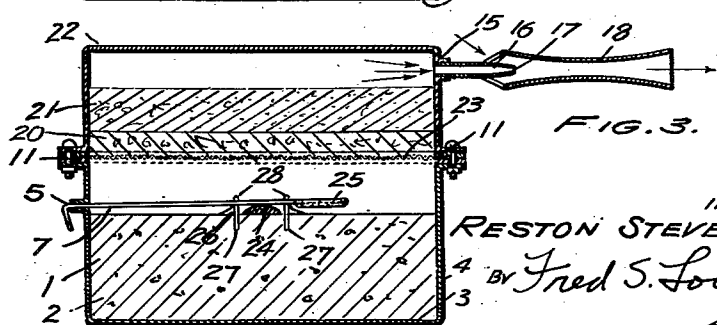
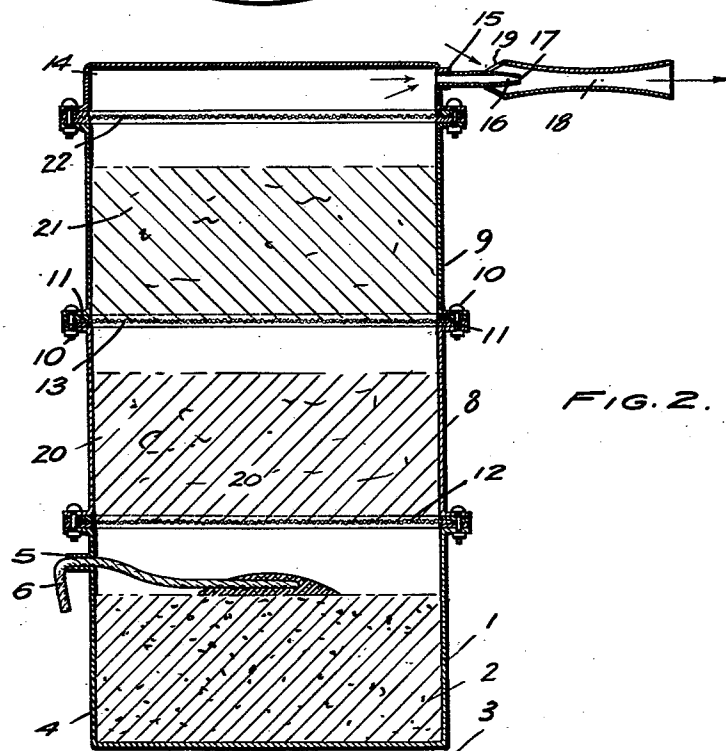
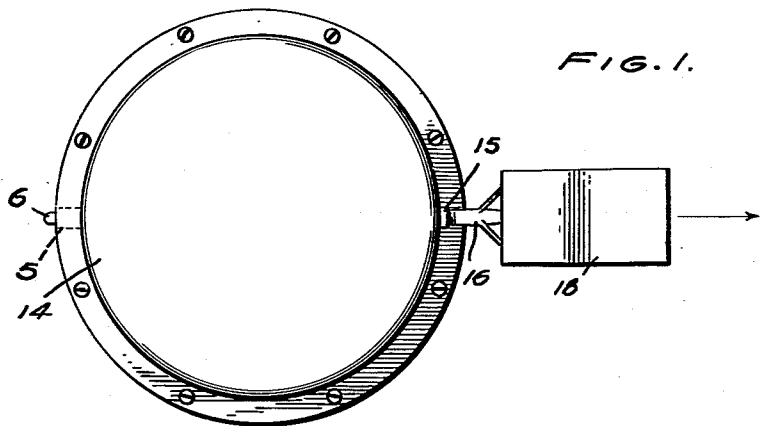


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R. STEVENSON
SMOKE GENERATING DEVICE
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INVENTOR
RESTON STEVENSON
BY Fred S. Lockwood
ATTORNEY

UNITED STATES PATENT OFFICE

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SMOKE GENERATING DEVICE

Reston Stevenson, New York, N. Y., assignor to
the United States of America as represented by
the Secretary of War

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2 Claims. (Cl. 252—359)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to a type of device useful for forming an aerosol dispersion of screening smokes, irritant smokes, toxic smokes and simulated toxic smokes. It is a device which may be described as a smoke candle or smoke pot and which is particularly well adapted for producing particulate clouds of irritant or vesicant smokes which have ability to penetrate gas mask canisters and are difficult to protect against.

An object of this invention is to provide a chemical warfare smoke agent generator having a simplified construction, adapted for convenient manufacture, shipping and salvaging.

Another object of this invention is to provide a generating device which is capable of producing vast clouds of colloiddally dispersed particles from difficultly vaporized substances.

A further object of this invention is to provide an efficient method of forming highly dispersed aerosols from substances which have a tendency to decompose at their normal vaporization temperatures.

Additional objects will be understood from the following disclosure and accompanying drawing.

Hitherto, irritant smoke candles and smoke pots, in general, have operated on the principle of steam distillation by passing a stream of hot gases from a fuel over a solid block of the agent, through a series of ducts and flues formed by baffles. The internal construction of these devices is somewhat complicated, making the cost of construction high and making salvaging of these devices difficult. Parts of the solid agent are exposed in these devices to intense radiant heat and conducted heat, which tends to cause decomposition of many agents. Furthermore, the effectiveness of these devices for obtaining a highly dispersed aerosol has been subject to improvement in order to obtain clouds which are more extensive, more capable of penetrating filters, and more persistent in suspension.

Factors influencing the rate, degree and efficiency of dispersion of smoke particles into air include: the temperature at which the smoke agent is vaporized; the rate of vaporization; the rate at which the vapors are cooled in coagulating; and the rate at which air is mixed with the coagulating smoke particles. There are still other factors of less determinate nature, such as the presence of ionized gas and the ionization of the smoke particles.

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The principal features of interest for use where needed and desired in the present invention include: (a) use of granulated or loosely packed solid agent on a screen or perforated plate through which hot gas passes from a fuel chamber to intimately contact with a large free-surface area of the agent; (b) the use of a device which effects rapid cooling of the vaporized agent and rapid mixing of the coagulated smoke particles with air, preferably the use of a Venturi-type ejector, more particularly a flat ejector that forms a ribbon-like smoke stream; (c) the use of a layer of granulated or loosely packed solid material which is readily vaporized or decomposed into gas, e. g., ammonium carbonate, placed between the fuel and the smoke agent to protect the smoke agent from excessive heating and aid vaporization; and (d) the incorporation into the smoke agent of a substance which lowers the vaporization point of the smoke agent to aid in preventing decomposition of the agent undergoing vaporization.

The smoke generating device of the present invention, in addition to its advantageous features for efficient smoke generation, has the advantages of substantially eliminating complicated internal baffle structure. The generator can be readily filled, disassembled, refilled and reassembled. It can be made into a large-size stationary type for generating a lasting smoke, yet can be transported in sections for emplacement. It can also be made in a readily portable small-size type. It can be made in any desired shape, e. g., cylindrical or box type, and convenient for shipping with low space displacement.

In the accompanying drawing are illustrated diagrammatically two types of smoke generators embodying features of the present invention.

Figure 1 shows a top view of the generator.

Figure 2 shows a vertical cross-sectional view of a four-section, three-compartment generator.

Figure 3 shows a vertical cross-sectional view of a two-section, two-compartment generator.

Referring to Figure 2, there is shown a smoke generator assembly comprising a bottom receptacle section 1 for containing a block of fuel 2, such as smokeless powder. This bottom receptacle for fuel is closed at the bottom 3 and at the sides 4, but a restricted entrance 5 is provided for introducing an igniting means, such as a fuze 6, or for manipulation of a lighting means, such as a match-head scratcher wire 7, illustrated in Figure 3.

Superposed and attached to the bottom receptacle 1 may be one or more intermediate body

sections, such as sections 8 and 9. These intermediate sections are open at the top and bottom and have flanged side walls. Each of these sections is attached to an adjacent section by bolts and nuts 10 or equivalent clamping devices to secure the flanges together, preferably with gaskets 11 between the flanges. Each of the pairs of flanges also serves to hold in place a screen, grid or perforated plate retaining means 12 and 13. These retaining means are used for supporting loosely packed or granulated solid material while being gas permeable to permit free flow of gaseous fluid into and through the supported material from a compartment underneath.

A flanged cover plate 14 is attached at the flange to the upper flange of the top compartment. This cover is provided with a gas and vapor outlet opening 15, which is threaded to receive a threaded nipple 16 of an ejector device. The nipple 16 acts as a nozzle so that the gas and vapor pass through the center thereof and are discharged through a restricted opening 17, thence into the Venturi tube 18 of the ejector. Upon flow into the constricted channel of tube or conduit 19, the gases and vapors develop a suction which causes air to be drawn in at the inlet 19 of the Venturi tube. The mixture of gas vapor and air, upon flowing through the constricted passage of the Venturi tube, undergoes a substantially homogeneous intermingling; and the mixture becomes rapidly expanded and cooled.

As illustrated in Figure 1, the ejector is flat and broadened so that the issuing fluid mixture comes out as a ribbon. Modification of this unit was made employing parts of a Meker burner as an exit tube. However, the ribbon-forming type of ejector produced a much finer aerosol.

In an operation demonstrating the use of the generator illustrated in Figure 2, the bottom compartment 1 was made to hold a fuel block composed essentially of 1400 grams ammonium nitrate-charcoal mixture of which 83.4% was ammonium nitrate. On the first grid 12 was placed 1 kilogram of ammonium carbonate. On the second grid 13 was placed the smoke agent in varying quantities ranging from about 1 kilogram to 2 kilograms. The fuel mixture was ignited through a common powder fuze, and a highly effective aerosol cloud was produced.

In a test generator of the type illustrated in Figure 2, the four sections were cylindrical in shape and were fitted together at their external flanges. Two $\frac{1}{8}$ -inch asbestos gaskets were placed between each pair of flanges. The sections were made from cold drawn seamless steel tubing 7 inches O. D. with $\frac{1}{8}$ inch wall. The height of the bottom section was 6 inches. The height of the next upper section 8 was $3\frac{1}{4}$ inches and of the top chamber 9 was $4\frac{1}{2}$ inches, and the depth of the top cover was about 1 inch. The retaining screen 12 for supporting the layer of ammonium carbonate 20 was a 12 by 12 mesh 0.023 inch steel wire cloth. The retaining means 13 for the loosely packed smoke agent layer 21 was a 20 by 20 mesh 0.016 inch steel wire cloth. The outlet opening 15 in the cover was $\frac{1}{2}$ inch. The Venturi ejector tube $3\frac{1}{4}$ inches long and $1\frac{1}{4}$ inch wide was constricted at the middle to $\frac{1}{4}$ inch inside dimension and expanded at the discharge end to $\frac{5}{8}$ inch inside dimension. This tube was spot brazed to the nipple 16. The nipple was made from a standard iron nipple 1 inch long. The ejector device is screwed into the cover, so that it may be readily detached for convenience

of shipment. A 20-mesh wire cloth 22 may also be used above the layer of smoke-forming agent to prevent clogging of the outlet.

In the compartment between the fuel compartment and the smoke agent, instead of using ammonium carbonate, other substances which tend to evolve gas at temperatures of the order desired for vaporizing the smoke agent may be used. An endothermically decomposable substance in the intermediate compartment may be used to aid in preventing decomposition of a smoke agent that cannot withstand the heat of hot gases directly from the fuel. A decomposable substance in the intermediate compartment may be selected to evolve gases of suitable ionization properties for inhibiting coagulation and precipitation of the smoke agent particles. For example, salts, such as sodium bicarbonate, ammonium chloride, ammonium sulfate or sodium sulfite, may be selected. Also, such substances in the intermediate compartment are effective for controlling the volume and velocity of gas passed through the generator.

If desired, substances may be mixed intimately with the intended smoke agent in order to modify its vaporization. Aside from substances which gasify for this purpose, there may be used substances which increase the vapor pressure of the smoke agents. Substances capable of performing this function are solids which, when mixed with the solid smoke agent, are miscible therewith in the molten state. For example, using a diphenyl or diphenylamine as a smoke agent, the added substance may be ammonium stearate, cyanacetic acid, or 2,4,6-tribromophenol.

In the modified apparatus illustrated in Figure 3, there may be only two compartments or sections: fuel receptacle section 1 containing a fuel cake 2, and an upper smoke agent compartment 21. The upper compartment body includes a cover or top closure 22 and is connected through threaded outlet 15 to the ejector 18 in a manner described with respect to Figure 2. The upper compartment is secured by bolted flanges to the bottom compartment with gaskets 11 and a supporting screen 23 clamped between the flanges. The screen supports a loosely packed layer of solid smoke agent, which may be mixed with a vaporization or dispersion-modifying additive of the kinds described; or the screen may support a layer 20 of a decomposable substance, such as ammonium carbonate, for reducing the temperature of the heating gases and increasing the volume of the gases; and a layer 21 of loosely packed solid smoke agent may rest superimposed on this layer.

The solid substance tending to gasify, e. g., ammonium carbonate, may thus be placed in a position to avoid thermal decomposition of a solid smoke agent by preventing direct radiant heat of the burning fuel from reaching the smoke agent. Also, the solid smoke agent does not have to rest as a solid block on a highly heated plate above the fuel, and accordingly the smoke agent is protected against overheating by heat of conduction. The loosely packed smoke agent supported by a screen or similar retainer receives heat mainly and almost entirely by convection from gaseous products of combustion moderated in temperature and increased in volume by gas evolved from the intervening layer of the decomposable substance. It is also possible to use a substance which gasifies to form a noxious gas as the intermediate protective material and thus increase the harassing effects of the generator.

In Figure 3 is illustrated another form of igniting device which may be used in any modification of the generator. This ignition device comprises a match-head 24 and a scratcher wire 7 having a phosphorus coating, e. g., a coating of red phosphorus (6 parts), fine sand (3 parts) with 2 parts dextrine as binder. The match-head, e. g., a mixture of KClO_3 (5 parts), antimony sulfide (2 parts), and dextrine (1 part), is crimped into a zinc cup 26 set in the center on the surface of the fuel cake 2 and held in place by anchor posts 27 that pierce the cup and are imbedded in the cake. The tops of the anchor posts have loops 28 which serve as guides for the scratcher wire 7. The coated portion of the wire normally lies to one side of the match-head. The uncoated portion of the wire extends outward through a hole 5 in the side of the compartment where it terminates in a ring or band for manipulation. The ring or band is held in place against the exterior side wall by a tape until used. When the generator is to be fired, it is placed on the ground in an upright position with the ejector attached and with the tape removed, and the wire is pulled outward quickly to make the scratcher rub against and set afire the match-head.

Still other types of ignition devices may be used with the generators, such as those having a striker, primer and starter, as in smoke candles.

With its simplified internal arrangement, the present generator is adapted to be made in a form which readily and automatically rolls into an upright position regardless of the position in which it falls or is placed upon the ground. To have this form, the smoke generator may be provided with a weighted bottom and a rounded body shape. The top and bottom parts of the generator body need not be held together by bolted external flanges; they may be secured together by a friction fit, by threading, a slot and head combination or similar means which leave the body exterior smooth and avoid interference with the pot righting itself. The ejector or means for emitting the smoke from the generator may be placed at the top of the generator. An advantage of this type of smoke pot is that such pots can be dropped from fast-moving armored cars or tanks or even dropped with parachutes from airplanes, and when thus distributed with adequate security in a field of combat, will operate efficiently by assuming an upright position automatically.

The generator of this invention is capable of making a highly effective dispersion of noxious gases and irritant smokes from solid agents which are difficult to vaporize or disperse normally without decomposition, such as diphenylamine-chlorarsine, diphenylcyanarsine and the like. It further makes an improvement in the dispersion of agents which could not be effectively dispersed by other means, for example, solid toxic vesicants, such as mustard sulfone.

The generators may have a thermal insulating material covering for increasing their heat efficiency and to give them protection in shipment.

When the generators are not in use and the smoke ejector attachment is not in place, the smoke outlet opening 15 may also be stoppered or taped as well as the ignition device opening.

In addition to the many technical advantages, the smoke generator of this invention very well satisfies tactical requirements in its simplicity, a large-mass cloud formation capacity, flexibility and adaptability for movement and emplacement.

Principles of the invention have industrial applications too, e. g., when it is desired to obtain aerosols by sublimation into fine particles from various solid substances, and particularly in treating substances which are difficult to vaporize without thermal decomposition.

It is to be understood that although the invention has been described with reference to specific illustrations of its embodiment, other modifications come within the spirit and scope thereof.

I claim:

1. A device for generating a smoke having noxious physiological effects from a solid material having a tendency to decompose when vaporized in the device at an elevated temperature; said device being tubular in vertical cross section and including an upper chamber portion and a lower chamber portion adapted to be readily connected together in a substantially airtight manner and when so connected are separated from each other by a gas pervious diaphragm adapted to prevent the passage of large particles of solid material between said chamber portions, said upper portion being provided with a flat, broad Venturi type projector consisting of a nozzle member operatively secured and in communication with said upper chamber portion and having on its outer end portion a tubular member open at either of its end portions to the outer atmosphere and having its upper and lower wall portions arcuate in form and converging at their midsections in a manner adapted to mix atmospheric air with the smoke projected from said nozzle between said upper and lower wall portions and to project the intermingled air and smoke into said air in a ribbon-like stream.

2. A device for generating a smoke having noxious physiological effects from a solid material having a tendency to decompose when vaporized in the device at an elevated temperature; said device being tubular in vertical cross section and including an upper chamber portion, an intermediate chamber portion and a lower chamber portion adapted to be readily connected together in a substantially airtight manner and when so connected are separated from each other by a gas pervious diaphragm adapted to prevent the passage of large particles of solid material between said chamber portions, said upper portion being provided with a flat, broad Venturi type projector consisting of a nozzle member operatively secured and in communication with said upper chamber portion and having on its outer end portion a tubular member open at either of its end portions to the outer atmosphere and having its upper and lower wall portions arcuate in form and converging at their midsections in a manner adapted to mix atmospheric air with the smoke projected from said nozzle between said upper and lower wall portions and to project the intermingled air and smoke into said air in a ribbon-like stream.

RESTON STEVENSON.

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