March 3, 1953 W. J. BESLER 2,630,412

ARTIFICIAL FOG GENERATOR

Filed Nov. 12, 1947 4 Sheets-Sheet 1

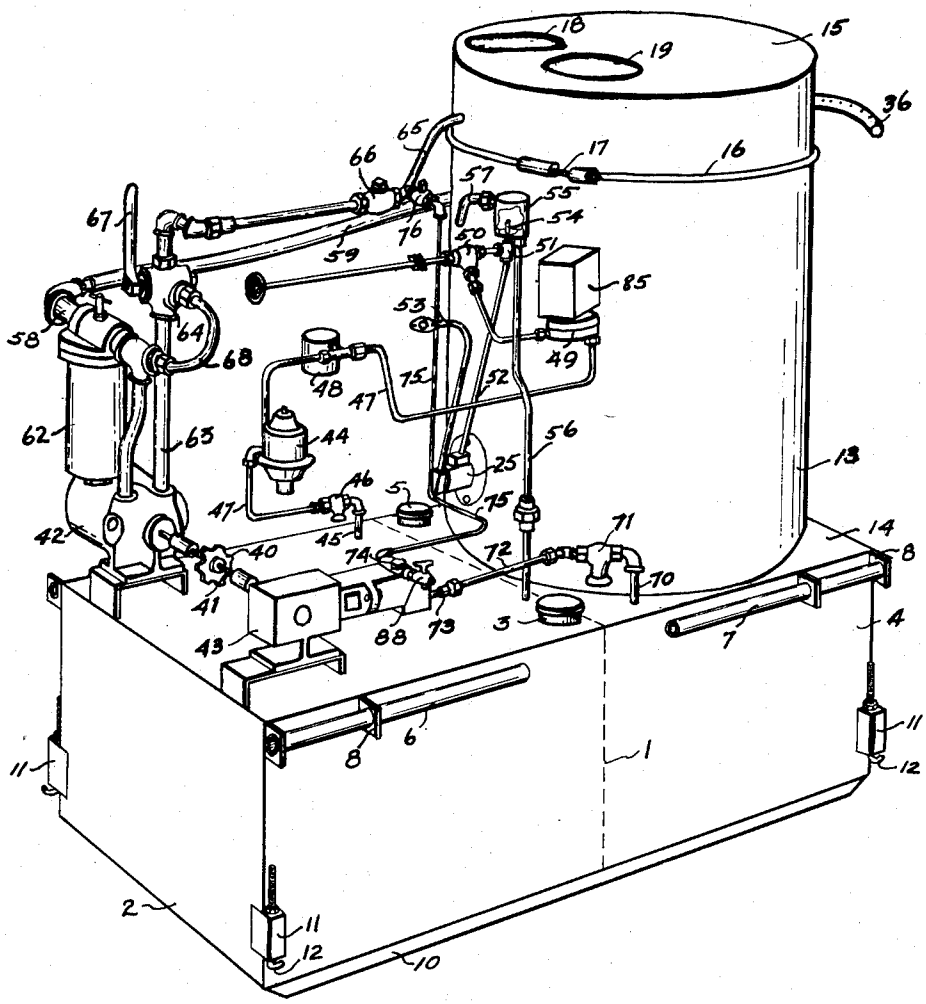



Fig. 1

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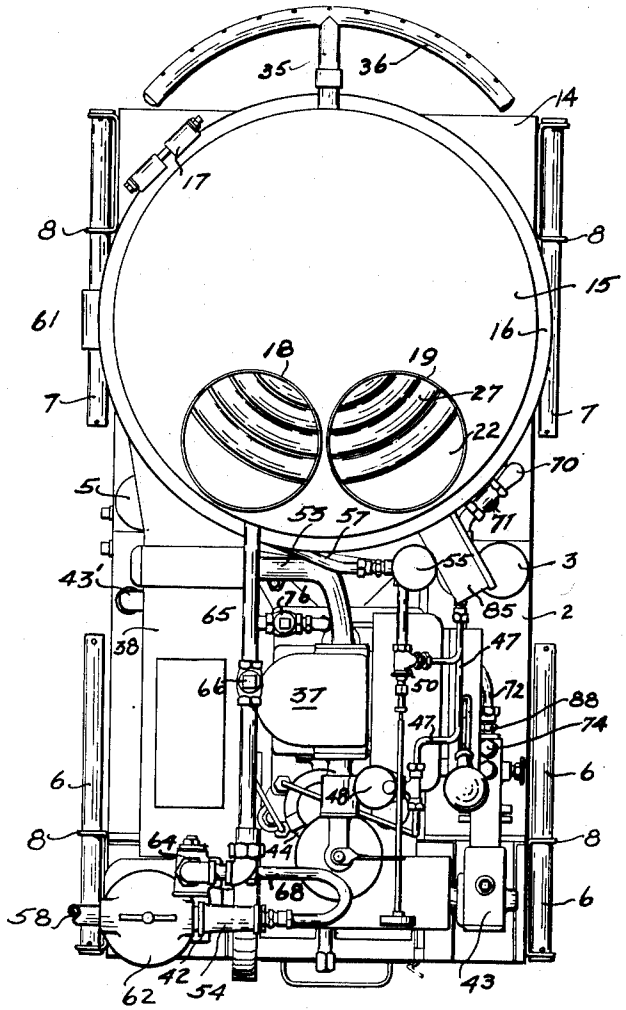



Fig. 2

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Fig. 3

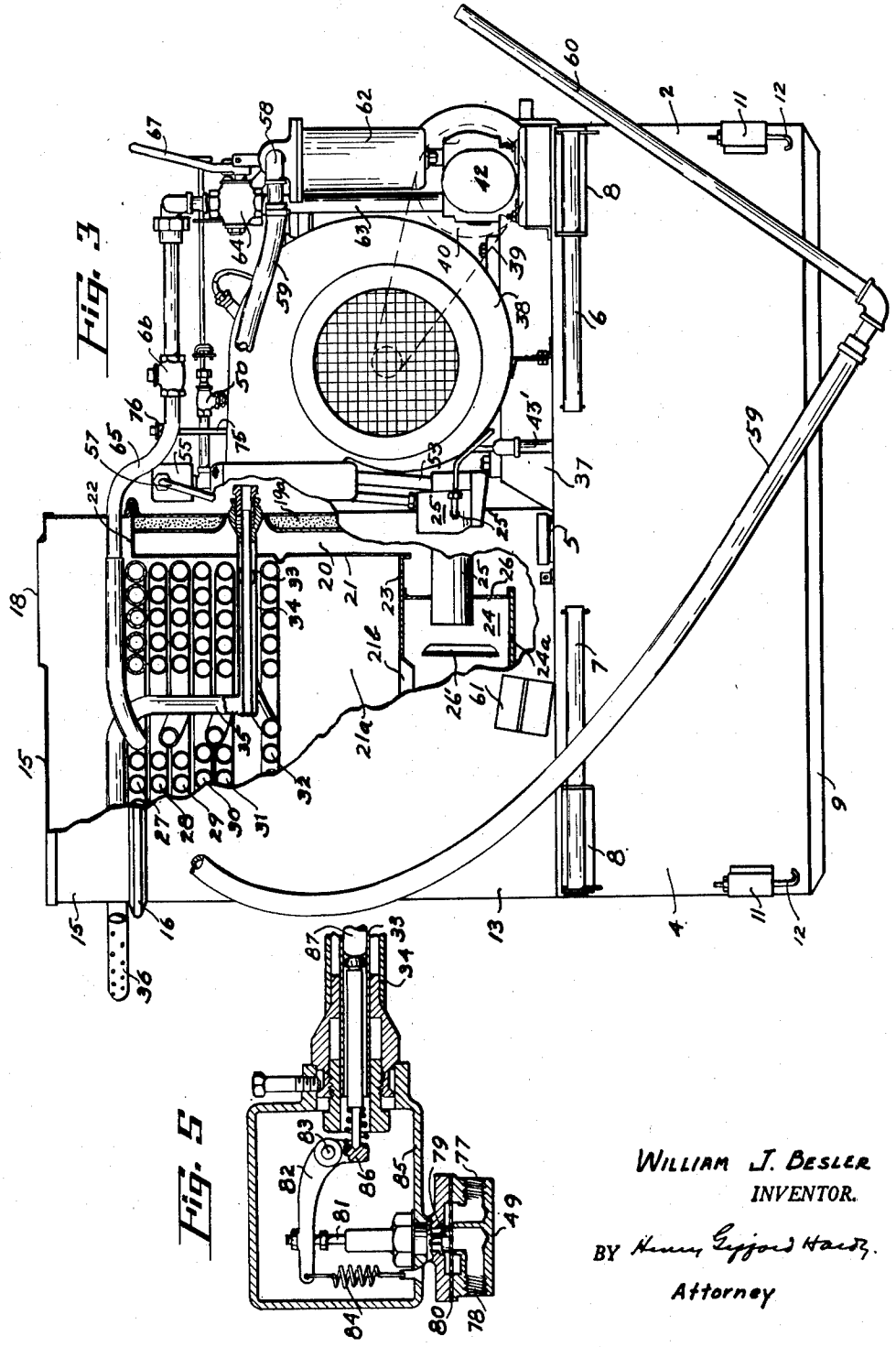


Fig. 5



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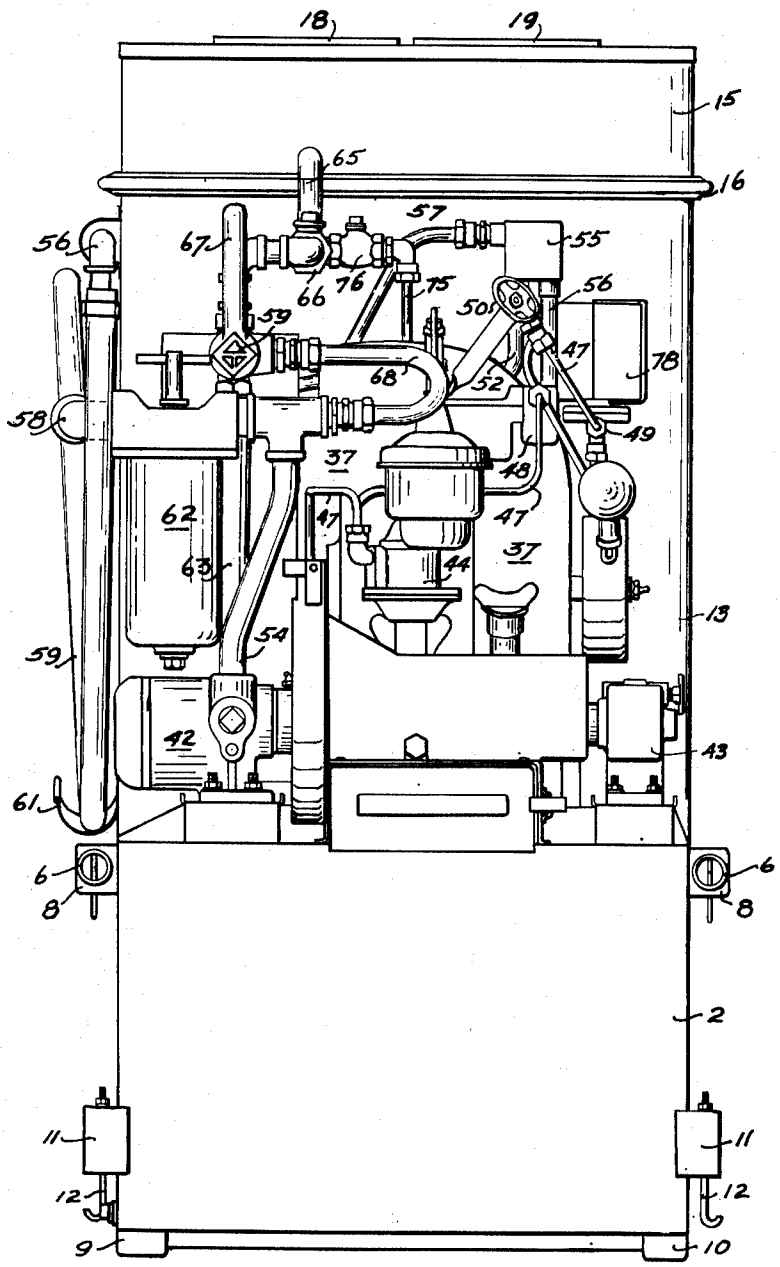



Fig 4

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# UNITED STATES PATENT OFFICE

2,630,412

## ARTIFICIAL FOG GENERATOR

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Application November 12, 1947, Serial No. 785,351

3 Claims. (Cl. 252—359)

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The present invention relates to a portable, compact, self-contained unit for producing and dispersing an artificial fog or aerosol.

Among the objects of the present invention is the creation of a device which is capable of producing at will a thick, persistent, obscuring fog for military purposes in the concealing and masking of strategic objects and activities.

Similarly it is an object of the present invention to provide a device which will produce such an obscuring fog which may be breathed by humans and animals without toxic effects or respiratory depression.

Another object is to provide a portable, fast acting means for generating a maximum volume of fog in the minimum of time while at the same time requiring a minimum of effort and attention by the operator.

The invention has peacetime uses as well and it is an object to provide a device which can be operated as an insecticide disseminator or as an artificial aerosol for the protection of crops of all kinds.

Another object is the coordination of the fuel supply to the engine and the generator, and the utilization of the products of combustion of both in a most efficient manner.

It is also an object of the invention to provide thermostatic means which may be set at a maximum operating temperature as indicated by the temperature adjacent the outlet of the generator and to automatically cut off the fuel to the burner when the temperature reaches the predetermined setting and restoring fuel and fire when the temperature drops below the setting.

Further objects are to provide a construction of maximum simplicity, economy and ease of assembly and disassembly and such further objects, advantages and capabilities as will fully appear and as are inherently possessed by the device and invention described herein.

The invention further resides in the combination, construction and arrangement of parts illustrated in the accompanying drawings, and while there is shown therein a preferred embodiment it is to be understood that the same is illustrative of the invention and that the invention is capable of modification and other uses and comprehends other details of construction without departing from the spirit thereof or the scope of the appended claims.

In the four sheets of drawings:

Figure 1 is a diagrammatic perspective view of a fog or aerosol generator constructed in accordance with this invention showing the fluid flow systems, the motor unit being omitted.

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Figure 2 is a plan view from above, of the assembled device.

Figure 3 is a side elevation of the same from the blower side.

Figure 4 is an elevation of the systems end of the same.

Figure 5 is a vertical section of the thermostatic fuel supply control.

In detail the structure shown in Figure 1 comprises the base preferably in the form of a rectangular tank having a central partition 1 dividing it into the fuel tank 2 having the capped filling spout 3 and the water tank 4 having a similar filling spout 5.

For portability the base tank is provided at its four corners with the handles 6 and 7 slidable in brackets such as 8, welded to the four corners of the base tank. For protection the base tank is provided with the skids 9 and 10 secured along the longitudinal marginal edges. For anchoring the device in any given location, as to the deck of a ship, the bed of a truck or the like, brackets 11 are fixed to the four corners of the base tank adjacent the bottom. The hooks 12, adapted to be engaged in eyes or clips (not shown), are adjustable within said brackets 11. There are several other conventional means for securing the device to a surface and any of these may be used.

The cylindrical generator housing 13 has its lower edge welded, bolted, or secured by any other suitable means to the top 14 of the base tank. The meeting edges of housing 13 and the cover 15 are flanged outwardly and held together by the tension girth 16, the ends of which are drawn together by the turnbuckle 17. The cover has the top outlets 18 and 19 for the escape of the products of combustion with a minimum of glow. The housing 13 is insulated as at 19a and its interior wall and bottom form combustion air space 20 (see Figure 3) between the insulated housing 13 and the inner cylindrical combustion chamber wall 21. This wall 21 is supported at its top by outwardly directed annular flange 22 interposed between the flanges of the housing 13 and cover 15 and secured by the single tension ring 16. The floor 23 of the combustion chamber proper 21a has an outturned peripheral flange secured to the lower edge of wall 21. Depending from the floor 23 of the combustion chamber proper 21a and about the central opening 21b in said floor, is the preliminary combustion and mixing chamber 24, closed at the bottom by plate 24a and having louver openings 26' in the circular wall 26.

The burner means comprises the fuel oil burner 25 secured to a burner plate—attached to the

outside of the casing or housing 13. The burner produces a torch-like flame in the preliminary combustion chamber 24 that is open at the top 21b to the combustion chamber proper 21a above. The products of combustion flow upwardly through the chamber and out through the top openings 18 and 19. The fuel atomized into the burner 25 is ignited by the spark plug 25'.

The fog generating means comprises the assembly of flat horizontally spiraled or pancake coils 27 to 32 inclusive, interconnected to form a continuous tubular generator. The uppermost coil 27 is the inlet for the vapor forming components which successively flow downwardly through the series of coils to the lowest coil 32 nearest the flame in the combustion chamber 21a.

The lowest coil 32 discharges at 33 into the horizontal run of tubing containing the thermostatic tube 34. From thence it goes to the vertical portion 35 passing upwardly substantially on the axis of the series of coils, and outwardly above coil 27 through the cover 15, to the arcuate and perforated vapor jet 36 through which the generated vapor is ejected and expands into a fog in surrounding atmosphere, all as more fully explained hereinafter.

The motive unit, preferably a relatively small internal combustion motor 37, is mounted upon a platform on the top 14 of the base tank. The motor shaft is coupled to and directly drives the suction fan (not shown) mounted within the fan casing 38. This casing discharges tangentially and directly through the insulated casing 13 and into the air space 20 thence through the louvers 26' in the wall 26 of the preliminary combustion chamber 24, causing a whirling turbulence and distribution of the air. The engine exhaust is delivered to the burner 25 in the combustion chamber 24 which heats the burner and insures ignition in cold weather. Combustion takes place in combustion chamber 24 and continues in combustion chamber 21a where burning is completed. The products of combustion within the generator then pass upwardly around the spaced vaporizing coils 27 to 32, which absorb the heat from the products of combustion, and are dissipated to atmosphere through outlets 18 and 19 in cover 15.

The shaft of the motor 37 projecting on the side opposite from the blower, has a sprocket thereon for driving the sprocket chain 39 encircling the sprocket 40 on the countershaft 41 extending between the fog oil pump 42 and water pump 43 mounted upon the base fuel tank 2.

The conventional pulsating diaphragm servomotor fuel pump 44 is a part of and driven by the motor 37. It lifts fuel from the tank 2, through the pipe 45 and the strainer 46 and discharges it into the feed line 47 supplying the motor carburetor 48, having a regulating float valve therein as usual. Since in the device shown, gasoline is the fuel for the generator, a statically controlled valve 49 is provided in the line 47 (see Figure 1) before it reaches the manually controlled burner valve 50. From 50 the fuel flows through the T fitting 51 to the pipe 52 that discharges into the burner tube 25 through a restricted orifice, where it is warmed and vaporized by the exhaust gases flowing from the motor to the burner through the exhaust pipe 53 and mixed with the swirling combustion air entering through louvers 26'. The fitting 51 has the riser 54 extending upwardly into the fuel level



chamber 55 which functions as an overflow, leading back to the fuel tank 2 through return line 56. Chamber 55 has the duct 57 leading from the blower casing 38 for maintaining a plus atmospheric pressure in the chamber 55 to overcome the air pressure in the burner tube which would tend to prevent gasoline from entering the burner. The above fuel system supplies the motor 37 and the burner 25 with both an automatically and manually regulated flow of combustible fuel.

The fog oil system comprises a pump 42, which is here shown as a rotary or gear pump although any suitable type may be used, having the inlet pipe 58 connected with the flexible inlet hose 59, which in turn is provided with a nozzle pipe 60 for introduction into the source of fog oil supply, which may be a separate drum of fog oil.

When not in operation the hose 59 rests in the bracket 61 on the side of the generator casing 13. A fog oil filter 62 is interposed in the intake line 58 ahead of the fog oil pump 42.

The pump 42 discharges through the pipe 63 (see Figure 1) through the three-way valve 64 and into the generator inlet pipe 65 leading to the topmost coil 27 in the heating chamber 21 through the check valve 66. The three-way valve 64 has the handle 67 for opening or closing the discharge from the pump 42. This valve has the bypass 68 leading back to the inlet side of the pump, for balancing the pump pressure while idling, with the handle 67 in the vertical or "off" position shown.

The water pump 43 here shown preferably as a plunger pump is driven by the shaft 41 and lifts water from the water tank 4 (see Figure 1) through the pipe 70, the strainer 71, the pipe 72 into the pump through the check valve 73, and discharges through the check valve 74 into the pipe 75. This pipe feeds the water through the check valve 76 into the generator inlet pipe 65 where it mixes with the fog oil flowing therethrough from the pump 42 as previously described. The volume of water supplied is constant at a given engine speed and mixed with the fog oil in line 65 before entering the generator in proportion to the fog oil being pumped at the same engine speed. Normally the water to fog oil ratio is approximately 10:90.

The water and fog oil mixture enters the uppermost coil 27 of the generator. As it passes through the coils 27 to 32 the temperature is raised to around 900° F. thus vaporizing some of the fog oil and producing superheated steam under pressure. This vapor mixture with its entrained fog oil enters the thermostatic tube 34 at 33 and thence passes upwardly in outlet tube 35 to the perforated dispensing nozzle 36 on the outside of the generator housing top 15. The release to atmospheric pressure causes a fog like aerosol having a particle size of from .1 to .03 micron radius at the temperatures and mixtures stated above. To a large degree particle size of the aerosol is a function of temperature. The result is an immediate, dense, persistent covering fog which is neither inflammable nor injurious to respiration. The water supplied not only produces the vehicle, superheated steam, for the dispersion of the fog oil particles but performs several other functions. Its presence helps prevent the cracking of the fog oil and reduces the deposition of solids, particularly carbon, within the tubes. The relatively large vol-

ume of steam helps to scour the tubing and provide efficient heat transfer.

The fog oils used are usually a highly refined lubricating oil or any other type of oil conforming to the specifications of the Chemical Warfare Service code designation SGF. It is advisable to use pure clean water free from organic and mineral content or pretreated water for the operation of the device to avoid fouling and scaling the generator coils 27—34.

Referring to Figure 5 the thermostatic valve 49 is introduced to control the supply of fuel to the burner 25 in order to automatically maintain the proper vaporizing temperature in the combustion chamber 21*a*.

The fuel valve 49 has the fuel inlet 77 and outlet 78 closed by the diaphragm 80 under spring pressure on the valve head 79 above the outlet 78. The valve head has its stem 81 in contact with the bell crank 82 which is pivoted at 83 and depressed by the spring 84 attached to the bottom of the surrounding case 85. The entire fuel valve assembly is mounted at the end of the expansion tube 34 outside the casing. The arm 86 of bell crank 82 bears against the thermal sensitive rod 87 composed of quartz or the like which extends through and is secured in the tube 34. It is apparent that by adjusting the length of the stem 81 the closing of the fuel valve can be accomplished for the temperature required. As the temperature approaches the setting only enough fuel will pass through the valve 49 to maintain the temperature of the setting.

The invention operates substantially as follows: The motor 37 is started first and run for a few moments so that the exhaust gases will preheat the burner 25 before the fuel is manually turned on at 50. As soon as the motor 37 starts, then all of the elements driven by it also begin to operate. The water pump driven by the motor delivers water to the inlet of the generating coils 27—32 before the burner is ignited. The pumping of water to the generator can be checked by opening drain cock 88. The blower is started and air is supplied to the generator. The motor fuel pump 44 forces gasoline fuel through the fuel control valve 49 to the fuel valve 50. Within a few seconds after the motor is started the valve 50 can be opened and the vapor burner ignited by switching on the spark plug 25' in the motor ignition system.

When the burner fuel valve 50 is opened the fire will start and in a few seconds will automatically diminish to low fire. The device is then ready for the admission of the fog oil. The fog oil handle 67 is moved downwardly to the horizontal or "on" position. When the valve 64 is open or in the "on" position the pump 42 pumps the fog oil through the intake pipe or nozzle 60 through the flexible hose 59 and through the strainer 62. It is delivered by the pump to line 63 through check valve 66 where it is mixed with water from line 75 in line 65 just prior to entry into the generator. By the time the motor is started and the fog oil handle is moved to the "on" position the fog oil pump 42 is in operation pumping fog oil from the source of the supply through the strainer 62 to the shut-off valve 64. When the handle 67 is in the "off" position the fog oil is diverted back to the pump through by-pass line 68.

The mixture of fog oil and water as it enters the first coil 27 passes in substantially a counterflow path with respect to the products of combustion, from the combustion chamber 21*a* and the waste products of combustion pass out through the deflected path at openings 18 and 19. The unit comes up to temperature very quickly and as the tube 34 expands with the heat it will expand more rapidly than the thermostatic element 37 secured at its outer end (see Figure 5). The expansion of this tube moves the arm 86 away from the end of the element 37 increasing the tension of the spring 84 on the stem 81, thus reducing the flow of fuel through the valve 49 to the burner. This in turn decreases the temperature within the combustion chamber 21*a* and further automatic control is maintained. For fogging purposes the thermostat control is set for approximately 900° F. which means that the valve 49 will be open to permit just enough passage of fuel to maintain the temperature at the setting. If the temperature goes higher the expansion of tube 34 will increase causing the thermostatic control to close the diaphragm valve on its seat.



As shown above water is supplied to the device by a positive displacement pump 43 which supplies enough water to the fog oil to accomplish the purpose required. It is to be understood that if a different proportion or ratio is required a different water pump may be placed in its stead or its operation speeded up so as to deliver the increased amount. In addition to the other drives on the motor 37, it also drives a small magneto which furnishes the energy to the spark plug 25' in the burner assembly 25. It will also be observed that the gasoline fed to the burner 25 is under a constant head from the gasoline leveling chamber 55. The amount of gasoline supplied is limited by an orifice at the bottom of the gasoline tube 52 in the burner 25.

While there has been described herein the operation in connection with the making of fog with aerosols having a particle size of from .1 to .03 micron radius, it has been discovered that the size of the particle released is directly proportionate to the operating temperature of the device. Thus, aerosols having a particle size of from 2 to 10 microns radius for example, are obtained by operating the device at temperatures from 450 to 500° F.

As has been explained before the function of the water supplied to this system in the operation of the device is primarily to secure enough water for the generation of steam which is the vehicle for the dissemination of the particles. Obviously, if the fluid put through the device is an insecticide, for example, which contains water in proper portion, then it is not necessary to operate the water system on the device and the same may either be disconnected or removed without altering the function or operation of the device. In any event steam is produced which is the vehicle for securing an aerosol or fog which, if fog is used, will result in a dense, persistent covering fog, or if an insecticide is used will result in a penetrating thick fog which carries the lethal material to trees or crops or whatever may be the object of the treatment. Obviously the nozzle 36 may be adjusted by any well known means to any direction desired.

This application is a continuation-in-part of application Serial No. 523,292, filed February 21, 1944, now Patent No. 2,432,372 issued December 9, 1947.

I claim:

1. Fog generating apparatus comprising a coil having an inlet end and an outlet end, heating

means comprising a combustion chamber and a burner therefor arranged to heat said coil by combustion gases countercurrently to the flow of fluid through the coil from the inlet end to the outlet end thereof, a fog oil pump and a water pump, means communicating each pump with the inlet end of said coil to deliver fog oil and water thereto in a predetermined ratio, an internal combustion engine for operating said fog oil pump and water pump, a fuel pump operated by said engine, means communicating said fuel pump with said engine to supply fuel thereto, means communicating said fuel pump with said burner to supply liquid fuel thereto by gravity, preheating means for preheating the fuel thus delivered to said burner by heat exchange with the hot combustion gases from said engine, thermostatically controlled valve means controlling the amount of liquid fuel delivered to said burner, said thermostatic means being in heat exchanging relation to the fluid in the outlet of said coil and being responsive to the temperature thereof to control the amount of fuel delivered to said burner thereby maintaining said fluid at a predetermined temperature.

2. A portable self contained fog generating apparatus having a heat exchange unit and auxiliaries, said heat exchange unit comprising in combination a coil having an inlet end and outlet end, heating means comprising a combustion chamber and a burner therein located relatively to said coil so that combustion gases from said burner will flow countercurrently to fluid flowing from the inlet end to the outlet end of said coil, said auxiliaries comprising in combination gravity feed means for supplying fuel to said burner, a fog oil pump and a separate water pump, means communicating the discharge of each said pump with the inlet end of said coil, means for driving said pumps to deliver fog oil and water to said inlet end in a predetermined ratio, and thermostatic means within said heat exchange unit and within said coil adjacent its outlet end operatively connected to said fuel feed means to control the flow of fuel to said burner thereby continuously maintaining said fluid in said coil at a predetermined temperature.

3. Fog generating apparatus having a heat exchange unit and auxiliaries, said heat exchange unit comprising in combination a coil having an inlet end and an outlet end, heating means comprising a combustion chamber and a burner therefor adapted to burn gasoline and arranged to heat said coil by combustion gases therefrom, said auxiliaries comprising in combination pump means for pumping a mixed fluid to the inlet end of said coil, a gasoline engine for operating said pump means, a fuel pump operated by said engine, means including a carburetor for supplying fuel from said fuel pump to said engine, means communicating said fuel pump with said burner to supply gasoline thereto by gravity, means for preheating the gasoline thus supplied to said burner by hot combustion gases from said engine, and thermostatic means located within the coil of said heat exchange unit and adjacent the outlet end, operatively connected to said gasoline supply means to said burner to control the flow of fuel thereto.

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