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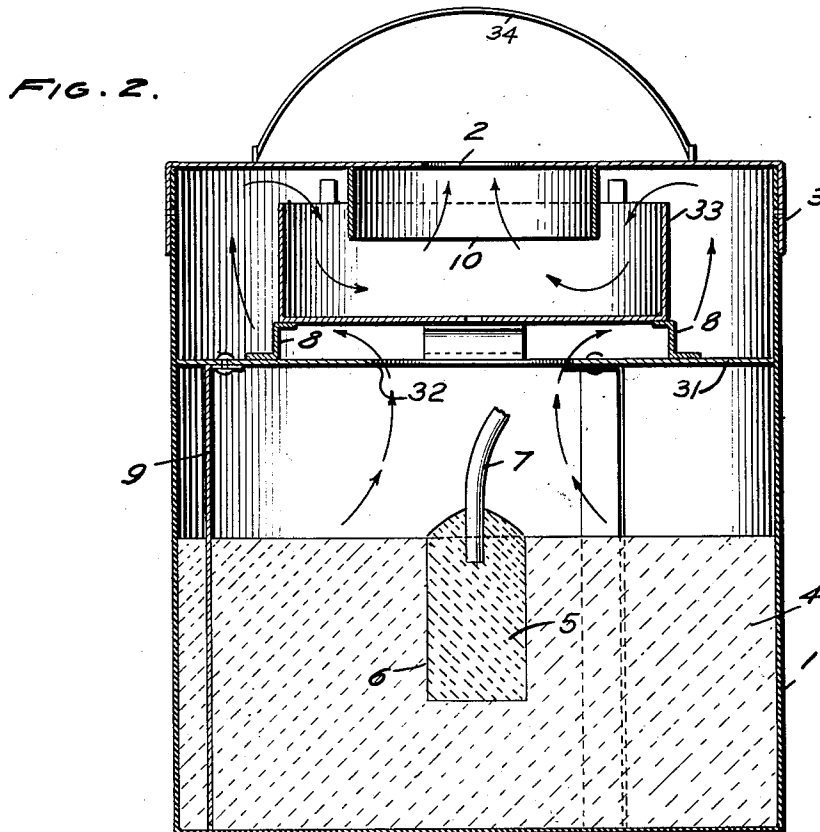
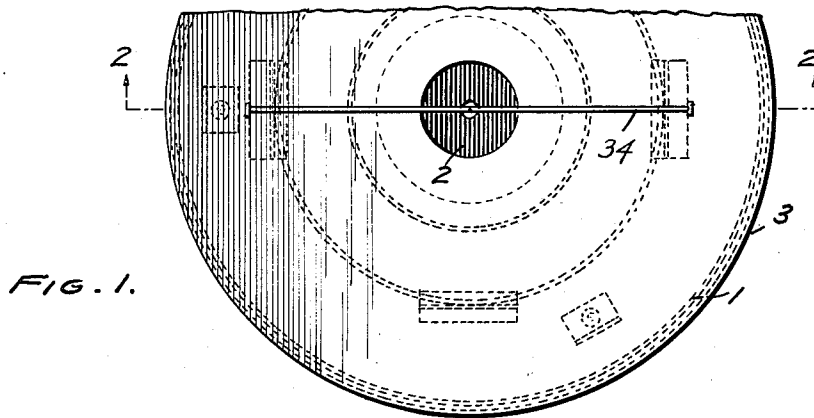
H. H. CHAMPNEY ET AL

2,565,352

SMOKE POT

Filed Oct. 31, 1946

2 Sheets-Sheet 1



INVENTORS
HUBERT H. CHAMPNEY
LEWIS B. COUNTERMAN
BY *Millard F. Peake*
ATTORNEY

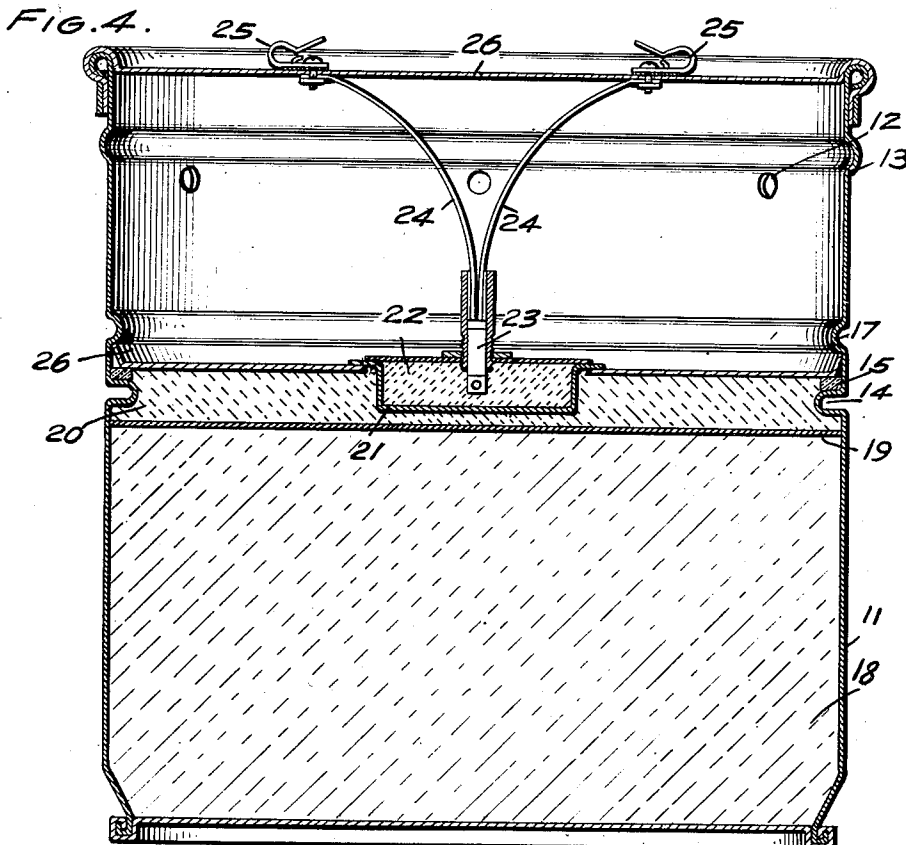
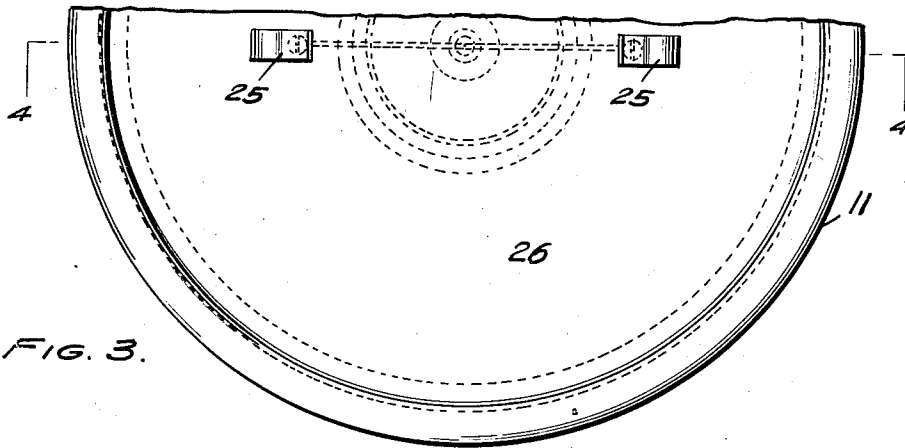
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HUBERT H. CHAMPNEY
LEWIS B. COUNTERMAN
BY *Millard F. Peake*
ATTORNEY

UNITED STATES PATENT OFFICE

2,565,352

SMOKE POT

Hubert H. Champney, Succasunna, and Lewis B. Counterman, Kenil, N. J., assignors to the United States of America as represented by the Secretary of War

Application October 31, 1946; Serial No. 706,886

2 Claims. (Cl. 102—90)

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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 us of any royalty thereon.

This invention relates to smoke pots and more particularly to smoke pots of the aerosol type.

Aerosol-type smoke pots operate through vaporization of a high-boiling material, such as an oil, from a mixture of the material and a fuel. The smoke-producing vapors are condensed upon mixing with the atmosphere, giving a smoke composed of liquid droplets of small size.

In accordance with this invention, an aerosol-type smoke pot has been prepared which liberates copious quantities of smoke of excellent screening powers. This has been accomplished by utilizing smoke pots of novel design together with a new smoke-producing charge containing a gas-producing combustible material, such as black powder, mixed with a smoke-producing material, such as a petroleum hydrocarbon vaporizable at elevated temperatures at pressures approximating atmospheric pressure. The mixture may also contain an absorbent material.

The containers employed in this invention are provided with single or with several orifices of a size sufficient to permit a high steaming velocity of the oil vapors at a small internal gas pressure while producing oil droplets of optimum screening power. The complete smoke-producing charge includes a base charge, a transition charge, and a priming charge. The base charge is relatively slow-burning and is responsible in large part for the smoke screen. The base charge contains the essential ingredients mentioned above, that is, a gas-producing combustible material and an oil, and may also contain an absorbent. The transition charge is placed above the base charge. The transition charge produces rapid, uniform, and positive ignition of the base charge and usually contains the same ingredients as the base charge but in slightly different proportions so as to effect a more rapid burning. The transition charge is ignited by the priming charge which may be placed in a cloth, paper, metal, or other container embedded in or held in close proximity to the transition charge. The priming charge may be ignited by an electric initiator of the types well known to the art or by a fuse train. Smoke pots of this type produce a thick, persistent, non-toxic smoke for a period of about fifteen minutes and attain their maximum rate of evolution of smoke within a few seconds after ignition.

The nature and purpose of this invention have now been generally set forth. There follows a

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more detailed description of preferred embodiments thereof with reference to the accompanying drawings, in which:

Fig. 1 is a plan view, partly broken away, of the top of a smoke pot in accordance with this invention having a single orifice at the top and ignited by a dynamite igniter fuse;

Fig. 2 is a cross-sectional elevational view of the smoke pot of Fig. 1, taken along the line 2—2 of Fig. 1;

Fig. 3 is a plan view, partly broken away, of the top of a smoke pot in accordance with another embodiment of this invention having several orifices and ignited by an electric squib; and

Fig. 4 is a cross-sectional elevational view of the smoke pot of Fig. 3, taken along the line 4—4 of Fig. 3.

The smoke pot of Figs. 1 and 2 comprises a container 1, provided with a single orifice 2 centrally located in the lid 3. At the bottom of the container is a base charge 4 which comprises a mixture of 50% glazed black powder (through a 12/24 mesh wire screen), 5% balsa (ground, density 0.15 g./cc., Diol absorbency 63%), and 45% Vaseline. The primer 5, a mixture of powdered red lead, aluminum, and silicon, in a wax paper container 6 is embedded in the base charge 4. The primer is ignited by a dynamite fuse train 7. The container 1 is divided into an upper and lower chamber by a horizontal partition 31. This partition is supported within the container by the legs 9. A central opening 32 is provided in the partition to permit passage of smoke vapors from the lower chamber into the upper chamber. Above the opening 32 is the cup 33, which is supported in its upright position by the legs 8 upon the partition 31. The diameter of the cup 33 is greater than the diameter of the opening 32, so that the smoke vapors from the lower chamber will be deflected outwardly between the base of the cup and the partition 31. The top of the cup 33 is spaced apart from the lid 3 so that smoke passing upwardly through the channel formed by the walls of the cup 33 and the container 1 will be deflected inwardly over the top of the walls of the cup.

A cylindrical baffle 10 is secured to the under side of the lid 3. It extends into the cup and the lower end thereof is spaced apart from the bottom of the cup. This baffle surrounds the orifice 2. The arrows in Figure 2 of the drawings show the tortuous path of smoke vapors around the partition 31, the cup 33, and the baffle 10. Any solid smoldering or burning particles produced during burning of the base and transition charges

will be arrested in the upper chamber as the smoke passes through this tortuous path, thereby preventing sparks from passing out through the orifice 2. The smoke pot has a handle 34 for ready carrying.

The smoke pot of Figs. 3 and 4 comprises a steel container 11 having a plurality of orifices 12 placed below an outwardly projecting, reinforcing bead 13. An inwardly projecting bead 14 is rolled in the side of the container 11 and the ridge which is formed by this bead is used as a seat for a gasket 15, and the flanged diaphragm 16, which is placed in position above a transition mixture. After addition of the flanged diaphragm 16 a bead 17 is rolled in the side of the container 1 immediately above the edge of the flange of the diaphragm, thereby holding the diaphragm in place.

The container 1 has in its bottom a base charge 18 comprising a mixture of 48% black blasting powder (through a 16/24 mesh screen), 8% AL wood pulp (density 0.30 g./cc., Diol absorbency 53%), 2% coarse sawdust (through a 30 mesh screen), and 42% of Diol gel. Above the base charge is placed a thin sheet of cellulose nitrate 19, upon which is placed the transition mixture 20 comprising a mixture of 53% black powder, 6% AL pulp, 21% sodium nitrate pellets, and 30% of Diol gel (Diol 55 gelled with 1½ sodium stearate). Embedded in the transition mixture is a flanged zinc cup 21. This cup is secured to the diaphragm 16. The cup 21 contains a priming mixture 22 of 63.3% red lead, 6.7% aluminum powder, and 30% ferrosilicon. The priming mixture 22 is ignited by an open-type electric squib 23 which is connected by wires 24 to Fahnestock clips 25 affixed to a lid 26 of the container.

The practical application of this invention is illustrated by the following examples:

Twelve-inch smoke pots were prepared employing containers of the type shown in Figs. 1 and 2 with the exception that in place of a single top orifice the containers had 5 orifices ⅜ inch in diameter and 8 orifices ⅜ inch in diameter disposed in the sides as shown in Fig. 4. The smoke pot had 14,000 grams of a base charge comprising 42% 3FG milled glazed sporting powder (through a 24/46 silk screen), 5% T-14 wood pulp (density 0.29 g./cc., Diol absorbency 56%), 4% sawdust (through ⅜ mesh screen, density 0.25 g./cc., Diol absorbency 55%), 2% coarse sodium nitrate, and 47% of Diol 55 gelled with 1% sodium stearate. Above the base charge was placed 2,000 grams of a transition mixture comprising 40% 3FG glazed sporting powder, milled for 1½ hours, 4% sawdust, 10% coarse sodium nitrate, 4% T-14 wood pulp, and 42% Diol 55 gelled with 1% sodium stearate. The transition mixture formed a layer 1 inch in thickness above the base charge. One hundred grams of a primer, which contained 63.3% red lead, 6.7% aluminum powder, and 30% ferrosilicon, was used. To this mixture was added 5-10 grams of black powder to achieve a greater scattering effect. The priming charge was placed in a plain cloth bag (a plain bag was found to produce less initial flaming than a paraffined bag) suspended over the center of and out of contact with the transition mixture. The primer was ignited by a black powder fuse.

The above smoke pot was compared with an HC smoke pot of the type now in use by the U. S. Army and fully described in U. S. Government specifications. The atmospheric conditions during the comparative tests were quite favorable to the production of smoke clouds. The wind was

light and steady, the sun was shining, the temperature was between 35-40° F., and the humidity was fairly low. Although a large volume of smoke was produced by the HC pot, a much larger volume of smoke was put out by the smoke pot in accordance with this invention. The color of the smoke of the former was light gray while that of the latter was white. A considerable amount of flaming was observed with the HC pot, while the smoke pot of the invention did not produce any external evidence of flaming. The breadth of ground covered by the HC pot was much narrower than that of the oil-smoke pot. The container of the HC pot contained only a single orifice at its top, and permitted evolution of smoke in the form of a rather narrow plume. The smoke from the pot of this invention issued under pressure from orifices located around the circumference of the pot and smoke was therefore widely dispersed at its source. In fact, the smoke screen was effective right up to the source, since the smoke was ejected parallel to the ground. In striking contrast, the smoke produced by the HC pot did not settle down to give protection on the ground until it was 30-40 feet downwind from the pot.

The smoke pot of this invention reached maximum burning rate two seconds after its ignition. It burned with a maximum volume of smoke for 7½ minutes and continued to produce smoke for a total of 8 minutes. It showed a good uniformity in burning. The smoke droplets were rated magenta and orange in color when the sun's disc was viewed through smoke of this particle size. Oil vapor particles having a radius of 0.3 micron possesses maximum light scattering power. The sun's disc viewed through smoke of this particle size is magenta in color. The average pressure generated within the pot was 1 lb./sq. in. with a maximum pressure of 6 lb./sq. in.

The HC pot was 5½ inches in diameter and contained 5,450 grams of base charge. The smoke pot required twenty seconds to reach maximum smoke volume. It produced maximum smoke volume for five minutes and continued to produce smoke for a total time of 5½ minutes. The smoke particles were of a considerably larger size than that of this invention and were liberated at no internal pressure.

Example 2

A 12-inch smoke pot identical with that described in Example 1 was charged with 14,000 grams of a base charge comprising 48% glazed "B" blasting powder (through a 16/24 mesh screen), 5% T-14 wood pulp, 3% sawdust, and 44% Diol 55 gelled with 1% sodium stearate. Above the base charge was placed 2,000 grams of the transition mixture described in Example 1. The transition mixture was primed by the red lead-aluminum-ferrosilicon priming mixture of Example 1, suspended in a cloth bag over the charge. The primer was ignited by a dynamite-taped fuse.

After ignition, the smoke pot required two seconds to reach maximum smoke volume. It produced maximum smoke volume for 12½ minutes and continued to produce smoke for a total of fourteen minutes. It displayed good uniformity in burning and showed no evidence of flaming. The oil droplets were between orange and red in color when the sun's disc was viewed through smoke of this particle size. The average pressure generated within the pot was 0.5 lb./sq. in. with a maximum pressure of 1.5 lb./sq. in.

Example 3

A 12-inch smoke pot container having 40 orifices $\frac{1}{8}$ inch in diameter disposed in the side in the manner shown in Fig. 4 was charged with 16,000 grams of a base charge comprising 42% 3FG regular glazed sporting powder (through a 24/26 mesh silk screen), 3% coarse wood pulp, 7% T-14 wood pulp, and 48% Diol 55 gelled with 1% sodium stearate. Above the base charge was placed 2,000 grams of a transition mixture comprising 40% 3FG glazed sporting powder which had been milled for 1½ hours (through 24/46 mesh silk screen), 4% coarse sawdust, 10% coarse sodium nitrate, 4% T-14 will pulp, and 42% Diol 55 gelled with 1% sodium stearate. The transition mixture was primed with 100 grams of the red lead-aluminum-ferrisilicon priming powder, held in a cloth bag, described in Example 1. Ten grams of 3FG sporting powder was mixed with the primer to achieve a greater scattering effect on bursting of the bag. The primer was ignited using an electric squib.

After ignition, the pot required thirty seconds to reach maximum smoke volume. Smoke was evolved at the maximum volume for 12½ minutes and continued to be evolved for a total of fourteen minutes. The charge burned at a uniform rate, giving smoke between orange and permanganate in color when the sun's disc was viewed through smoke of this particle size. There were no evidences of flaming. The average pressure generated within the container was 2 lb./sq. in. with a maximum pressure of 6 lb./sq. in.

In order to observe the effect of temperature on the burning characteristics, one charge from each of six pairs of smoke pots was stored at a temperature 12–64° F. while the other charge of each pair was stored at a temperature between 77–108° F. In general, the cool pots started almost as fast as the warm pots but burned at a slower rate and produced a somewhat less effective smoke screen.

Example 4

One hundred smoke pots were prepared employing 11¼ inch diameter, 5 gallon, 24 gauge, steel containers of the type shown in Figs. 3 and 4. These contained seven $\frac{3}{8}$ -inch holes in their sides either immediately below the reinforcing bead or in the vertical ring portion of the raised center pour spout-type covers. In each of the containers was placed 11.3 kilograms of a base charge containing 48% "B" blasting powder (through a 16/24 mesh silk screen), 8% AL wood pulp (Diol absorbency 59.5%, density 0.26 g./cc.), 2% coarse sawdust, and 42% of Diol 55 gelled with 1½% sodium stearate. Upon the base charge was placed 1,500 grams of the following transition mixture: 39% 3FG glazed sporting powder, 4% coarse sawdust, 10% coarse sodium nitrate pellets, 4% T-14 wood pulp, and 43% Diol 55 gelled with 1% sodium stearate. A flanged sheet metal diaphragm (18 gauge) was then inserted in the container in order to hold the two charges in place. Centered in the diaphragm was a flanged zinc cup 2¾ inches in diameter, 1 inch deep, and 0.016 inch thick. The zinc cup was embedded in the transition mixture to a depth of $\frac{7}{8}$ inch. The cup was soldered to the diaphragm. In the zinc cup was placed 100 grams of a priming mixture comprising 63.3% red lead, 6.7% aluminum powder, and 30% ferrosilicon. The zinc cup was fitted with

a cover to which was soldered a $\frac{1}{8}$ -inch collar. A $\frac{1}{8}$ -inch by 1½ inch pipe nipple was screwed into the collar and an open-type electric squib inserted in the nipple so that the open end of the squib was in direct contact with the priming composition. The squib wires were attached to Fahnestock clips attached to the container cover. Ignition of the transition mixture by the primer in the zinc cup was found to be much more rapid than when the primer was suspended over the ignition mixture in a cloth bag.

In order to form a ridge on which to rest the flanged diaphragm, the container was provided with a rolled bead $\frac{3}{8}$ inch deep and $\frac{1}{8}$ inch wide encircling the pot on a line about seven inches from the bottom. However, sealing compound was found to be a good substitute for the gasket. The diaphragm, whose flange formed a press seal with the sides of the pot, was pressed firmly against the gasket on insertion into the container. A $\frac{1}{8}$ inch deep by $\frac{1}{8}$ inch wide continuous bead was rolled into the side of the pot immediately above the edge of the flange of the diaphragm. The upper bead thus served to hold the diaphragm against the gasket, thereby insuring a positive oil seal and at the same time preventing movement of the diaphragm during rough treatment of the pot.

At -40° F. the smoke-producing charges were found to contract as much as 1¼ inches in depth. This contraction was believed due to decrease in volume of air entrained in the mixture. Similarly, at elevated temperatures the charges expanded. Such changes in volume adversely affected the burning rate, contraction decreasing it and expansion increasing it. Experiments were therefore conducted to determine methods of avoiding entrainment of air. Various mixing procedures were employed, as follows:

(1) Ingredients and mixer were held at room temperature with the air pressure in the mixer reduced to 3.5 lb./sq. in. absolute.

(2) Same conditions as (1) except that air pressure was atmospheric.

(3) Same conditions as (1) except that the ingredients were kept at an average temperature of 135–140° F. and the mixer was kept at an average temperature of 175–185° F.

(4) Same conditions as (3) except that air pressure was atmospheric.

Procedure (4) avoided entraining air to a considerable extent, producing charges which burned at normal rates at room temperature and at 150° F. Procedure (3) removed more entrained air than any of the other methods, giving charges which burned at normal rates at temperatures between 15° F. and 150° F.

In order to determine what corrosive effects, if any, the oil-smoke mixture would have on the various metals with which it would come in contact during mixing and storage, strips of zinc, tin, copper, sheet iron, and galvanized sheet iron were connected by copper wire and pushed into a gelled mixture. At the end of 21 days, the strips were examined and found to be unchanged.

Example 5

Sixty smoke pots were prepared employing 11¼ inches diameter, 5 gallon, 24 gauge, steel containers. Half of the containers were equipped with raised-center pour spout-type lug covers in the vertical portion of which seven $\frac{3}{8}$ -inch smoke ports were drilled. The other half of the containers were equipped with flat covers and with

seven $\frac{3}{8}$ -inch smoke ports drilled immediately below the reinforcing bead in the side.

Base charges were prepared containing 48% "B" blasting powder (through a 16/24 mesh silk screen), 2% coarse sawdust, 8% AL wood pulp, and 42% of Diol 55, gelled with $1\frac{1}{2}$ % sodium stearate. In order to prevent entrainment of air, the charges were mixed or treated under various conditions:

(1) Storing the mixed charge at an elevated temperature followed by agitation at atmospheric pressure.

(2) Mixing the hot Diol gel and the carbonaceous material, storing for 18 hours at 150° F., adding the black powder, and then agitating at atmospheric pressure.

(3) Mixing as in (2) followed by agitation under a pressure of 5 lb./sq. in. absolute.

(4) Mixing the ingredients at an elevated temperature followed by jouncing for fifteen minutes at 128 jounces/minute under a pressure of 5 lb./sq. in. absolute.

The third and fourth procedures reduced the amount of entrained air to a minimum. The charge dropped in height from seven inches to $5\frac{1}{2}$ inches without separation of ingredients. When subjected to a range of temperature from 150° F. to -40° F., the volume of the charge decreased only 6% as compared to a decrease in volume of about 22% when no jouncing or agitation, either with or without reduced pressure, was used.

Eleven thousand, five hundred grams of base charge was placed in each container. Upon the base charge was placed a 1,000-gram layer of a slow-burning transition mixture containing 52% "B" glazed blasting powder (through a 16/24 mesh silk screen), 2% coarse sawdust, $7\frac{1}{2}$ % AL pulp, and $38\frac{1}{2}$ % Diol 55, gelled with $1\frac{1}{2}$ % sodium stearate. Upon this was placed 500 grams of a fast-burning transition mixture containing 40% 3FG glazed sporting powder, 10% coarse sodium nitrate, 3% coarse sawdust, 6% treated AL pump, and 41% Diol 55, gelled with $1\frac{1}{2}$ % sodium stearate. This fast-burning mixture assured rapid and complete ignition of the slower-burning mixture yet did not develop enough pressure to blow the lid from the pot.

In order to hold the transition and base charges in place, a diaphragm (18-gauge steel) was inserted containing a zinc cup soldered in its center, as described in Example 4. In the cup was placed 100 grams of a priming composition comprising 63.3% red lead, 6.7% aluminum powder, and 30% ferrosilicon. The priming composition was ignited by an electric squib fitted in position as shown in Fig. 3.

All of the pots tested proved quite satisfactory both in the volume of smoke produced and in the burning time.

Example 6

Smoke pots were prepared employing 6-inch diameter containers, $7\frac{1}{4}$ inches high having a single orifice $\frac{3}{8}$ inch to 1 inch in diameter or a number of $\frac{1}{8}$ -inch diameter orifices equally spaced on a line about the side of the pot near the top, as shown in Fig. 1. Pots equipped with a number of small orifices produced a whiter, denser smoke of smaller particle size which was more persistent than smoke from pots which had only a single large orifice. Ejecting the smoke parallel to the ground through these side orifices also reduced the tendency of the smoke to rise. The smoke vapors of pots having a number of

smoke orifices show little tendency to flame even when the pot is not equipped with a spark filter.

The pots were charged with 1,500 grams of a base charge comprising 48-50% 4FB glazed black powder, 5% balsa wood (through a 24-mesh screen), and 45-47% Vaseline. Above the base charge was placed 200 grams of a transition mixture comprising 46% 3FG black powder, 4% Celotex bagasse (Diol absorbency 67.2%, density 0.14 g./cc.), and 50% Diol 55, gelled with 1% sodium stearate. However, it was found that the need for a transition mixture in pots of this diameter was not as great as with larger diameter pots.

The priming charge comprised 63.3% red lead, 6.7% aluminum powder, and 30% ferrosilicon. Thirty-five grams of primer was used, to which was added a few grams of black powder. The primer was placed in a container embedded in the transition or, where lacking a transition charge, in the base charge. Wax paper shells 1 inch by $2\frac{1}{2}$ inches, zinc containers and cellulose acetate cups 2 inches in diameter by $\frac{3}{4}$ inch deep were used as containers. The priming mixture was ignited by a fuse train which entered the pot through the orifice at the top or one of the side orifices. It was found that the primer would ignite the base charge readily when embedded in it.

The pots gave a dense, white smoke which was highly persistent and was effective within thirty seconds after ignition.

Example 7

One hundred twenty-six smoke pots were prepared employing $11\frac{1}{4}$ inch diameter, 5 gallon, 24 gauge, steel containers. All containers were fitted with flat lug covers. Six $\frac{1}{2}$ -inch diameter orifices were equally spaced around the pot immediately below the reinforcing bead. After insertion of the base and transition charges, an 18-gauge sheet metal diaphragm having a $\frac{1}{2}$ -inch flange around its outer edge and a priming cup soldered at its center was inserted to hold the charges in place. The priming cup contained a priming composition and was fitted with an electric squib, as illustrated in Fig. 4. The orifices of each of the pots were covered with 1-inch squares of Scotch acetate tape.

Each of the pots contained $25\frac{3}{8}$ pounds of a base charge comprising 45% "B" black blasting powder (through 16/24 mesh silk screen), 10% Godchaux bagasse, and 45% of Diol 55, gelled with $1\frac{1}{2}$ % sodium stearate. The transition mixture employed comprised 43 $\frac{1}{2}$ % "B" blasting powder, $3\frac{1}{2}$ % Godchaux bagasse, 20% sodium nitrate, 10% Diol 55, and 23% Diol 55, gelled with $2\frac{1}{2}$ % sodium stearate. Two and two-tenths pounds of transition mixture was added in each case. One-third of this amount was blended into the top of the base charge, and the remaining $\frac{2}{3}$ was added in a layer over the blended portion.

Extrusion of the charge into a region of low air pressure was employed in order to remove air entrained in the charges during mixing. The freshly-mixed hot base charge was placed in a cone-shaped container having an adjustable valve in its base regulating the flow of charge into the smoke pot. The container was attached to the cover of one of the smoke pots and this assembly then crimped on the smoke pot itself, which was evacuated to a pressure of about 5 lb./sq. in. absolute. The valve was opened sufficiently to allow emission of a small stream of the charge while the pressure was maintained at a constant level. The charge was held at a temperature of about 130° F. in order to remove a maximum

of entrained air. Subjecting the pot to mild vibrations as it was being filled caused no more air to be removed than when no vibration was used. This method of preparing the smoke charges and filling the container produced smoke pots which burned more uniformly throughout the burning period than the mixture prepared by jouncing or agitation.

The priming mixture employed was the same as that of Example 6. One hundred grams of the primer was placed in the zinc cup set in the center of the flanged diaphragm. Positive ignition of the transition mixtures was obtained in all cases.

Example 8

Standard five-gallon containers equipped with six $\frac{1}{8}$ -inch orifices as shown in Fig. 2 were charged with 11.3 kilograms of a base charge comprising 48% "B" black powder (through a 16/24 mesh silk screen), 3% coarse sawdust, 8% AL pulp, and 42% of Diol 55, gelled with $1\frac{1}{2}$ % sodium stearate. Above this base charge was placed 1,300 grams of a transition mixture comprising 48% "B" black powder, 8% AL pulp, 10% sodium nitrate pellets, 23% Diol 55, and 11% of Diol 55, gelled with 6% sodium stearate. Above this slow-burning transition charge was placed 450 grams of a fast-burning transition charge comprising 50% "B" black powder, 8% treated AL pulp, 10% sodium nitrate pellets, 22% Diol 55, and 10% Diol 55, gelled with 6% sodium stearate. The transition was ignited by 85 grams of a priming composition comprising 63.3% red lead, 6.7% aluminum powder, and 30% silicon. The priming mixture was ignited by an electric squib.

The smoke pots gave a thick, persistent smoke of fine particle size.

In order to secure ignition of the oil-smoke mixture, a priming composition is required. This composition must be of such a nature as to be ignited readily, as by a fuse or an electric igniter. It should also burn quickly and produce a considerable quantity of intense heat, retaining its heat as long as possible. Preferably, it should liberate no gases during its combustion. A suitable composition contains highly absorbent carbonaceous materials impregnated with a melt of oxidizing salts such as ammonium or sodium nitrate, sulfur and A reel dust. This composition liberates gases, however. The preferred composition in accordance with this invention comprises red lead, preferably between 200-325 mesh size, in an amount between 60 and 70%, aluminum powder, preferably between 125 and 400 mesh size, in an amount between 5 and 10%, and either powdered silicon in an amount between 25 and 35% or powdered ferrosilicon in an amount between 25 and 35%. To this composition may be added a small quantity of black powder in the ratio of 5 to 10 grams to 100 grams of primer to achieve a greater spreading effect over the surface of the transition mixture. In general, the priming composition is placed in a container embedded centrally in the transition mixture or, if none is present, in the base charge. Suitable containers which have been employed may be formed of oil-impervious inflammable or readily ruptured materials of various shapes, including containers of paper, cloth, cellulose acetate cups, or zinc. It has also been found satisfactory to suspend the priming composition over the transition mixture in a container such as a cloth bag. When the container is in contact with the transi-

tion or base charge, it is necessary that it be oil-proof, since the priming composition will not ignite when wet with oil.

The transition mixture is generally included in order to produce rapid, uniform, and positive ignition of the base charge. It may, however, be omitted in smaller smoke pots without serious effect. The transition mixture usually contains the same ingredients as the base charge but in somewhat different proportions so as to increase their rate of burning. Thus, it includes a fuel in an amount between 40 and 50% and an oil in an amount between 30 and 50%. A mixture of fuels may be employed, if desired. It may also include an oxidizing material, such as sodium nitrate, and an absorbent in amounts between 10 and 21%, and between 4 and 8%, respectively. The transition mixture should in burning give off sufficient heat to warm the upper portion of the smoke pot in a relatively short time, thus minimizing the condensation of the oil vapors on the inner walls of the container. It should cause combustion to transfer smoothly to the base charge so that there may be no interruption in the production of smoke vapors which would interrupt the continuity of the smoke cloud produced by the pot. Thus, it follows that the transition mixture should generate a good cloud of smoke in itself. It should ignite the base charge over its entire surface within a few seconds. In order to prevent migration of oil, the transition mixture should have the same oil-to-absorbent ratio as the base charge.

The transition mixture may comprise a layer superimposed above the base charge or it may be mixed in part with the upper layer of base charge, the remainder of the transition mixture being placed above the base charge-transition charge mixture as a separate layer. The latter procedure has been found desirable to prevent interruption in the production of the smoke. A satisfactory procedure for preventing smoke interruption has also included the use of two transition mixtures, one more rapid burning than the other and employed as the top layer. In operation, the top layer of transition mixture thus burns in a few seconds, igniting the second lower slower layer and at the same time blowing off the protective tabs which, in general, cover the orifices of the container.

Several transition mixtures of those investigated have proved to be superior under most conditions, and are preferred. These include a composition containing 46% 3FG sporting powder, 4% Celotex bagasse, and 50% Diol 55, gelled with 1% sodium stearate, a composition containing 40% 3FG sporting powder, 4% coarse sawdust, 10% sodium nitrate, 4% T-14 wood pulp, and 42% Diol 55, gelled with 1% sodium stearate, and compositions containing between 48 and 50% "B" black powder, 8% AL pulp, 10% sodium nitrate pellets, between 22 and 23% Diol 55, and 10-11% Diol 55, gelled with 6% sodium stearate.

The base charge must be of such a composition as to produce a dense, persistent, nontoxic smoke for a period as long as fifteen minutes. It should produce this smoke at a maximum rate within a few seconds after ignition, the rate preferably being the same as 0° F. and at 150° F. Satisfactory base charges contain between 40 and 50% fuel, between 6 and 14% absorbent, and between 40 and 46% smoke-producing material.

It is preferred to employ sodium nitrate base black powders as the fuel in the base charge.

The potassium nitrate base black powders are more expensive and somewhat more difficult to obtain. Also, such black powders are somewhat quicker in burning. However, they are stronger, resist moisture better, and keep in good condition better than sodium nitrate base black powders. The powder should be between 16 and 24 mesh size and may be either glazed or unglazed. Other fuels which have been employed and which have given good results include double and single base smokeless powders and nitrocellulose.

The absorbent material prevents undue fluidity of the base charge. It should have a Diol absorbency between 53 and 70%, preferably between 65 and 70%. Diol absorbency is a measure of the ability of the absorbent material to hold Diol 55 under a pressure of 75 lb./sq. in.:

Absorbency Per Cent=

$$\frac{\text{weight of Diol 55 held}}{\text{weight of absorbent and Diol}} \times 100$$

The material should have a density between 0.14 and 0.30 g./cc. carbonaceous absorbent materials which have been employed include T-14 wood pulp, ground balsa wood, S and B wood pulp, Celotex bagasse, Godchaux bagasse, sawdust of fine and coarse grades, regular and water-treated AL wood pulp, hammer-milled newsprint, shredded asbestos, and kieselguhr.

Smoke-producing materials which may be employed are preferably petroleum hydrocarbons having a boiling point between 750 and 800° F. at pressures approximating atmospheric pressure. The preferred material is Diol 55, a naphtha base oil formed by blending Diol 40 and Diol 70 and having the following properties:

Flash point.....	405° F.
Gravity A. P. I.....	22.4
Pour point.....	Less than 0° F.
Viscosity (Saybolt Universal)...	100° F. — 516 seconds
Viscosity (Saybolt Universal)...	210° F. — 55.3 seconds
Mid-boiling point.....	7850 F.
Boiling range.....	Between 770° F. and 800° F.

This oil is produced by the Standard Oil Company of New Jersey. Vaseline having a melting point of 112° F., paraffin-petrolatum having a melting point of 122° F. (such as Product 2295 I. A. produced by the Socony Vacuum Oil Company), a mixture of petrolatum and microcrystalline waxes (such as Product 2300 produced by the Socony Vacuum Oil Company), a mixture of microcrystalline wax and rosin (such as P. D. 300 produced by the Socony Vacuum Oil Company), and commercial motor oils (such as SAE 10) may be employed instead of Diol 55.

A number of other ingredients may be added to either the transition or base charge or both to improve burning uniformity or to alter the rate of burning. Such materials include sulfur, oxidizing materials, such as sodium and potassium nitrate, barium peroxide, and ammonium nitrate, or charcoal. Oxidizing materials are usually added in amounts between 3 and 21%.

The base charge following mixing of the ingredients should preferably be dense, soft, and oily. When the charge is low in density, dry, and porous, the burning rate tends to be uneven and uncontrollable. Air entrapped in the charge during mixing will give excessive burning rates at elevated temperatures and extremely slow-burning rates at low temperatures, and hence

should be eliminated. Excessive burning rates are caused by expansion of the charge which makes the mixture porous. Similarly, contraction of the air entrapped on cooling of the base charge increases the density of the mixture which adversely affects the burning rate. Since the entrained air may be as high as 22% of the volume occupied by the charge, such effects are not surprising.

Air entrained during mixing of the charge is preferably removed by one of two methods. One method, an application of which is described in Example 5, comprises jouncing or otherwise agitating a smoke pot containing the charge at an elevated temperature between 120 and 150° F. under reduced pressure. The air pressure should be between about 4 and 6 lb./sq. in. absolute, preferably below 6 lb./sq. in. absolute. A simple, practical method comprises extruding the freshly-mixed charge held at an elevated temperature between 130 and 150° F. into a region held at a pressure below 6 lb./sq. in. absolute. The smaller the orifice through which the charge is extruded, the more efficient is the process. An orifice below about $\frac{3}{8}$ inch in diameter is preferred. This procedure is illustrated in Example 7. Each of these methods gives charges substantially free of entrained air.

A number of base charges have been found to give excellent results and are therefore preferred. A composition containing 48% "B" blasting powder ($\frac{16}{24}$ mesh), 3% coarse sawdust, 5% T-14 wood pulp, and 44% Diol 55, gelled with 1% sodium stearate, produces a good cloud of smoke at a uniform rate. A composition containing 48% "B" blasting powder ($\frac{16}{24}$ mesh), 2% coarse sawdust, 8% AL wood pulp, and 42% Diol 55, gelled with $1\frac{1}{2}$ % sodium stearate, was the most satisfactory charge of all those tested. A composition containing 40% "B" blasting powder ($\frac{16}{24}$ mesh), 14% shredded asbestos, and 46% Diol 55 was the most efficient smoke charge tested. Only $1\frac{3}{4}$ parts of fuel were needed to vaporize 2 parts of oil. Also, the mixture entrained very little air during mixing and therefore required no additional treatment to avoid adverse effects on burning rate at high and low temperatures. The smoke produced by this charge was very white, dense, and persistent and possessed excellent screening qualities.

The particle size of the smoke particles produced and therefore the screening power of the smoke has been found to be dependent to a great extent upon the pressure within the smoke pot. Pressures between 0 and 0.1 lb./sq. in. gave coarse particles (blue sun's disc). Pressures between 0.1 and 0.9 lb./sq. in. gave somewhat smaller particles (permanganate sun's disc). Pressures between 0.9 and 1.1 lb./sq. in. gave particles of the optimum size (magenta sun's disc). Pressures of over 1.1 lb./sq. in. gave very fine particles which were easily dispersed (orange sun's disc). The average pressure for pots equipped with $\frac{3}{8}$ -inch orifices was lower than that for pots equipped with $\frac{1}{8}$ -inch orifices of equivalent total cross-sectional area. This was in part due to the fact that the larger orifices did not become clogged with residue as readily as the smaller orifices. The tests showed that the internal pressure of the smoke pot should vary between 0.9 and 1.1 lb./sq. in. for optimum screening effects.

Any type of container may, of course, be employed with the smoke-producing charges of this invention. The type of pot illustrated in Fig. 1 having a single orifice at the top between $\frac{3}{8}$ -inch

to 1-inch diameter orifice has proved satisfactory. In pots of this type, the oil vapors tend to carry glowing particles out of the pot, thus giving it the tendency to flame. Thus, pots of this type are desirably fitted with baffles or spark filters in order to hold any sparks within the container. It has been found that a novel type of container will produce a smoke which gives the greatest screening power and lies close to the ground in a desirable manner. This container is provided with a number of orifices in the sides rather than a single orifice at the top of the container. The orifices are preferably small so as to assist production of an internal pressure of not over about 1.2 lb./sq. in. within the container during combustion of the smoke-producing composition. Orifices between $\frac{1}{4}$ and $\frac{1}{8}$ inch in diameter have given good results. The smoke from pots containing multiple side orifices is whiter, denser, of smaller particle size, and more persistent than smoke emitted through a single large orifice of the same total cross-sectional area. Side orifices eject the smoke parallel to the ground, thereby reducing the tendency of the smoke to rise, which is quite marked when the smoke issues in a column perpendicular to the ground. A preferred 6-inch container is provided with two $\frac{3}{8}$ -inch orifices and a preferred 12-inch container with eight $\frac{3}{8}$ -inch orifices or six $\frac{1}{2}$ -inch orifices.

The gelled mixtures may be held in place in the pot by means of a disk of nitrocellulose between 0.003 inch and 0.005 inch in thickness. The film is held in place by a large mesh metal screen which in turn, is held in place by a sheet metal flanged ring which fits tightly against the sides of the container. This type of seal, however, is not oilproof.

An oilproof seal holding the charge in the bottom of the container may be provided as shown in Fig. 4 and as described in Example 4. A bead between $\frac{1}{4}$ and $\frac{3}{8}$ inch deep and not over $\frac{3}{8}$ inch high is rolled in the side of the container adjacent the top of the transition mixture or, where it is lacking, the base charge. A gasket or a sealing compound is then placed on the upper face of this bead. Against the gasket or sealing compound is placed a flanged diaphragm formed of a rigid material, such as sheet metal, which fits tightly against the walls of the container. After the diaphragm is in place it is secured by means of a second bead between $\frac{1}{8}$ and $\frac{3}{8}$ inch deep which is rolled in the container immediately above its flange. A better oil seal between the diaphragm and the side of the container may be secured by replacing the flanged diaphragm with a flat one and then rolling a bead similar to the first or lower bead immediately above the diaphragm. As the bead is formed a downward pressure is exerted against the diaphragm, resulting in a positive oil seal. It is desirable to produce an oilproof seal above the smoke-producing charge because the priming composition will not ignite when wet with oil.

The diaphragm should have an opening or openings for insertion of the container carrying the priming composition. Preferably the primer container is soldered or otherwise sealed in the diaphragm. The primer container is fitted with means for holding an electric squib or fuse in the vicinity of the priming composition.

The smoke pots in accordance with this invention produce a heavy, dense, persistent, white smoke with excellent screening power. The containers of this invention direct the smoke along the ground in such a manner that the smoke screen is effective right up to the source. In smoke pots previously known to the art, the smoke is projected in the form of a fairly narrow plume from a hole in the top of the container and does not usually settle down to give protection on the ground until it is several feet away from the pot. The smoke is produced at a uniform rate within a few seconds after ignition.

All parts and percentages expressed in the specification are by weight.

It will be realized from the nature of this invention that many substitutions and modifications will be apparent to those skilled in the art without departing from the scope of this invention. Accordingly, it is intended that all matter described and set forth hereinbefore shall be interpreted as illustrative and not in a limiting sense.

We claim as our invention:

1. A smoke pot including a container having a cover provided with a central orifice, a base, a side wall, a partition dividing said container into an upper and lower chamber, a central opening in said partition, said lower chamber being only partially filled with a smoke composition and ignition means therefor, said upper chamber having a baffle mounted above said partition, said baffle means including a circular cup mounted slightly above and spaced apart from said partition over said opening and a tubular section secured to the lower side of said cover around its central orifice and extending inwardly into and being spaced apart from the upper portion of said cup.
2. A smoke pot including a container having a cover, a central orifice in said cover, a horizontal partition dividing said container into an upper chamber and a lower chamber, a central opening in said partition, said lower chamber being partially filled with a smoke composition and ignition means therefor, said upper chamber having a baffle means therein to serve with said partition as a spark arrester, said baffle means including an upright, circular cup mounted on and spaced above said partition over said opening, the diameter of said cup being greater than the diameter of said opening, the top of said cup being spaced apart from said cover, and a tubular section secured to the under side of said cover around said central orifice and extending into and being spaced apart from said cup.

HUBERT H. CHAMPNEY.
LEWIS B. COUNTERMAN.

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