Aug. 19, 1952 J. W. HESSION, JR 2,607,743

MECHANICAL AEROSOL GENERATOR

Filed May 24, 1944 2 SHEETS—SHEET 1

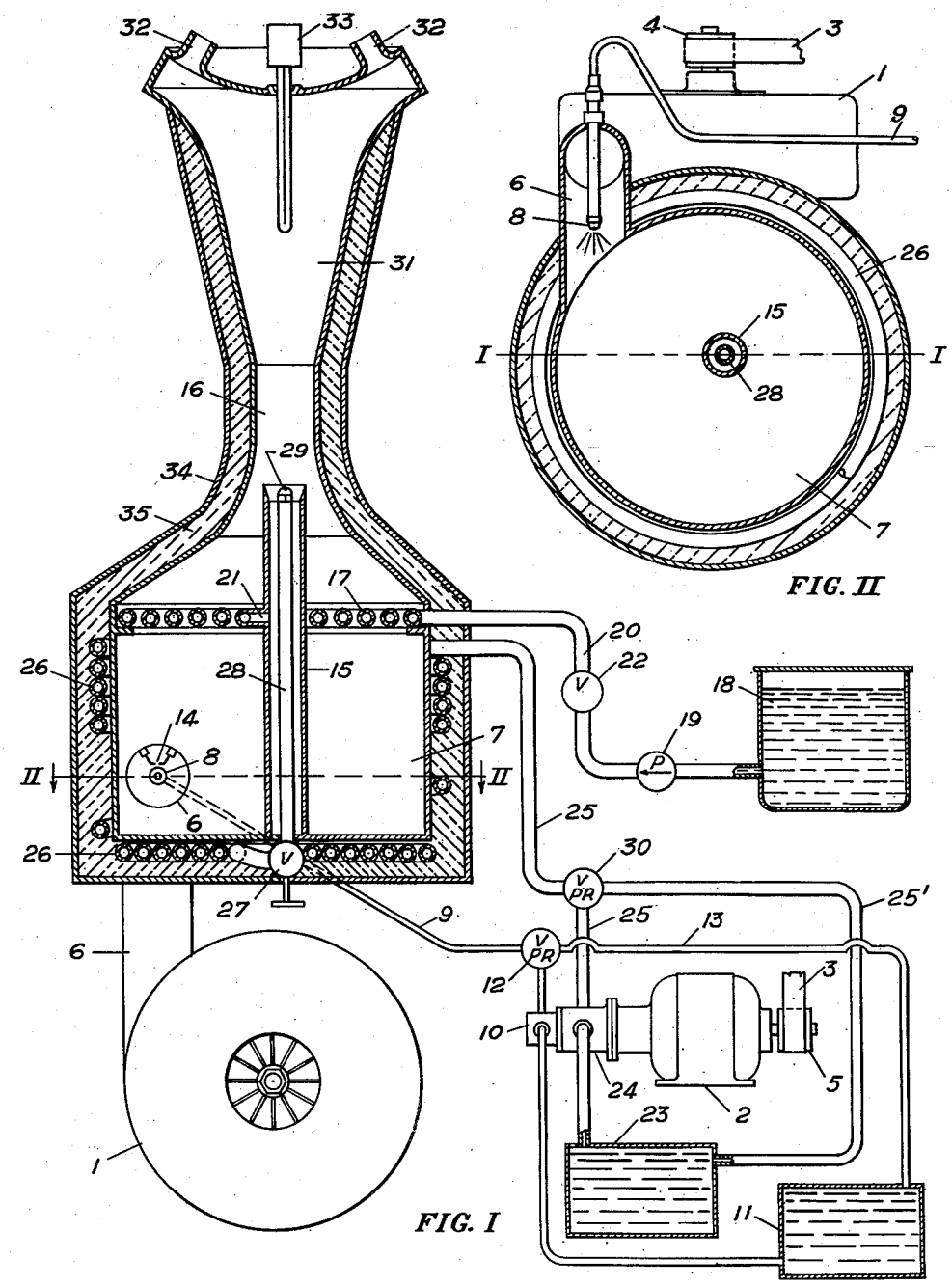


FIG. I

FIG. II

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BY

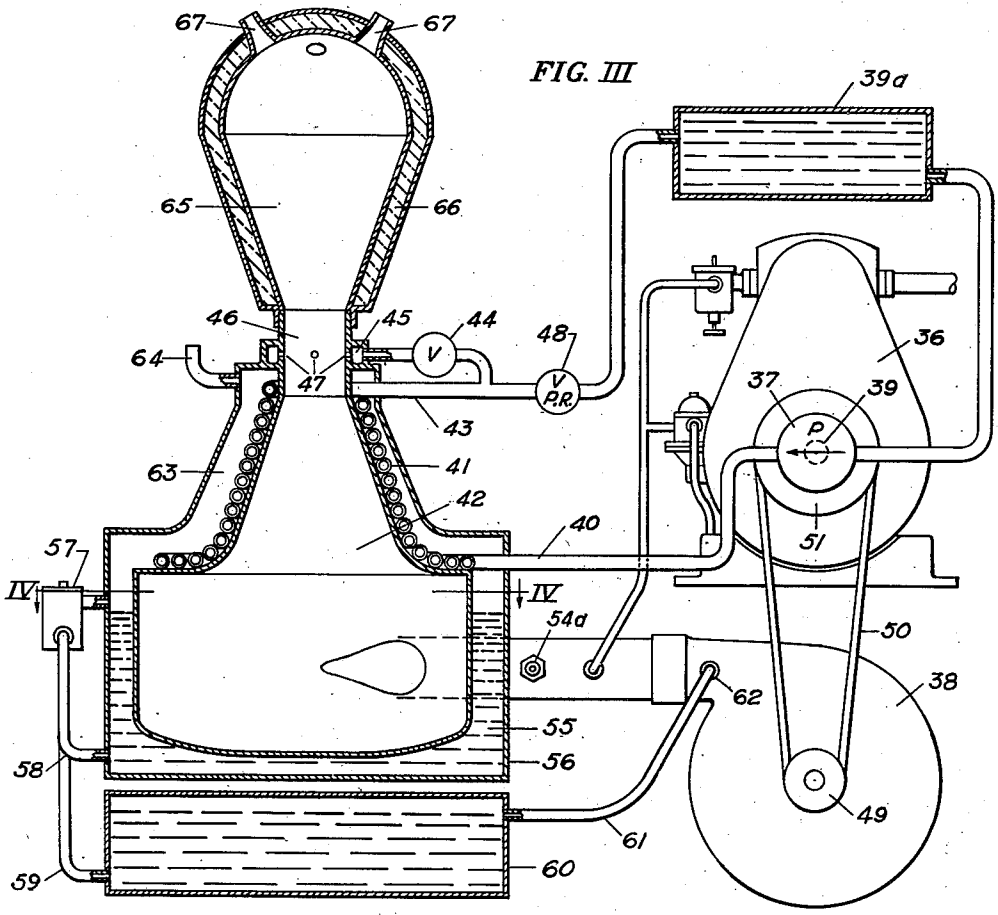
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MECHANICAL AEROSOL GENERATOR

Filed May 24, 1944 2 SHEETS—SHEET 2

FIG. III



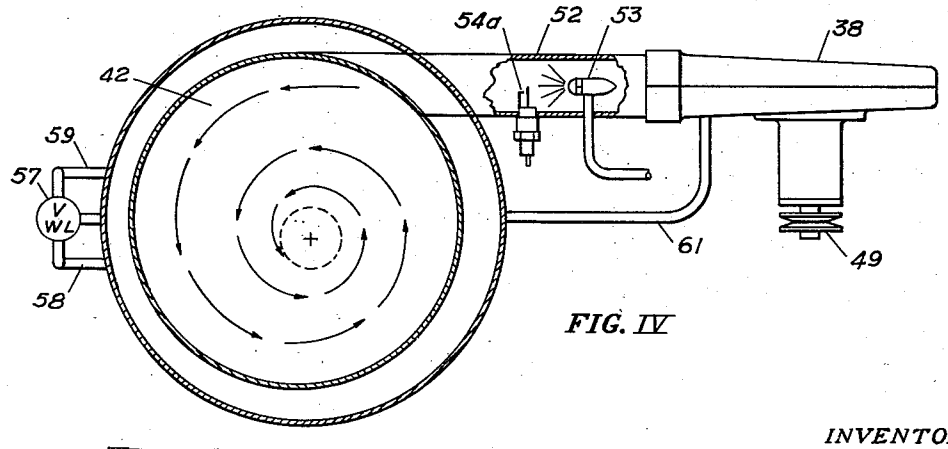


FIG. IV

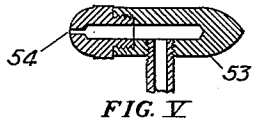


FIG. V

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UNITED STATES PATENT OFFICE

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MECHANICAL AEROSOL GENERATOR

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Application May 24, 1944, Serial No. 537,176

8 Claims. (Cl. 252—359)

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My invention relates to a machine for the generation of an aerosol composed of any one of various materials and its distribution into the atmosphere in the form of a cloud useful for a number of purposes, such as the concealment of ships at sea, or troops on land or sea, or protective operations of the various kinds.

The aerosol produced also may be composed of material containing an insecticide capable, for example, of clearing an area of mosquitos or other dangerous insects, or killing insects damaging to fruits, vegetation, trees and the like.

The invention consists of a machine, preferably power operated, which utilizes heated high velocity combustion gases, into which the aerosol material in the form of a liquid is introduced, to atomize the liquid without injury thereto into comminuted particles of microscopic and reasonably homogeneous character, capable of floating as a cloud in the air.

My generator may be described as a motor operated unit comprising preferably a blower or compressor; a combustion chamber; a mixing chamber connected by a Venturi passage to the combustion chamber; a fuel pump for gasoline or fuel oil to feed the combustion chamber as well as the motor when of the internal combustion type; a second pump for the aerosol producing liquid; and a source of cooling water under moderate pressure. The motor drives the blower which delivers air at high speed into the combustion chamber, the air being fed with the fuel oil or gasoline past a spark plug or ignition electrodes to ignite the air and fuel mixture under such conditions that the combustion gases in the combustion chamber have a whirling motion or eddy around an axis. In line with this axis is a constricted orifice leading from the combustion chamber such, for example, as a Venturi passageway, in which the pressure of the gases is converted largely to velocity and where an aerosol oil or liquid is introduced into the combustion gases and there subject to vaporization as they travel through the Venturi passageway at high velocity.

Above or beyond the Venturi passageway is an expansion chamber where the gases and vapor slow down in speed and increase in pressure, still retaining, preferably, the characteristic whirling motion, after which they are vented through additional constrictions or Venturi tubes into the air at considerable velocity in an expanding volume.

The combustion gases are maintained as devoid of excess air as is practical, and are given such a high velocity through the Venturi passageway at the point where the aerosol liquid is injected as to prevent any appreciable "cracking" or breaking up of the aerosol liquid into its component parts, chemically speaking. As the pressure of the combustion gases is passing through the Venturi orifice is converted into velocity, there is a balancing of temperature which completes vaporization and also contributes to preventing the aerosol oil from cracking.

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In the drawings:

Figure I is an elevational view partly in section of one form of my apparatus for creating the aerosol.

Figure II is a horizontal view partly in cross section taken on line II—II of Figure I.

Figure III is an elevational view taken partly in section of an improved form of my machine.

Figure IV is a horizontal view partly in cross section of the improved machine taken on the line IV—IV of Figure III.

Figure V is a cross sectional detail of the fuel oil nozzle.

The machine as shown in Figs. I and II comprises a blower 1, adapted to be operated by a motor 2, the belt 3 connecting them turning the blower pulley 4 and driven by the motor pulley 5, these parts being properly located for the purpose. The blower 1 delivers air sufficient in both pressure and volume to create the needed high velocity in the constricted passageway and through the outlets to prevent injury to the aerosol producing material. Air pressure preferably about one pound above atmosphere is employed in the machines shown in Figs. I to IV. The air passes through the blower duct 6 into the combustion chamber 7. On the way through the duct 6, fuel oil or gasoline, or the like, is driven through the atomizer 8 from pipeline 9 by a fuel pump 10 operated by the motor 2, the fuel pump 10 drawing its supply from any suitable source such as a reservoir 11. A pressure relief valve 12 may be provided to adjust the amount of oil delivered to the pipe 9, permitting the unused portion to travel back through the pipe 13 to the reservoir 11. An ignition device 14 ignites the mixture of fuel oil or gasoline and air so that the gas entering the combustion chamber is a resultant gas of combustion. By carefully adjusting the valve 12, the requisite ratio of fuel oil or gasoline and air is arrived at so that the combustion gas is substantially neutral, it being understood that a small excess of

air is usually unavoidable. The less excess air there is, the less injury to the aerosol. In place of combustible mixtures of air and fuel oil or gasoline, any other combustible material may be used. My invention is not limited to this particular means of producing combustion gases, the main requisite being that there shall be a volume of hot gases entering the Venturi section and that they shall be substantially neutral in their effect upon the aerosol producing liquid or other liquid utilized in the machine.

It will be noted by referring to Fig. II that the duct 6 leads into the combustion chamber 7 tangentially so that the gases have a whirling motion, with the axis of the whirl in the particular arrangement shown being off center in the combustion chamber, as indicated in Fig. II by the position of the tube 15. It is found that when this whirl axis, naturally produced by circular combustion, is also in alignment with the vertical axis of the constriction or Venturi tube 16, the best results are obtained.

One of the objects of this invention is to provide a machine of high efficiency and small size, and if the axis of the whirling action is not in line with the vertical axis of the Venturi tube 16, unnecessary power would be consumed which would require a corresponding increase in size and weight of the machine.

When it is desirable to cool the combustion gases before the introduction of the aerosol liquid, or to cool the aerosol pipe 28, a coil pipe 17 may be used as shown in Fig. I, to supply steam to the duct 15 enclosing the aerosol pipe 28. Some of the heat of combustion is imparted to the water in this coil pipe 17, converting it into steam. Water is drawn from the reservoir 18 by a suitable pressure pump 19 to create sufficient pressure to drive the water through the pipe 20 into the coil 17. The water issues in the form of steam through the coil outlet 21 and into the tube 15 to cool the aerosol liquid supply pipe 28 and thereby reduce the dangers of "cracking" or decomposition into carbon of the aerosol producing liquid as it travels upward through the Venturi passageway 16. A valve 22 in the pipe 20 may be provided to adjust the amount of water supplied to coil 17 so that all water is converted into steam in the coil 17 and no water is delivered into the Venturi passageway 16. The aerosol producing liquid is ejected from the nozzle portion 29 of supply pipe 28 and introduced into the combustion gas passing through the Venturi passageway 16.

The aerosol producing liquid and combustion gas mixture flowing through the Venturi passage 16 has a lineal velocity of from 400 to 600 feet a second, which high lineal velocity prevents the aerosol liquid from thermal cracking and discoloring the cloud. Since sufficient concealing fog is white in color, a discolored cloud would indicate thermal cracking and inefficient conversion of the liquid to fog.

Another factor important to the prevention of cloud discoloration is the maintenance of the neutral character of the combustion gases, since excess oxygen would cause combustion of the aerosol producing liquid. Discoloration of the cloud indicates cracking or decomposition of the aerosol producing liquid. Liquid for concealment purposes has low vapor pressure, and useful persistence of the cloud requires that the liquid be neither cracked nor decomposed.

A third factor of operating importance is the production of a large volume of aerosol fog which can be produced from a specified quantity of aerosol producing liquid. My machine produces a large volume of aerosol fog from a given quantity of aerosol liquid, and will convert to fog approximately its own weight in aerosol liquid in fifteen minutes, and is lighter in weight than the machines heretofore used in fog making.

It will be appreciated, that if a substantial percentage of the aerosol producing liquid is cracked or oxidized or decomposed, there must be a corresponding increase in the load of aerosol oil carried with the machine with which to operate it, and an additional supply of combustion gas producing fuel must also be carried. If the aerosol liquid is cracked, oxidized or decomposed to any appreciable extent, the increased amount of liquid required to produce a fog screen of comparable volume may well be of such proportions as to render the instrument substantially valueless.

Another factor of importance is the degree of opacity of the cloud produced. When the aerosol liquid is cracked, carbonized or decomposed, its opacity is correspondingly reduced so that objects may be seen through it, in which case it loses concealment values. The aerosol fog produced by my machine has a persistent floating effect so that it is able to be borne along by breezes to distant points. My machine combines the many scientific factors required to produce a cloud that will float long distances and be opaque for purposes of concealment.

When the aerosol liquid contains an insecticide, it is also important to avoid cracking and oxidation of the insecticide containing liquid so that the cloud is sufficiently dense to maintain its insecticide quality, and reduce the volume of aerosol producing liquid which has to be transported for the operation of the machine.

The combustion gas pressures generated are more or less related to the barometer at the point where the machine is used, and when the barometer is substantially different, as at high altitudes, pressures and velocities may be reduced or stepped an average barometer level the combustion gas pressure and velocities may be reduced or stepped up for various purposes so long as their relation remains such as to attain the results set forth. This machine is therefore not limited to the attainment of any specific velocity or pressure, but may be adjusted as operating conditions indicate to produce successful clouds for concealment and/or insecticide purposes.

The aerosol producing liquid is composed preferably of an oil of the type having a relatively high viscosity and low vapor pressure, such as "#500 Pale Oil" or the like, and is drawn from a reservoir 23 as shown in Fig. I. A pump 24 operated by motor 2 drives the aerosol liquid through the duct 25 into the coils 26 contained in the side and bottom walls of the combustion chamber and finally to the valve 27 through the tube 28 to the nozzle 29. The valve 27 or valve 30 in the duct 25 may be adjusted to deliver such a volume of aerosol producing liquid as will be converted into a cloud when ejected into the atmosphere as will now be described, the balance returning to the tank 23 through branch line 25'.

The combustion gas carrying the aerosol producing liquid in vaporized form passes upward from the Venturi passage 16 and into an expansion chamber 31 of such shape and size that the velocity of the gas-vapor mixture is reduced and the pressure increased to effect complete mixing of the combustion products and the aerosol vapor. After mixing in chamber 31, the combined gas

and aerosol liquid vapor mixture issues through one or more Venturi outlets or nozzles 32 into the atmosphere. The speed at which the gaseous vapor mixture issues through the second Venturi outlets or nozzles 32 determines the rate at which the aerosol vapor is chilled in the atmosphere.

The purpose of the upper expansion chamber 31 is to insure thorough vaporization of the highest boiling point parts of the aerosol oil, which will take longer by a minute fraction of a second than that required to completely vaporize the lower boiling point parts of the oil, thereby permitting the use of various boiling hydrocarbon oils. A good aerosol producing oil may be described as a high boiling range oil possessed of exceedingly low vapor pressure with the boiling range rather narrow. The reason the cloud persists if produced correctly is low vapor pressure. For example, if kerosene was put through the machine, it would turn to fog capable of travelling probably 100 feet after which it would almost entirely disappear. No. 2 fuel oil would produce a fog which would persist for approximately ½ to ¾ of a mile. Best of all is the oil described above which persists an indefinite distance.

As the gases pass through the Venturi passageway 16 and up through the expansion chamber 31, the whirling effect is more or less maintained, assisting in the more even distribution of the aerosol vapor in the neutral gases of combustion.

A thermostat 33 may be provided to indicate the temperature of the gases in the expansion chamber 31. The various valves may be manipulated to secure the best temperatures in the chamber 31 for producing the cloud, the thermostat facilitating the correct setting of the various flow and pressure valves for attaining optimum results.

It will be noted that this particular form of apparatus is suited for location near a steam plant, for example, such as is used in various steam driven ships or craft where the source of pressure 19 is conveniently supplied from a boiler or from other apparatus as desired. The combustion chamber 7, Venturi passageway 16 and expansion chamber 31 are preferably surrounded by a double walled casing 34 with insulation 35 between the inner and outer walls. Thus the outer wall retains its full tensile strength unweakened from the effect of heat within.

There is shown in Figs. III and IV my improved form of fog generating machine utilizing as a source of power any suitable prime mover 36, such for example, as an internal combustion engine. This engine drives the pump 37 and the blower 38. The pump 37 may be directly driven by the engine shaft 39 to pump the aerosol liquid from a supply tank 39*a* in the direction of the arrow through the pipe 40, coil 41 positioned outside of and surrounding the combustion chamber 42, and pipe 43 to the valve 44 where the aerosol liquid is supplied to the annular duct 45 around the restricted Venturi passageway 46. The aerosol producing oil in the annular duct 45 enters the Venturi passageway 46 through the holes 47, of which there may be any suitable number to evenly distribute the aerosol oil into the gas passing up through the passageway 46. The valve 44 may be used to regulate the amount of aerosol oil admitted. A pressure valve 48 in line 43 may be provided to regulate the return of such liquid as is not needed to the supply tank 39*a*.

The blower 38 is driven by its pulley 49 from the belt 50 driven in turn by the pulley 51 on the engine shaft 39. The blower 38 is not shown in detail but may be any suitable blower or compressor preferably of the centrifugal type. Air from the blower 38 passes through the duct 52 into the combustion chamber 42 tangentially, to create the whirling motion indicated by the arrows in Fig. IV.

Gasoline or fuel oil is introduced into the pipe 52 by a pressure volume regulating nozzle 53 of any well known type. One form of suitable nozzle 53 is shown in Fig. V having an orifice 54 adjustable in size to supply the proper amount of gasoline or fuel oil for perfect combustion when ignited by the plug 54*a* with the volume of air supplied by the blower 38. As such apparatus is never 100 per cent perfect in attaining combustion, a slight excess of air such as a few per cent is calculated upon to get the combustion as perfect as is practical. Such a slight excess of air distributed through the combustion gas appears to have no discernible effect or impairment of the color and quality of the cloud produced.

The combustion chamber 42 at its upper end is reduced in area to gradually and efficiently convert the pressure of the gas leaving the combustion chamber into velocity as it passes through the Venturi passageway 46.

The aerosol liquid pumped through the pipe 40 and through the coil 41 is heated somewhat by the heat of combustion to thereby reduce its viscosity so that it flows more easily through the valve 44 and the orifices 47, at the same time cooling that portion of the wall of combustion chamber surrounded by the coil 41.

The combustion chamber 42 may be partly immersed in a cooling liquid or water 55 contained in an enclosing casing 56 so that its walls do not become overheated. The water in the casing 56 is maintained at the proper level by the water level control valve 57 connected to the casing 56 by a pipe connection 58. The intake water to the valve 57 is supplied by a pipe 59 connected to a suitable supply tank 60, the amount of cooling water required being relatively small. A pressure pipe 61 extending from the top of the tank 60 to a source of pressure such as the high pressure side 62 of the blower 38 may be employed to provide the pressure to cause the water in the tank 60 to ascend through the pipe 59 into the water level control valve 57, which when open permits the water to flow through the connecting pipe 58 into the tank 56. The water in casing 56 has the effect of cooling the combustion chamber 42, and the water thus heated is partly converted to steam which enters the upper conical portion 63 of the casing 56 to thereby warm up the aerosol liquid in the coil 41, after which the steam is vented into the atmosphere through escape port 64. The amount of heat thus lost to the system is perhaps some 4 B. t. u. out of 70 B. t. u. As the combustion gas passes up through the Venturi passageway 46, the aerosol liquid is introduced into it through the orifices 47 as described, after which the gas-vapor mixture enters the expansion chamber 65. This chamber has an outer and an inner wall with suitable insulation 66 between them. The velocity of the gas-vapor mixture in the expansion chamber 65 is reduced and its pressure increased until the mixture reaches the streamlined outlet nozzles 67 where the mixture issues at high speed into the atmosphere. The pressure of the gas-vapor mixture in the expansion chamber 65 determines

the velocity at which it is ejected into the atmosphere.

The velocity of the gas-vapor mixture flowing out of the nozzles **67** is important. Too low a velocity results in flaming characteristics which destroy the utility of the mechanism. With the proportions of chamber shown, at sea level, a blower pressure of about one pound maintains a high efficiency throughout the system and this relation of pressure to the final velocity through the orifices **67** is termed the system pressure and is a controlling factor of the efficiency of the machine.

With such pressures and speed through the nozzles **67**, there is an ultra rapid chilling and condensation of the aerosol vapor to a point below its flash or fire point, thus forming an opaque cloud. It may be noted that for purposes of concealment the aerosol fog produced should be homogeneous in the matter of particle size, which size should be not less than .3 micron radius nor more than .4 micron radius for best results.

Almost any liquid hydrocarbon will produce a cloud in my machine, though liquid hydrocarbons having low vapor pressures are preferable. For insecticide purposes a suitable light weight poison is added, in which case the liquid hydrocarbon is the carrier. I have used "DDT" (dichlorodiphenol trichloroethane) effectively in about the proportion of one part of "DDT" to 50 parts of liquid hydrocarbon by weight.

It is obvious that the moment the engine **36** is started the whole system is put into full operation, with the creation of the combustion gas in the combustion chamber **42** and the introduction of the aerosol liquid into the Venturi passageway **46**. There are no long passageways or coils for the gases to pass through which may cause pressure increase above the point of safety. The amount of heat loss is negligible, and the heat produced is almost entirely applied to the mixing of the aerosol liquid and the gas to effect liquid vaporization and diffusion to the atmosphere. The machine is simple to build and repair and in the smaller sizes can be lifted by manual effort.

This improved fog generator may be constructed to be readily portable and may be used to produce large volumes of cloud for concealment purposes, or for disseminating insecticides. The machine shown in Figs. III and IV is relatively small in size and light in weight, has the capacity to produce large volumes of cloud from a relatively small amount of aerosol liquid and fuel oil, and converts over 95% of the liquid into useful aerosol.

As a combustible oil is usually employed for generating the gases in the combustion chamber, I prefer an engine capable of operating with the same oil as fuel. A gasoline engine meets these objectives, since gasoline is also usable as fuel for the combustion chamber. However, any practicable source of combustion gas may be supplied to the combustion chamber, and the air supply may be provided by any suitable power, the apparatus above described being merely illustrative.

Accordingly, my invention is not limited to the particular elements and forms shown and described, its essential characteristics being set forth in the following claims.

What I claim is:

1. A machine for producing a persistent fog which includes, a throat section having a constricted Venturi type passage, pressure means for forcing a combustion gas through said constricted passage at high lineal velocity, an inlet nozzle for spraying an aerosol liquid into said constricted passage and into said high velocity stream of combustion gas to be vaporized thereby, an enclosed reception chamber connected to the outlet end of said constricted passage for receiving said mixture of aerosol vapor and combustion gas, and a discharge nozzle having a passage leading from said enclosed chamber to the atmosphere through which said vapor and combustion gas mixture is ejected to the atmosphere.

2. A machine for producing a persistent fog which includes, a combustion chamber, means for forcing combustion air and fuel into said combustion chamber, a throat section having a constricted Venturi type passage connected to said combustion chamber whereby the combustion gas from said chamber is projected through said constricted passage at high lineal velocity, an inlet leading into said constricted passage through which aerosol producing material is sprayed into said high velocity stream of combustion gas to be vaporized thereby, an enclosed pressure chamber connected to the outlet end of said constricted passage for receiving said mixture of aerosol vapor and combustion gas, and a plurality of discharge nozzles each having a restricted passage leading from said pressure chamber to the atmosphere through which said vapor and combustion gas mixture is ejected to the atmosphere.

3. A machine for producing a persistent fog which includes, a tapered funnel, a throat section having a constricted Venturi type passage connected to the reduced end of said funnel, means for forcing highly heated combustion gas into the enlarged end of said funnel and through said constricted passage at high velocity, an inlet opening leading into said constricted passage through which aerosol producing material is conducted into said high velocity stream of combustion gas to be vaporized thereby, an enclosed reception chamber connected to the outlet end of said constricted passage for receiving said mixture of aerosol vapor and combustion gas, and a discharge nozzle having a restricted passage leading from said chamber to the atmosphere through which said vapor and combustion gas mixture is ejected to the atmosphere.

4. A machine for producing a persistent fog including in combination, a combustion chamber, means for forcing a combustible mixture of air and hydrocarbons into said combustion chamber, a tapered funnel having the base end thereof connected to said combustion chamber, a throat section having a constricted Venturi type passage connected to the reduced discharge end of said tapered funnel, an enclosed mixing chamber connected to the discharge end of said constricted passage, means for feeding a liquid aerosol material into said constricted passage whereby said liquid aerosol material is vaporized and suspended in said stream of combustion gas moving into said mixing chamber, and a discharge nozzle having a restricted discharge passage connecting to said mixing chamber through which the aerosol vapor and combustion gas mixture is discharged to the atmosphere.

5. A machine for producing a persistent fog including in combination, a combustion chamber, means for forcing a combustible mixture of air and hydrocarbons into said combustion cham-

ber, a tapered funnel having the base end thereof connected to said combustion chamber for receiving the combustion gas escaping from said combustion chamber, a throat section having a constricted Venturi type passage connected to the reduced discharge end of said tapered funnel through which the escaping combustion gas is discharged, an enclosed mixing chamber connected to the discharge end of said constricted passage, means for feeding a liquid aerosol material into said high velocity stream of combustion gas during its passage through said constricted passage whereby said liquid aerosol material is vaporized and suspended in said stream of combustion gas moving into said mixing chamber, and a plurality of discharge nozzles each having a restricted passageway connecting to said mixing chamber through which the aerosol vapor and combustion gas mixture is discharged to the atmosphere.

6. A machine for producing a persistent fog including in combination, a combustion chamber, a fuel supply line leading into said chamber, means for forcing a controlled supply of air into said combustion chamber whereby a combustible mixture of air and fuel is formed in said chamber, a tapered funnel having the base end thereof connected to said combustion chamber for receiving the combustion gas escaping from said combustion chamber, a throat section having a constricted Venturi type passage connected to the reduced discharge end of said tapered funnel through which the escaping combustion gas is discharged, an enclosed mixing chamber connected to the discharge end of said constricted passage, means for feeding a liquid aerosol material into said high velocity stream of combustion gases during its passage through said constricted passage whereby said liquid aerosol material is vaporized and suspended in said stream of combustion gas moving into said mixing chamber, and a discharge nozzle having a restricted passage connecting to said mixing chamber through which the aerosol vapor and combustion gas mixture is discharged to the atmosphere.

7. A machine for producing a persistent fog including in combination, a combustion chamber adapted to contain a substantially oxygen free combustion gas, a discharge funnel having the base end thereof connected to said combustion chamber through which said combustion gas may escape, a throat section having a constricted Venturi type passage connected to the reduced discharge end of said tapered funnel, pressure means for driving said combustion gas from said pressure chamber, through said funnel and through said constricted passage at high velocity, a nozzle projecting through the wall of said throat section through which liquid aerosol material may be sprayed angularly into said high velocity stream of combusted gas during its passage

through said constricted passage whereby vaporization of said liquid aerosol material is effected, an enclosed pressure and mixing chamber of larger internal diameter than the diameter of said constricted passage connected to the discharge end of said constricted passage for receiving the vapor and combustion gas mixture discharging from said restricted passage, and a discharge nozzle connected to said mixing chamber through which the aerosol vapor and combustion gas mixture is discharged to the atmosphere.

8. A machine for producing a persistent fog including in combination, a combustion chamber adapted to produce a substantially oxygen free combustion gas, a discharge funnel having the base end thereof connected to said combustion chamber through which said combustion gas may escape, a constricted Venturi type passage connected to the reduced discharge end of said tapered funnel, pressure means for driving said combustion gas through said constricted passage at high velocity, a heating coil positioned adjacent the wall of said tapered funnel and in heat exchange relationship with the combustion gas discharged through said funnel, an inlet to said coil through which liquid aerosol material may be supplied to said heating coil, an outlet conduit connected to said coil through which the heated aerosol material passing through said coil may be discharged, a nozzle projecting through the wall of said constricted passage and connected to said discharge conduit through which liquid aerosol material may be projected angularly into said high velocity stream of combusted gas passing through said constricted passage whereby vaporization of said liquid aerosol material is effected, a mixing chamber connected to the discharge end of said constricted passage for receiving the vapor and combustion gas mixture discharging from said restricted passage, and a discharge nozzle connected to said mixing chamber through which the aerosol vapor and combustion gas mixture is discharged to the atmosphere.

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