June 2, 1959 G. P. HAYNES ET AL 2,889,284

VORTEX FOG GENERATORS

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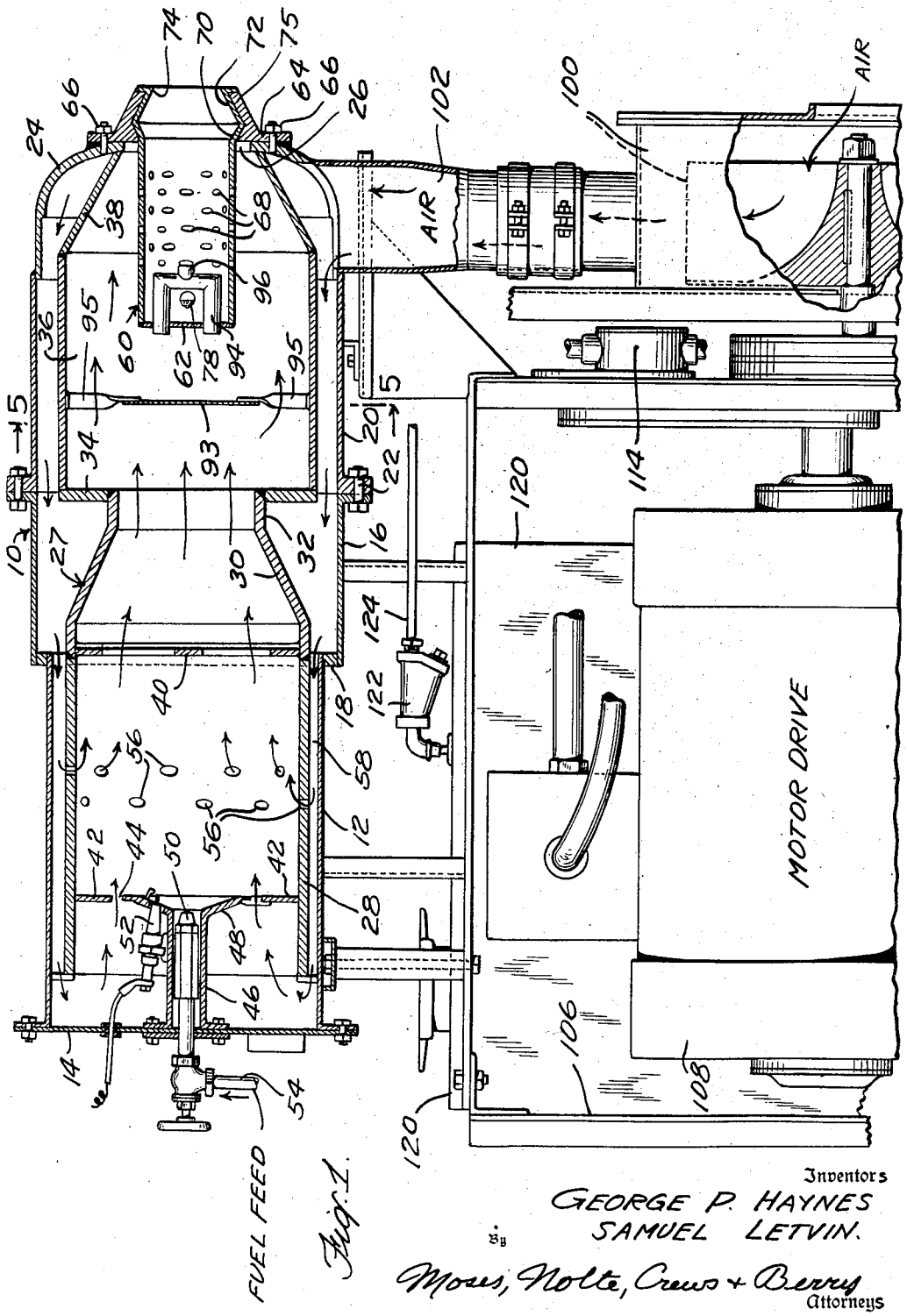


Fig. 1.

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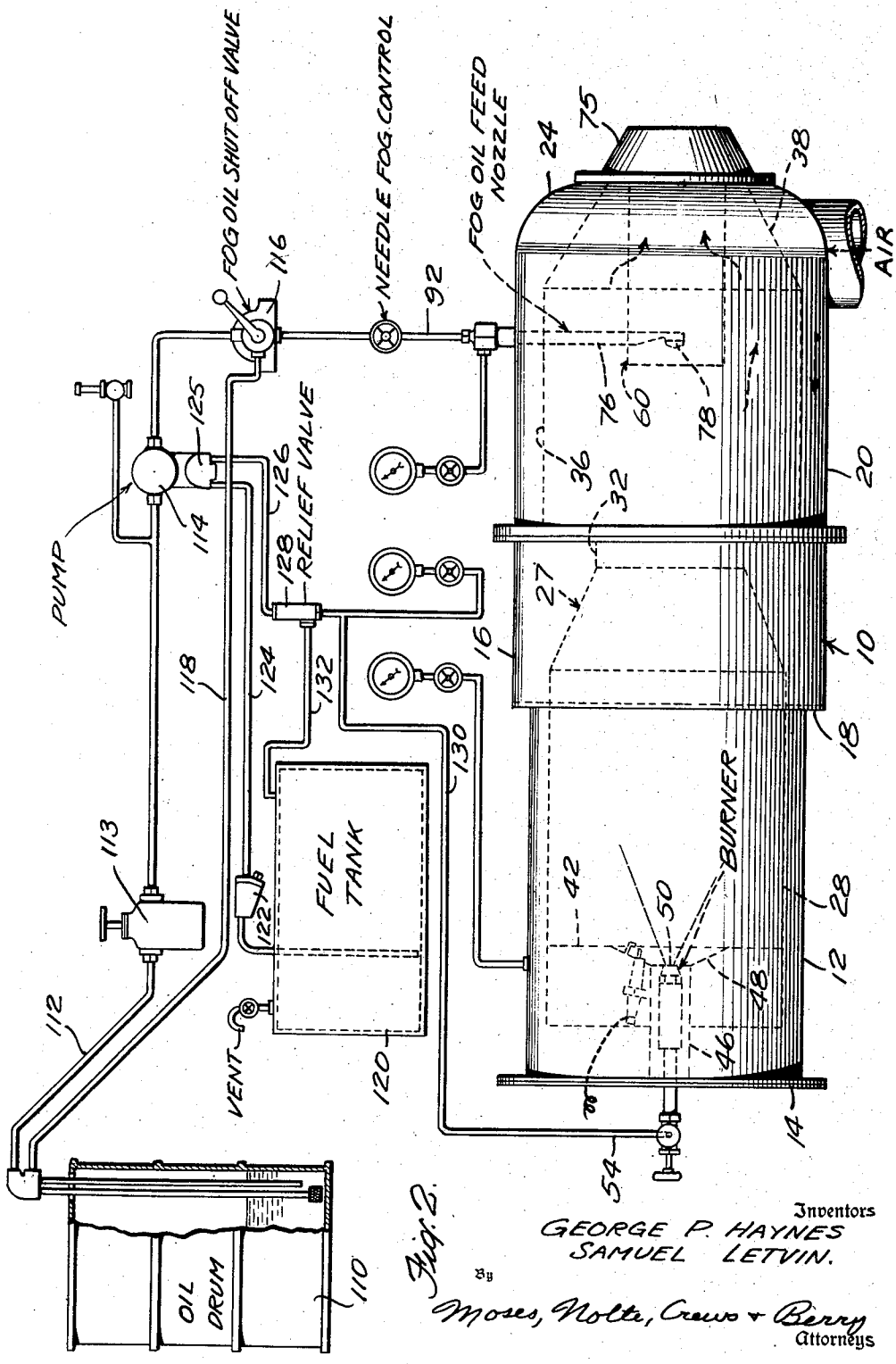


Fig. 2.

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Fig. 3.

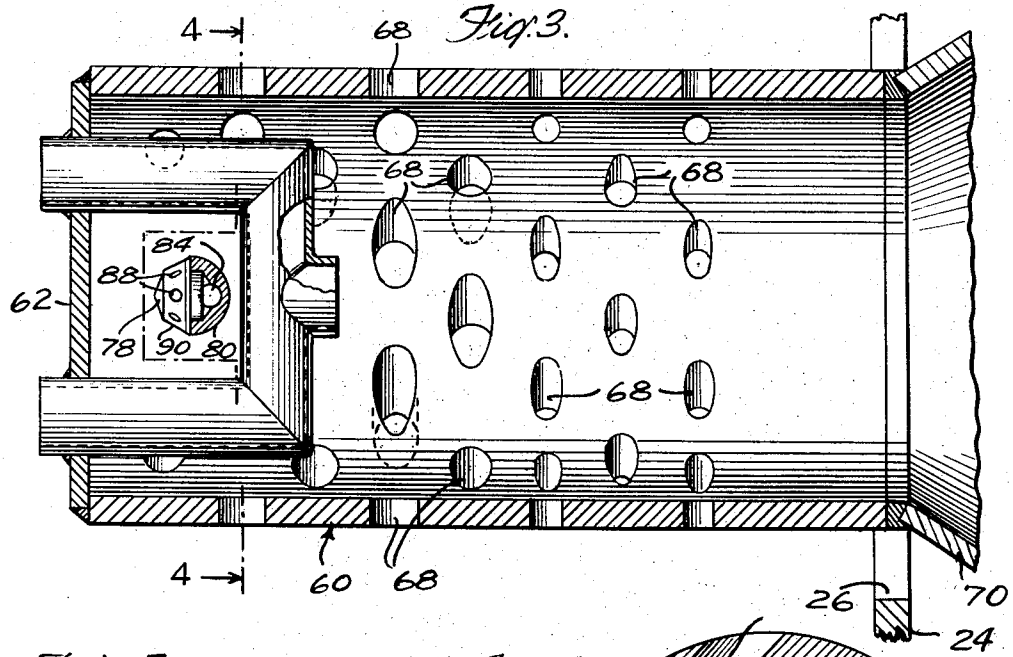


Fig. 5.

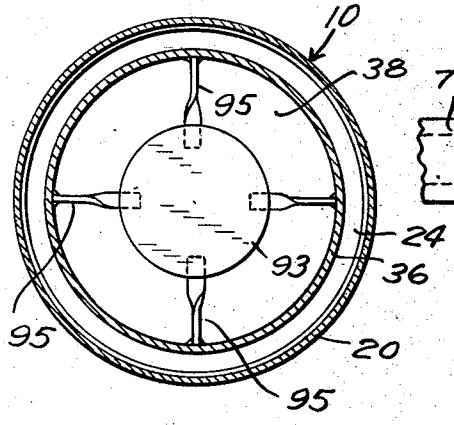


Fig. 4

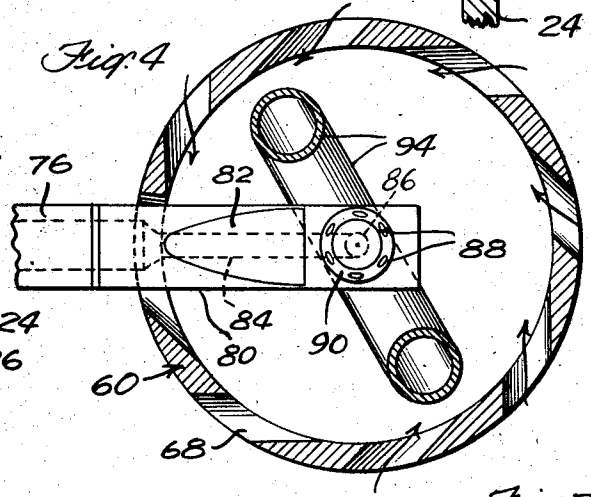
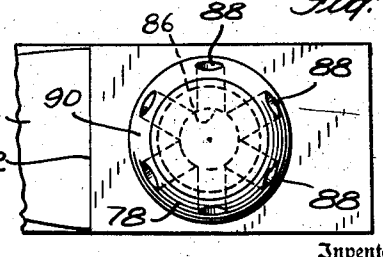


Fig. 7.



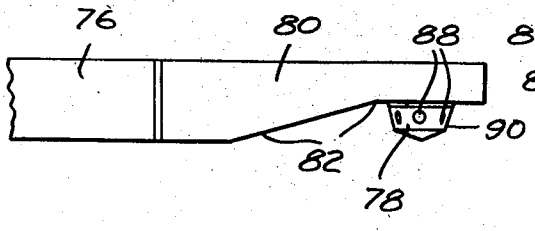


Fig. 6.

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VORTEX FOG GENERATORS

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Application March 10, 1951, Serial No. 214,891

14 Claims. (Cl. 252—359)

This invention relates to fog generators for generating and discharging a fog or cloud of vapor. The generator of the present invention is particularly suitable for continuous production of a large volume of fog as a protective screen for military use. It may also be utilized for other purposes, as for providing a body of fog for protecting orchards against frost or for dispersing insecticides, fungicides, etc.

In the production of fog screens for military purposes, certain considerations are vital. One is that the fog generator must be able to operate for long periods of time without interruption for cleaning or purging. It is also important that when the generator is shut down, there should be no afterglow or discharge of sparks or flames which might be visible to the enemy. It is also important to provide a generator in which the fog formation is uniform, in which the fuel and fogging materials are used without waste, and in which the temperatures of the parts are kept under control to secure reliable results and to prevent rapid destruction of the apparatus.

The nature and objects of the invention will be better understood from the description of one preferred illustrative embodiment of the invention shown in the accompanying drawings which form a part of this specification.

In the drawings, Figure 1 is a view partly in side elevation and partly in vertical section of a fog generator embodying the invention;

Fig. 2 is a diagrammatic view showing the generator in plan and illustrating the piping connections thereto;

Fig. 3 is a vertical section on an enlarged scale showing the vortex cup or mixing chamber;

Fig. 4 is a transverse section on line 4—4 of Fig. 3;

Fig. 5 is a transverse section through the generator on line 5—5 of Fig. 1;

Fig. 6 is a plan view of a nozzle for discharging the fogging substance; and

Fig. 7 is a side elevation on a larger scale of the discharge nozzle.

Referring to the drawings in detail, the fog generator in the illustrative form shown comprises an outer casing **10** of generally cylindrical form having portions of two diameters. The casing **10** comprises a rear cylindrical portion **12** closed at the back by an end wall **14**. A central section **16** of the casing is of slightly larger diameter than the cylinder **12** and is connected thereto by a flange or ring **18**. A third portion of the casing **20** is of the same diameter as the portion **16** and is connected thereto by bolts **22** passing through flanges on the respective casing parts. The front portion of the casing comprises a curved breast **24** in the front of which is a central opening **26**. Inside of the outer casing is an inner casing **27**, the rear portion of which is a combustion chamber having a cylindrical rear section **28**, a neck **30** of decreasing diameter and a cylindrical collar **32** at the end of the neck. Mounted on the collar **32** is a ring or flange **34** forming a rear wall of a cooling or expansion chamber **36** which is partly cylindrical and at its front end has a sloping band portion **38** of decreasing diameter, the front

edge of which fits against the inner wall of the breast portion **24** of the casing around the opening **26**. An adjustable damper ring **40** is mounted in the combustion chamber near the front of the cylindrical part thereof, by which the size of the opening in this part of the combustion chamber may be increased or decreased. Mounted near the rear end of the combustion chamber is a wall **42** having a circular opening **44** therein. Mounted on the end wall **14** of the outer casing is a tube **46** of an oil burner, which is shown as having an inclined flange **48** at the front end thereof, which is contained within the opening in the plate **42**, there being space for the entry of air around this flange, and through openings therein if such are provided. Mounted in the tube is an atomizer or spray nozzle **50** which may be of any suitable type, and also mounted on the tube and projecting through a hole in the flange **48** is an electric ignition device **52**. Oil is forced under pressure to the spray nozzle through an oil pipe **54**. The combustion chamber is provided with a series of inclined or tangentially disposed holes **56** through which air under pressure may enter from the space **58** between the casing wall **12** and the wall of the combustion chamber. This air supports the combustion of fuel sprayed into the chamber and also causes rapid rotation of the air and atomized oil to procure proper mixing and combustion thereof.

Mounted in the front end of the casing is the vortex cup or mixing chamber **60**. This is shown as a cup of generally cylindrical form with a rear wall **62** and supported near its front end by a ring **64** secured over the opening **26** by bolts **66**. The part of the cup extending into the gas chamber is of preferably cylindrical form and is provided with a multiplicity of tangentially inclined holes **68**, through which hot gases will enter, and owing to the tangential arrangement will be caused to rotate rapidly in the cup, forming a central vortex. At the forward end of the cylindrical portion of the cup is an outwardly flaring portion **70** followed by an inclined portion **72** of contracting diameter which bounds a fog discharge orifice **74**. The projecting portion of the cup is preferably enclosed by a ring **75** of insulating material. The fogging substance, which may be oil or a vehicle carrying a chemical fog forming or treating agent, is introduced into the vortex cup through a suitable nozzle. In the construction shown, a nozzle pipe **76** is provided which projects laterally through the walls of the casings and the wall of the vortex chamber and has at its end a spray head or nozzle **78** which is located on the axis of the vortex chamber. As shown particularly in Figures 3, 4, 6 and 7, the nozzle pipe **76** terminates in a fitting **80**, which is flattened on one side, as indicated at **82**, and has a hole **84** therein. Mounted on the flattened portion **82** of the pipe is the spray nozzle head **78** which has a central bore **86** which communicates with a plurality of radial discharge orifices **88**. The bore **86** is closed at its outer end so that all of the oil is discharged through the orifices **88**. The side wall **90** of the nozzle head through which the orifices **88** open is preferably slightly sloped, as shown particularly in Fig. 6. The discharge nozzle is preferably so placed in the cup that it is near the rear wall thereof and faces the rear wall so that the oil is discharged in a radial and somewhat rearward direction, as appears clearly from Fig. 3. Oil or whatever other fogging substance is used is discharged into the nozzle pipe **76** through a feed pipe **92** (Fig. 2).

The form and arrangement of nozzle described injects the oil or other fogging substance uniformly on the side wall at the rear of the cup. The oil is then picked up by the rotating gas film entering through the holes **68** and the oil and hot gases are mixed thoroughly by the vortex action of the cup, and the resultant mixture is projected from the cup as a fog. The rapid rotary action of the

gases not only breaks up and mixes the fog oil thoroughly but prevents accumulations of deposit or carbonization of the fog oil on the inside of the cup. The described formation at the mouth of the cup comprising the divergent and convergent walls **70** and **72** acts to homogenize the discharge from the cup, providing complete mixture of heated gas and fog, so that the fog discharge from the outlet is of a highly uniform character.

Mounted in the back of the cup is a gas inlet which may be termed a vacuum breaker. This bleeds a small amount of the heated gases into the center of the vortex in the cup. This prevents the formation of a vacuum or area of very low pressure in the center of the cup in which a small quantity of the fog vapor would remain. Such residual vapor might ignite when the unit is shut off and cause a visible flash which would be very objectionable in the case of military operations. In the construction shown, the vacuum breaker comprises a short U-shaped pipe **94**, the legs of which project through holes in the bottom **62** of the cup and are open to permit entrance of gases. At the center of the crosspiece of the U is a short projecting pipe **96** which opens into the center of the vortex cup.

A baffle plate **93** of circular outline is preferably mounted in the chamber **36** between the plate **34** and the back of the vortex cup. This baffle plate is supported on two or more radial arms **95** and serves to prevent direct impingement of the flames on the back of the vortex cup, so as to prevent overheating of the latter and possible ignition of the charge within the cup.

The necessary volume of air under pressure for operating the generator is supplied by blower **100**, which forces the air through a pipe **102** connected to the casing near the front end thereof. The air then passes rearwardly in the space between the inner and outer casings, entering the combustion chamber through the ports **56** as already described. By introducing the cool air at the front end of the casing, such air circulates around the forward part of the inner casing constituting the "cooling chamber," as it may be termed, and cools this part of the apparatus to some extent, thereby keeping the temperature of the vortex cup under control so as to prevent any danger of ignition of the oil vapor which is to be discharged as a fog, not as a flame. The cool air also acts as an insulator between the wall of the casing and acts to keep the outer casing from getting too hot. The air also prevents the combustion chamber itself from being heated to a destructive temperature. At the same time the air absorbs the surplus heat which is carried into the combustion chamber so as to secure a high thermal efficiency.

Any suitable manner of mounting the parts on a supporting structure and supplying the fuel and fogging oil may be employed. In the construction shown, the parts are mounted on a frame **106** which carries an electric motor **108** connected to drive the blower **100** and also the oil pump or pumps. In the construction shown separate sources of supply are used for the fuel for the burner and for the fogging substance, but obviously a single source could be used if the same oil were used for both purposes. Figure 2 shows diagrammatically a double supply system. The fogging oil is contained in a drum or reservoir **110**, from which it is drawn through a pipe **112** and strainer **113** by pump **114**. The fogging oil passes through a fog oil shut-off valve **116** to the fogging oil feeding pipe **92**. From the fog oil shut-off valve a return pipe **118** leads back to the oil drum. If the fog oil shut-off valve is turned off while the pump **114** is being driven, the oil is simply pumped back to the drum. Fuel for the burner is contained in the tank **120** from which it is drawn through the strainer **122** and pipe **124** to a fuel pump **125**. From the pump the oil is pumped through a pipe **126**, relief valve **128** and pipe **130** to the atomizer. An excess of oil is usually pumped so that when the pressure rises to a higher value than that for which the relief valve is set, the surplus oil will pass through the return pipe **132** to the tank. Suitable gages are provided where needed.

The invention of the present application is a modification of or improvement upon the invention described in our application for U.S. Patent, Serial No. 689,158, filed August 8, 1946, now Patent No. 2,599,465. The apparatus of the present invention is a very compact, efficient and simple construction embodying features adapting it particularly for the production of fog screens for military purposes.

While one preferred embodiment of the invention has been illustrated and described in detail, it is to be understood that changes may be made therein and the invention embodied in other structures. It is not, therefore, the intention to limit the patent to the specific construction illustrated, but to cover the invention broadly in whatever form its principles may be utilized.

We claim:

1. A fog generator comprising an elongated outer casing, an elongated inner casing in the outer casing and extending longitudinally but spaced from the side walls thereof, the inner casing having an open front end adjacent to the end of the outer casing, said end of the outer casing having an opening therein communicating with the interior of the inner casing, a mixing cup having its mouth extending through said opening, the body of the mixing cup extending into the inner casing, an oil atomizer mounted at the rear end of the casings and discharging atomized oil into the rear end of the inner casing, means for introducing air under pressure into the space between the inner and outer casings, air ports for admitting air from the space between the casings into the inner casing adjacent to the oil atomizer, gas ports in the mixing cup for admitting hot gases from the forward part of the inner casing into the mixing cup, and means for introducing a fogging substance into the mixing cup.

2. A fog generator as claimed in claim 1, in which the gas ports for admitting gases into the mixing cup are inclined to radii so as to produce a vortex in the cup.

3. A fog generator as claimed in claim 1 in which the air under pressure is introduced near the front end of the generator adjacent to the location of the mixing cup, air ports for admitting air from the space between the casing into the inner casing adjacent to the oil atomizer, gas ports in the mixing cup for admitting hot gases from the forward part of the inner casing into the mixing cup, and means for introducing a fogging substance into the mixing cup.

4. A fog generator as claimed in claim 1 in which the air ports for admitting air into the inner casing adjacent to the oil atomizer are inclined to radii so as to cause rotation of the air entering said part of the inner casing.

5. A fog generator as claimed in claim 1 in which there is a baffle disc of smaller diameter than the diameter of the inner casing mounted transversely in the inner casing back of the mixing cup.

6. A fog generator comprising an outer casing, an inner casing therein having walls spaced from the outer casing so as to provide an air space around the inner casing, a mixing cup mounted inside of and near one end of the inner casing, said cup having a discharge orifice to the outer atmosphere, means for introducing a fogging substance into the mixing cup, means for introducing cool air under pressure into the space between said casings at a point adjacent to the location of the mixing cup, a combustion chamber, means for introducing fuel into said chamber, means for introducing air from the space between said casings into said combustion chamber, and means for conducting the hot combustion gases from said combustion chamber to the inner casing adjacent to the mixing cup, and ports for admitting said hot gases into the mixing cup.

7. A fog generator as claimed in claim 6 in which the ports for admitting gases into the mixing cup are inclined so as to produce a vortex in the mixing cup.

8. A fog generator comprising an outer casing, an inner casing therein having walls spaced from the outer casing so as to provide an air space around the inner casing, a mixing cup near one end of the inner casing having a discharge orifice to the outer atmosphere, means for introducing a fogging substance into the mixing cup, means for introducing air under pressure into the space between said casings adjacent to the location of the mixing cup, a combustion chamber, means for introducing fuel into said chamber, means for introducing air from the space between said casings into said combustion chamber, means for conducting the hot combustion gases from said combustion chamber to the inner casing adjacent to the mixing cup, ports for admitting said hot gases into the mixing cup, said ports being inclined so as to produce a vortex in the cup, and a vacuum breaker duct opening into the inner casing and having a discharge outlet located on the axis of said cup.

9. A fog generator as claimed in claim 8 in which the means for introducing the fogging substance into the mixing cup comprise a nozzle located axially of said cup between the back of the cup and the discharge orifice of the vacuum breaker duct.

10. A fog generator comprising an elongated outer casing, an elongated inner casing in the outer casing and extending longitudinally and spaced from the side walls thereof, the rear part of the inner casing constituting a combustion chamber and the forward part of the inner casing constituting a cooling chamber, said casing parts being connected by a tapered neck portion, the end of which communicating with the cooling chamber is of smaller diameter than the end connecting with the combustion chamber, the inner casing having an open front end adjacent to the end of the outer casing, said end of the outer casing having an opening therein communicating with the interior of the inner casing, a mixing cup having its mouth extending through said opening, the body of the mixing cup extending into the inner casing, an oil atomizer mounted at the rear end of the casings and discharging atomized oil into the rear end of the inner casing, means for introducing air under pressure into the space between the inner and outer casings near the front end of the generator adjacent to the location of the mixing cup, air ports for admitting air from the space between the casings into the inner casing adjacent to the oil atomizer, gas ports in the mixing cup for admitting hot gases from the forward part of the inner casing into the mixing cup, and means for introducing a fogging substance into the mixing cup.

11. A fog generator as claimed in claim 10 in which the gas ports for admitting gases into the mixing cup are inclined to radii so as to produce a vortex in the cup and in which the means for introducing the fogging substance into the mixing cup comprise a nozzle located axially of said cup near the rear end thereof and having radially and rearwardly inclined discharge orifices.

12. In a fog generator, a casing, means for supplying hot gases under pressure to said casing, a mixing cup of generally cylindrical form mounted in the casing, said cup opening at one end into the atmosphere and having at the outer end thereof an outwardly flared section followed by an inwardly contracted section constituting the discharge orifice of the cup, said cup having inclined orifices in the cylindrical wall thereof for admission of hot gases and having a spray nozzle located on the axis of the cup near the rear end thereof for admission of a fogging substance, said nozzle having discharge orifices therein directed in generally radial and rearwardly inclined directions.

13. The construction as claimed in claim 12 provided with a vacuum breaker duct having a discharge orifice located on the axis of the cup.

14. A fog generator comprising a casing, a means for supplying hot gases under pressure to said casing, a mixing cup mounted in the casing having a closed rear end, the front end of the mixing cup opening into the atmosphere, inclined ports in the cup wall through which the hot gases under pressure enter the cup and form a vortex therein, means for introducing a fogging substance into the cup including a discharge nozzle located axially of the cup near the back thereof and having discharge orifices directed radially outwardly and somewhat inclined towards the back of the cup, a U-shaped duct mounted on the back of the cup, the legs of the U projecting through said back and open to the interior of the casing, said duct having a discharge orifice located axially of the cup in front of the nozzle.

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