in FIG. 7 is identical in most respects with that illustrated in FIG. 1, and the elements common to both embodiments of the invention have been largely omitted from FIG. 7 for the sake of clarity. The combustion chamber 10 and the exhaust pipe 12 are spacedly enveloped by a cooling jacket 150 whose rear end 156 extends rearwardly beyond the combustion chamber and forms a silencer chamber to which air is admitted through a relatively small axial tube 152. The front end 154 of the jacket spacedly surrounds the orifice of the exhaust pipe 12 and extends forward beyond the orifice to an opening in a silencer chamber 160 to which the jacket is sealed.

The conically tapering intake orifice 164 of a discharge pipe 162 spacedly faces the orifice of the coaxial exhaust pipe 12 in the chamber 160. A drain nipple 161 collects liquid accumulating from the discharged spray in the silencer

chamber 160. A shutoff valve 166 on the nipple 161 and a drain line 168 return the collected liquid to the tank 70, not itself seen in FIG. 7, from which the liquid to be dispersed is supplied to the exhaust pipe 12 through the feedpipe 78.

The air intake section 40 of the carburetor 22 is equipped in the modified apparatus of FIG. 7 with a relatively large muffler or silencer chamber 170 to which air is admitted through a pipe 172 of much smaller flow section. The modified apparatus of FIG. 7 generates much less of the normally undesirable noise associated with operation of the apparatus shown in FIG. 1 even when the apparatus is equipped with a discharge silencer 88*a*, as shown in FIG. 4. Cooling air is drawn into the jacket 150 by the rapid stream of exhaust gases and dispersed liquid discharged from the exhaust pipe 12.

It is a common feature of the aforedescribed embodiments and modifications of the invention that the supply of liquid to the nozzles 84, 84*a* is stopped when combustion of fuel mixture in the chamber 10 ceases, and no further exhaust gases are driven through the pipe 12. If the apparatus is employed as a flamethrower, injury to the operator by burning liquid running from the discharge orifice of the apparatus, but not propelled away from the operator, is avoided. The liquid to be sprayed also is prevented from flowing back toward the combustion chamber in the absence of a stream of exhaust gases, and from fouling the combustion chamber or even the carburetor.

We claim:

1. In a spraying apparatus having a combustion chamber, a carburetor connected to said chamber for supplying the same with a combustible mixture of a liquid fuel with air of combustion, ignition means for igniting said mixture, an exhaust pipe connected to the chamber for discharging a stream of combustion gas from the same, a source of liquid fuel for said carburetor, a tank adapted to hold a liquid to be dispersed in said combustion gas for spraying there, an atomizing nozzle in said exhaust pipe, a conduit connecting said tank to said nozzle, a shutoff valve in said conduit, and operating means for operating said valve; the improvement which comprises:

a. sensing means for sensing the gas pressure in said exhaust pipe;

b. closing means operatively connected to said sensing means and responsive to reduction of the sensed pressure to a predetermined minimum value for closing said valve,

1. said closing means including yieldably resilient means biasing said valve toward the closed position, and latching means engageable with said valve for holding the same in the open position against the force of said biasing means,

2. said latching means being operatively connected to said sensing means for releasing the engaged valve when said sensing means senses the minimum value of said pressure;

c. manual operating means for moving said valve between the open and closed positions thereof,

1. said sensing means including a cylinder member communicating with said exhaust pipe, a piston member exposed in said cylinder member to the pressure of said combustion gas, the pressure tending to move the piston member in a predetermined direction, and a spring opposing the movement,

2. said latching means including a latch member connected to said piston member for movement therewith; and

d. locking means for locking said piston member against movement by said pressure and by said spring.

2. In an apparatus as set forth in claim 1, said carburetor including a conduit having a throat portion, a portion converging toward said throat portion and normally open to the atmosphere, and a portion diverging from said throat portion and communicating with said combustion chamber, said source of liquid fuel including a container and a fuel nozzle connected to said container and having an orifice in said carburetor near said throat portion, the improvement further comprising an air nozzle having an orifice in said carburetor near said throat and pump means connected to said air nozzle for discharging intermittent pulses of starting air under pressure into said throat, the fuel nozzle having a terminal portion formed with said orifice in said throat portion and tapering toward said orifice at a predetermined apex angle, and another portion contiguously adjacent said terminal portion and tapering toward the same at an apex angle substantially greater than said predetermined angle, said pulses being discharged by said air nozzle against said tapering portions of said fuel nozzle.

3. In an apparatus as set forth in claim 1, said source of liquid fuel including a container adapted to hold a body of liquid fuel, a conduit connecting said body with said carburetor, and pressure means for admitting a gas to the portion of said container above said body of liquid under a pressure sufficient to drive the liquid of said body into said carburetor.

4. In an apparatus as set forth in claim 3, said carburetor including a conduit having a throat portion, a portion converging toward said throat portion and normally open to the atmosphere, and a portion diverging from said throat portion and communicating with said combustion chamber, said source of liquid fuel further including a fuel nozzle connected to said container and having an orifice in said carburetor near said throat portion, the improvement further comprising pump means for discharging intermittent pulses of starting air under pressure into said throat portion, said pressure means including a conduit connecting said pump means to said container, and metering means in said conduit for controlling the ratio of fuel and air supplied to said carburetor.

5. In an apparatus as set forth in claim 1, a casing supporting said combustion chamber, said carburetor, said ignition means, said exhaust pipe, said tank, and said valve-operating means; and a carrying handle on said casing.

6. In an apparatus as set forth in claim 1, a cooling jacket spacedly enveloping said combustion chamber and said exhaust pipe, inlet means for admitting ambient air to a portion of said jacket adjacent said chamber, said jacket extending beyond said exhaust pipe in a direction away from said chamber and defining with said exhaust pipe an annular discharge opening.

7. In a spraying apparatus having a combustion chamber, a carburetor connected to said chamber for supplying the same with a combustible mixture of a liquid fuel with air of combustion, said carburetor including a conduit having a throat portion, a portion converging toward said throat portion and normally open to the atmosphere, and a portion diverging from said throat portion and communicating with said combustion chamber, ignition means for igniting said mixture, an exhaust pipe connected to the chamber for discharging a stream of combustion gas from the same, a source of liquid fuel for said carburetor, said source of liquid fuel including a container and a fuel nozzle connected to said container and having an orifice in said carburetor near said throat portion, a tank adapted to hold a liquid to be dispersed in said combustion gas for spraying there, an atomizing nozzle in said exhaust pipe, a conduit connecting said tank to said nozzle, a shutoff valve in said conduit, and operating means for operating said valve; the improvement which comprises:

a. sensing means for sensing the gas pressure in said exhaust pipe;

b. closing means operatively connected to said sensing means and responsive to reduction of the sensed pressure to a predetermined minimum value for closing said valve;

c. pump means for discharging intermittent pulses of starting air under pressure into said throat portion; and

d. common operating means connected to said pumping means and to said ignition means for operating the same in synchronization,

1. said operating means including a cam carrier, means for moving said cam carrier, two cam means on said carrier respectively associated with said pump means and with said ignition means, and motion transmitting means interposed between each cam means and the associated pumping means and ignition means respectively.

8. In a spraying apparatus having a combustion chamber, a carburetor connected to said chamber for supplying the same with a combustible mixture of a liquid fuel with air of combustion, said carburetor including a conduit having a throat portion, a portion converging toward said throat portion and normally open to the atmosphere, and a portion diverging from said throat portion and communicating with said combustion chamber, ignition means for igniting said mixture, an exhaust pipe connected to the chamber for discharging a stream of combustion gas from the same, a source of liquid fuel for said carburetor, said source of liquid fuel including a container and a fuel nozzle connected to said container and having an orifice in said carburetor near said throat portion, a tank adapted to hold a liquid to be dispersed in said combustion gas for spraying there, an atomizing nozzle in said exhaust pipe, a conduit connecting said tank to said nozzle, a shutoff valve in said conduit, and operating means for operating said valve; the improvement which comprises:

a. sensing means for sensing the gas pressure in said exhaust pipe;

b. closing means operatively connected to said sensing means and responsive to reduction of the sensed pressure to a predetermined minimum value for closing said valve;

c. a bulb member of resilient material;

d. nozzle means connected to said bulb member for discharging intermittent pulses of starting air under pressure into said throat portion when said bulb member is alternatingly compressed and permitted to expand; and

e. operating means responsive to said alternating compressing and expanding of said bulb member for operating said ignition means in synchronization with said pulses,

1. said ignition means including a make-and-break ignition mechanism,

2. said operating means including motion-transmitting means interposed between said bulb member and said mechanism for moving the same when said bulb member is compressed and expanded.

9. In a spraying apparatus having a combustion chamber, a carburetor connected to said chamber for supplying the same with a combustible mixture of a liquid fuel with air of combustion, ignition means for igniting said mixture, an exhaust pipe connected to the chamber and having a discharge orifice for discharging a stream of combustion gas from said chamber, a source of liquid fuel for said carburetor, a tank adapted to hold a liquid to be dispersed in said combustion gas for spraying there, an atomizing nozzle in said exhaust pipe, a conduit connecting said tank to said nozzle, a shutoff valve in said conduit, and operating means for operating said valve; the improvement which comprises:

a. sensing means for sensing the gas pressure in said exhaust pipe;

b. closing means operatively connected to said sensing means and responsive to reduction of the sensed pressure to a predetermined minimum value for closing said valve;

c. a silencer chamber having a flow section substantially greater than the flow section of said exhaust pipe and sealed to the portion of said pipe remote from said combustion chamber; and

d. a discharge pipe aligned with said exhaust pipe and leading outward of said silencer chamber, said discharge pipe having an orifice in said silencer chamber spacedly opposite said orifice of the exhaust pipe and flaring toward said exhaust pipe.

10. In an apparatus as set forth in claim 9, a drain line communicating with said silencer chamber and leading downward from the same to said tank.