CHEMICAL BOMB

Filed Nov. 7, 1944 2 Sheets-Sheet 1

Fig. 1

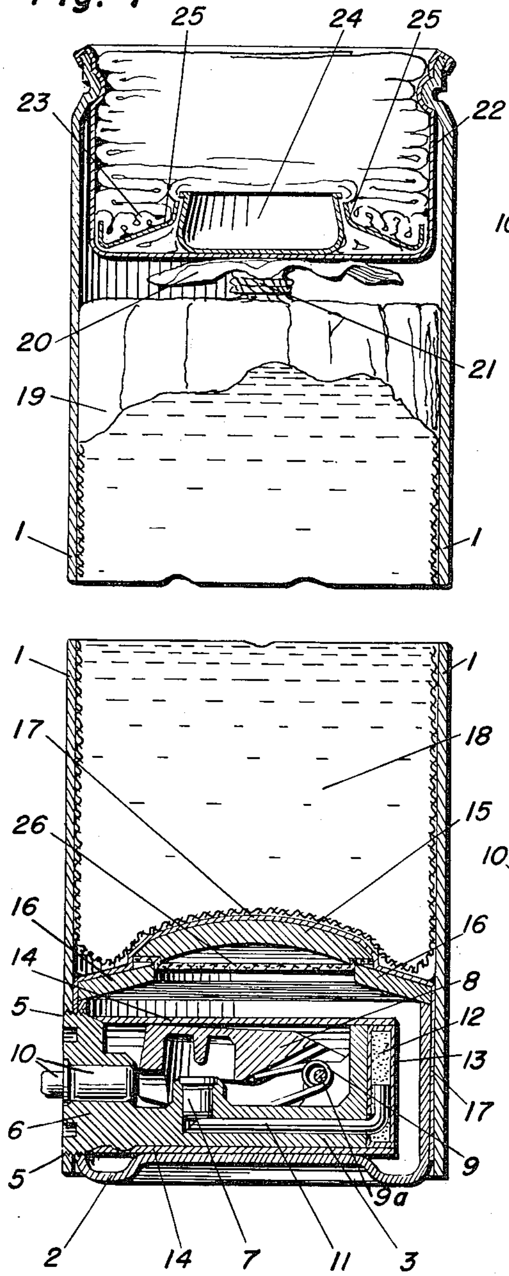


Fig. 2

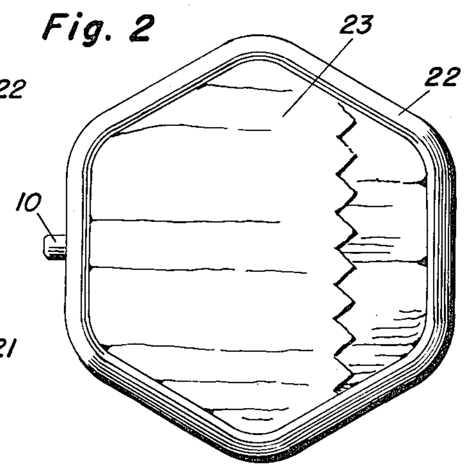
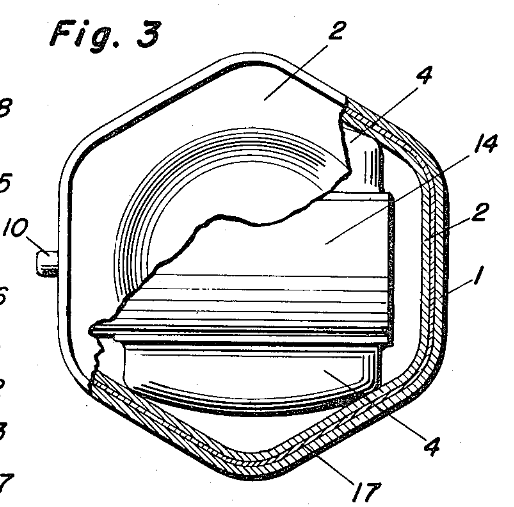


Fig. 3



Inventors

HAROLD A. RICARDS, JR. GEORGE L. MATHESON
LYLE M. COOPER WILLIAM T. KNOX, JR.
FRANCIS R. RUSSELL

By Fred S. Lockwood
and Henry Berk
Attorneys

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Filed Nov. 7, 1944 2 Sheets-Sheet 2

FIG. 4.

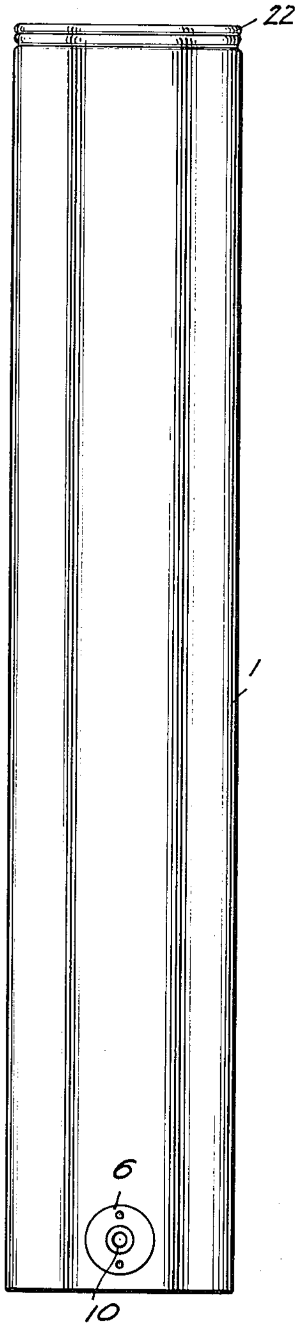


FIG. 5.

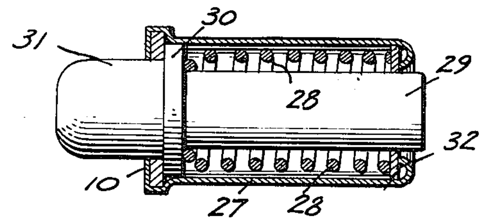
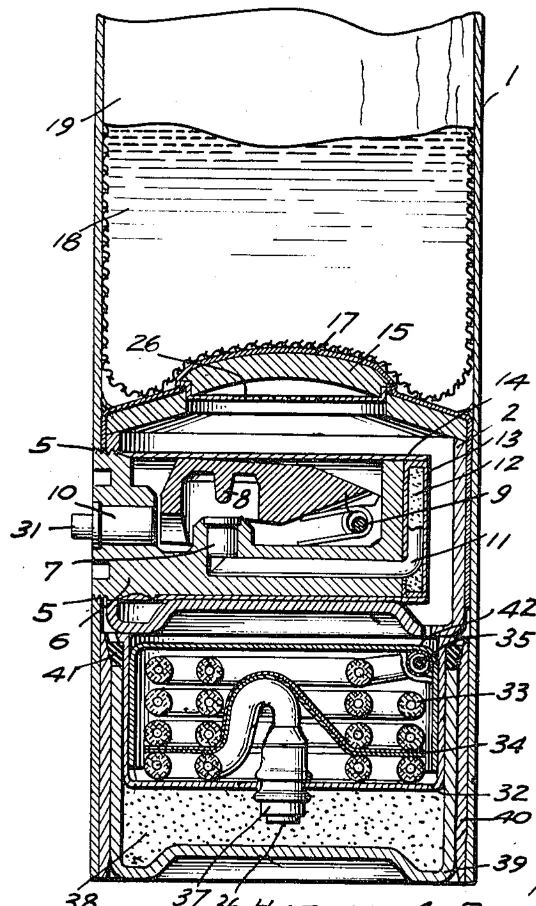


FIG. 6.



INVENTORS:
HAROLD A. RICARDS, JR.
LYLE M. COOPER
GEORGE L. MATHESON
WILLIAM T. KNOX, JR.
FRANCIS R. RUSSELL

BY Fred S. Lockwood
and Henry Berk
ATTORNEYS

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1

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CHEMICAL BOMB

Harold A. Ricards, Jr., Cranford, George L. Matheson, Union, Lyle M. Cooper, Rahway, William T. Knox, Jr., Roselle, and Francis R. Russell, Scotch Plains, N. J., assignors to the United States of America as represented by the Secretary of War

Application November 7, 1944, Serial No. 562,368

1 Claim. (Cl. 102—6)

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 a type of aerial drop bomb designed to eject from its tail a chemical agent, such as incendiary material, and throw such materials against surrounding objects after impact.

Prior to the present invention it was well recognized that dissemination of chemical agents from aircraft could constitute a serious threat in warfare, but the tactical employment of chemical bombs was largely handicapped by lack of a suitably designed bomb. In general there were two types of bombs, the intensive and scatter types. The intensive type was designed to penetrate a building by a direct hit and remain as a unit while functioning in a very restricted area if the bomb lands on combustible material. This type is represented by the thermit-filled incendiary bomb. The scatter type requires the use of a high explosive burster sufficiently powerful to rupture the entire bomb body on impact and diffuses or scatters very small particles of the chemical charge in all directions over an area surrounding the ruptured bomb body. Both of these types have a number of limitations. The intensive type necessitates a thick body wall and is not effective unless it lands exactly on a spot where the incendiary action can be started. It is known that only a small percentage of intensive type incendiary bombs land where they can initiate destructive action. The scatter type bomb fails to function effectively in that the charge becomes too widely spread out in small particles. A large proportion of small scattered particles from a scatter type incendiary bomb fail to ignite, and those that are ignited have too little heat and flame action to initiate burning of a structure they contact except in a few favorable circumstances. A large part of the diffused charge from the scatter type bomb is uselessly directed upwardly and downwardly.

An object of the present invention is to provide a type of bomb which has an advantageous loading efficiency by virtue of its high active agent capacity relative to the weight of the bomb, good security qualities for handling, clustering adaptability for area pattern bombing, and desirable distribution characteristics.

Another object is to provide a type of bomb simple and economical for manufacture, assembly, and use. Further objects and advantages will become apparent from the following description.

Broadly, for accomplishing the objects of the present invention, a bomb has been designed to eject forcefully from the tail end of the bomb body a chemical charge to be distributed. More particularly, the bomb used for incendiary action is provided with a combination percussion and time fuze which permits the bomb to fall to rest on its side after penetration into a target so that a mass of viscid incendiary material can be thrown out horizontally like a single projectile from a mortar to strike an object where a concentrated incendiary action can be started in the path of its trajectory. While ejection of the charge as a single projectile is desirable when the bomb is used with an incendiary agent, the bomb is adapted also for discharging other types of agents, such as a vesicant liquid in a thick spray, powdered material in a dense cloud, or the like, when spreading of such agents over an area is desired in the form of a concentrated mass travelling rapidly over the ground.

2

Various features of the bomb will be described in further detail with reference to illustrations of embodiments in the accompanying drawings which form part of this specification.

In the drawings:

Figure 1 shows a vertical sectional view of a standardized tail ejection incendiary bomb;

Figure 2 shows an elevational view of the tail end of the bomb;

Figure 3 shows a nose end view of the bomb in elevational view and partly in section;

Figure 4 shows an elevational full view of the bomb assembled and with nose end at bottom;

Figure 5 shows an enlarged longitudinal cross-section of a safety plunger assembly used in the type of fuze shown in Figs. 1 and 6;

Figure 6 shows a cut away view in a fragmentary section of the nose end of the bomb modified to contain an anti-personnel fragmentation unit;

In the drawings, similar parts are given the same reference characters.

Referring to the drawings, and particularly to Figs. 1 to 5, casing 1, made conveniently of about 18 to 20 gage pressed sheet steel, extends substantially the entire length of the bomb and forms a leakproof container for the assembly described hereinafter. A nose cup 2 made of sheet steel, preferably thicker than casing 1, is fixed into the nose (bottom) end of casing 1, forming a blunt nose and housing a suitable combination percussion and time fuze assembly 3 together with a charge of igniting-propellant powder 4. The powder 4 may be inclosed in thin walled cellulose nitrate plastic containers, which fit into the nose cup adjacent fuze assembly 3.

The fuze assembly 3 is screwed at its threaded head end into a threaded hole 5 in the casing 1 and nose cup 2. The fuze shown comprises a firing mechanism assembly of a die cast aluminum base alloy 6 having a well for holding a primer cap 7 and supporting a hinged striker 8 of die cast aluminum or steel with a torsion spring 9 for restraining movement of the striker 8 until the movement is caused by sufficient impact force on the bomb. A safety plunger assembly 10 is centrally recessed in the head end of the fuze base 6, where, in unarmed position, a spring held plunger is pressed inwardly under the striker to prevent movement thereof. A lead spitter fuse 11 leads in a groove through the base 6 from the primer cap well under primer cap 7 to a booster charge 12 contained in a cellulose nitrate plastic cup 13. The firing mechanism assembly is protectively encased in a steel cylinder 14.

A disc shaped steel impact diaphragm plug 15 is mounted in and above a hole in the impact diaphragm 16, which is securely brazed to the upper edge of nose cup 2. Diaphragm 16 and plug 15 serve as reinforcement for a thin sheet steel diaphragm 17 brazed to the casing 1 to act as a leakproof seal between the explosion chamber in nose cup 2 and the filling 18.

Gelled or viscid fuel charge 18, occupying the major part of the bomb, is preferably enclosed in a cheesecloth sock 19, the upper end 20 of which is tied securely by a piece of string 21.

In a standardized 6-lb. incendiary oil bomb of the type shown in Fig. 1 the casing is about 19½ inches long, hexagonal in shape, 2⅞ inches wide across the flats, nd weighs complete, filled and fuzed, about 6 lbs. Nearly ½ lbs. of this weight is a gelled gasoline charge. A ail cup 22, made of sheet steel, is mounted in the tail upper) end of the casing 1 and is crimped thereto to orm a leakproof seal but is releasable when subjected to predetermined pressure from within the casing.

As a simplified stabilizing means, tail streamers 23, which are lengths of mildew-proof cloth, are attached at one end to a retainer cup 24 spot-welded at the bottom o the tail cup proper 22. A retainer ring 25 fits over he retainer cup 24 to securely hold the fixed ends of streamers 23. When the bomb falls, the free ends of the streamers 23 fly out, retarding and stabilizing descent of he bomb, so that the bomb falls in approximately a vertical position at a regulated terminal velocity, e. g., of about 250 ft. per second.

In operation, when the bomb is separated from a cluster dropped by aircraft, the plunger in the safety plunger assembly 10 is retracted by a coiled spring away from under the striker to arm the fuze, the plunger being no longer pressed inwardly by an adjacent bomb in the cluster. Upon impact of the bomb at its nose end on a target surface, inertia of the weighted portion at the swinging end of the striker 8 pivotally mounted on the base 6 forces the striker 8 to overcome the restraint of the torsion spring 9 and to swing on hinge pin pivot 9*a* with its firing pin directed toward the primer material in primer cap 7. The firing pin of striker 8 upon being driven into the primer charge flashes the primer, which in turn ignites an underlying end of the lead spitter fuse 11. The lead spitter fuse 11 formed of black powder and collodion compressed in a lead tube burns to its opposite end in a period of about 1 to 5 seconds, giving a desired delay action, which permits the bomb to penetrate the target surface fairly heavy roof constructions, including common sheet metal and tile roofs, and if desired, also to penetrate one or more floorings in a building during the delay in the lead spitter fuse, which permits the bomb to penetrate such structures and fall to rest on its side before functioning.

Referring to Fig. 5, the safety plunger assembly 10 is of a type which has been manufactured for use in standardized thermit incendiary bombs, but an easily made modification is desirable on account of the relatively small distance of travel of the hinged striker in the fuze illustrated in Figs. 1 and 5. Safety plunger assembly 10 comprises a thin-walled sleeve 27 formed of brass, guilding metal, or the like, for housing a coil spring 28 under compression and the stem 29 of a plunger pin. The plunger pin has a flange 30 which bears against one end of the coil spring 28 and prevents the plunger pin from being entirely ejected from the sleeve 27. In the unarmed position, the plunger pin has a button end 31 projecting outside the sleeve 27, and in an armed position, the plunger pin is pressed inwardly against the coil spring 28 so that the narrow end of the stem 29 of the plunger pin opposite the button end 31 projects into the fuze underneath the striker 8 to prevent movement thereof. A thin washer 32, fitted closely around the plunger pin stem 29 between the spring 28 and the inner end of the sleeve 27 reduces the hole diameter at this end of the sleeve and thereby gives better control of the plunger movement. The fuze is maintained unarmed by pressure of an adjacent bomb in a cluster against the button 31 of the plunger pin.

The ignited first fire charge 12 ignites the igniting-propellant charge 4 adjacent the fuze unit 3, and explosion of the propellant powder causes an immediate increase in pressure which lifts the impact diaphragm plug 15, ruptures the sealing diaphragm 17 forces out of the tail cup 22, and violently ejects the mass of thickened fuel charge enclosed in the sock as a single flaming projectile with sufficient force to send it 25 to 200 feet or farther, or to where it is generally intercepted by an upright structure such as the wall or eaves of a building.

The ejection mechanism depends on the ability of burning propellant powder in the charge 4 to create sufficient pressure in the explosion chamber confined within the nose cup 2 to shear the sealing diaphragm 17, and shoot out the fuel charge from the tail end of the bomb so that the bomb acts like a mortar, with the fuel charge being ejected by its own piston action. It has been found that if the impact diaphragm plug 15 is made wide enough to fit so that its periphery is close to the inner wall of casing 1 to have a piston action, that the plug tends to disrupt the casing when it is lifted by the propellant charge explosion; also, such a closely fitted diaphragm would be prevented from moving by small deformations in the casing 1, such as may result from slight buckling upon impact. Accordingly, a substantial clearance is provided between the diaphragm plug 15 and the inner wall of the casing 1. Satisfactory performance is obtained by having the impact diaphragm plug 15 in the form of a dished plate about 0.2 inch thick resting on diaphragm disc 16 over the central hole about 1.5 inches in diameter in this disc and arched toward the tail. The thin sealing diaphragm 17 fits snugly over the impact diaphragm plug 15, the impact diaphragm, and nose cup 2. The sealing diaphragm 17 may not have sufficient strength to resist rupturing by the inertia force of the fuel charge on impact of the bomb if it is unsupported by diaphragm plug 15 and diaphragm 16. The impact diaphragm plug 15 acts somewhat in the fashion of a check valve which is opened by the explosive pressure of the propellant charge. An asbestos gasket 26 may be placed under the diaphragm plug 15 to keep it from being fused to its seat on diaphragm 16, and the arrangement is such that the impact diaphragm plug 15 is held in its proper position.

The cloth sock 19 made of cheesecloth has adequate mechanical strength to remain as an intact enclosure of the entire fuel charge during ejection; moreover, the sock improves ignition and helps to give the desired distribution, since it holds the fuel together to start ignition of the entire mass and allows the burning fuel to spread out as a large gob over the surface of a structure hit by the sock enclosed charge where the sock is finally broken.

From a large number of tests it was found that the use of a cloth sock for enclosing a viscid oil incendiary charge in the tail ejection type bomb of the present invention is highly advantageous for obtaining complete ejection, positive ignition, and good distribution of the ejected fuel charge. Although the cloth sock may be made from various fabrics, it is preferably made from a loosely woven material, such as, a netting, gauze, or cheesecloth. A suitable cheesecloth is covered in Federal Specification CCC–C–271; Type 1 (unbleached) with a warp thread count 36, filling thread count 23; approximate weight of 14 lbs. per yard; width of 36 inches; and known commercially as Grade 50 cheesecloth. The size of the sock depends upon the measurements of the bomb. The sock is made with simplicity and is preferably oversize relative to the volume of the filling. Preferably the sock should be of such length so that its top can be folded over the top of the bomb casing 1 with the tail cup 22 removed during the filling operation.

For a 5-lb. bomb, 14½ inches long and 3 inches in diameter, the cheesecloth is cut into swatches of 18 inches by 12½ inches. The cloth is folded once lengthwise and machine stitched along the bottom and along one side to form a long bag having a distance of about 5⅜ inches from fold to seam. The sock need not be turned inside out. After filling with fuel in the bomb, leaving an outage space of about 5% to 8%, the top of the bag is tied closed by string 21.

Many types of thickened and gelled fuels may be used with the sock enclosure in tail ejection bombs. The fuel should have a consistency which is not too thin with a tendency to excessive flash burning nor too hard with a tendency to rebound upon striking a hard surface. Briefly, among types of viscid fuels which may be used are:

Fuels gelled by soaps;

Fuels gelled or thickened by resins, e. g., rubber, polybutenes, isobutyl methacrylate, etc.;

Fuels thickened by gums or other resinous materials, e. g., rosin, asphalt, and the like; and

Fuels thickened by mixtures of soaps and resin.

A preferred type of gelled fuel may be made by admixing with naphtha hydrocarbons about 7 to 14% by weight of coprecipitated aluminum soaps of stearic acid and oleic acid, or mixtures of such soaps with soaps of other acids, such as, cocoanut oil fatty acids, and naphthenic acids. The gelled or thickened fuels may include fuel oils less volatile than gasoline, such as, kerosene and even viscous residual oils. They may contain in suspension finely divided pyrophoric metals, such as powdered magnesium, oxidizing agents, wood meal, carbon, sodium, or other combustion promoting substances. Such incendiary oils on combustion can develop much more heat than burning thermit mixtures compared on the same weight basis.

Fibrous materials, such as, cotton waste, sisal, excelsior, and the like, to some extent act as binders when added to an incendiary oil fuel, but the use of these binders is not necessary when the fuel is enclosed in a cloth sock and particularly when the fuel is heaved from a tail ejection bomb horizontally.

In demonstration tests and in practical bombs, a number 4 primer cap was used in the fuse 3 with a 1 to 5 second delay lead spitter fuse. The first fire charge **12** was about 1 gram of Army Grade A No. 4 glazed black powder. The ignition-ejection charge placed in each bomb was about 4 to 7 e. g. of powdered magnesium coated with about 3% boiled linseed oil and about 4 to 7 g. of Grade A No. 4 Army glazed black powder. The primer cap is covered in U. S. Army Specification (Primer New No. 4), a type of primer commercially manufactured for smokeless powder shot shells. The lead spitter fuse is a commercial type of fuse cut into about ⅞ inch lengths.

From studies of many tests it was found that between about 2 and 2½ lbs. of incendiary oil charge is an optimum quantity in each bomb for starting fires in typical structures. The incident of effective fire starting decreased rapidly in reducing the quantity of charge below this range, whereas the use of larger quantities was found unnecessary. The casing and the firing mechanism in the bomb can be appropriately designed for efficient clustering, suitable ballistics, and target penetration with an optimum quantity of the fuel charge in the bomb.

Efficient ejection is obtained generally with the following relationship of diaphragm strength, tail cup release pressure, powder charge and fuel viscosity:

Diaphragm (sealing) thickness, about 0.008 inch (about 400 to 500 lb./sq. in. rupture pressure resistance).

Tail cup release pressure, about 100 to 150 lb./sq. in. maximum.

Black powder charge, about 4 to 14 g.

Magnesium powder charge, about 4 to 7 g.

Fuel viscosity for sock inclosed charge, about 300 to 2000 g. Gardner.

Volume ratio of powder chamber to propellant powder charge, less than 10:1.

The kind of ejection may be varied with the amount and type of propellant powder. A typical composition of black powder is about 75 weight percent potassium nitrate, 15% charcoal, and about 10% sulfur. Differences in granulation and surface characteristics of the powder affect changes in the speed of burning and rate of pressure development.

In practical tail ejection bombs designed to hold optimum quantities of an incendiary oil charge, too low an amount of propellant powder, less than about 4 g., develops insufficient pressure to properly eject the incendiary charge; whereas amounts of propellant powder larger than about 14 g. tend to develop excessive pressures. Various igniting materials may be added to the propellant powder charge to act as a source of hot particles for igniting the incendiary oil charge as it is being ejected. Powdered magnesium was found to be a very satisfactory igniting material, particularly when coated with boiled linseed oil and to give close to 100% ignition over a complete temperature range from minus 40° F. to about 150° F. Other igniting materials may be used such as powdered aluminum with an admixture of oxidizing and promoting substances, such as barium nitrate and sulfur.

With the thin-walled casing having a substantially uniform polygonal, preferably hexagonal, cross-section from its nose to its tail, except for a slight crimping with a single seam at the tail end, the bomb has a high loading and ejection efficiency. With this shape, an extensible flight stabilizer, and suitably disposed fuse having a safety plunger, the bomb is adapted for efficient clustering with standardized aimable clustering means.

The tail ejection bomb may be provided with a delayed action anti-personnel element or burster to discourage approach by firefighters and increase damage in the vicinity of the bomb. A suitable burster or fragmentation unit is illustrated in Fig. 6.

Referring to Fig. 6, fixed into the casing **1** under the nose cup **2**, which holds the fuse and powder charge, is a delay fuse cup **32** for holding a helically wound delay fuse **33** in varying lengths. The delay fuse **33** may be of a standard type, such as, the "Crescent" fuse manufactured by the Ensign Bickford Co., Simsbury, Connecticut, otherwise known as Miner's safety fuse, which gives time delays of 30 to 90 seconds per foot. This type of fuse gives more satisfactory performance if dried to reduce its moisture contents to less than about 2% and preferably to less than 1.7%, although ordinarily it has on an average 3.5% moisture. The moisture resistance of the delay fuse may be further improved by replacing the usual fibrous jute covering of the powder train by a material, such as, glass, wool, asbestos, nylon, or the like, which does not absorb moisture. At the initial igniting end, the fuse is in firm contact with a quick match composition **35**, such as formed of Army black powder, Grade A No. 6, and collodion. This composition in turn is in firm contact with a short length of Navy quick-match which is readily ignited by the flame generated by the explosion in the nose cup **2** and transmitted to the Navy quick-match by a flash hole ³⁄₃₂″ in diameter. The delay fuse and Navy quick-match junction is maintained by a suitable crimp. At the other end, the delay fuse is secured in contact with a detonator **36** e. g., a tube containing lead azide, by crimping to a detonator holder sleeve **37** fixed by crimping to the bottom of the delay fuse cup **32**. The lower part of the detonator **36** is surrounded by a high explosive filling **38**, such as tetryl or TNT, contained in the end cup **39**. The end cup **39** is forced with a press fit snugly into an adapted sleeve **40**, which is brazed to the end of the casing **1**. A rubber gasket **41** may be placed between the upper edge of the cup **39** and the bottom of the powder chamber cup **2**. A strip of metal **42** fitted into the top of the delay fuse holder cup **32** serves to keep the coiled delay fuse **33** in place and to position the Navy quick-match end under a vent hole in the bottom of nose cup **2**.

With the added feature of a fragmentation unit, the bomb functions efficiently to first eject its incendiary or chemical charge.

The tail ejection bomb, based on the principles set forth by this invention, may be modified in various respects, as for example, in the construction of the fuze for setting off a propellant charge, the housing of the fuse and propellant powder charge, the design of the flight stabilizing sembly at the tail end of the bomb and the nature of the arge.

The described tail ejection bomb, also, is adapted for arging with various other chemical agents, such as, white iosphorus, liquid vesicants, or solid agents in powdered rm.

The action of the tail ejection bombs in penetrating a rget has been described. In landing on earth instead of ı unyielding structure, the bombs tend to sink into the ound to the extent of several inches, depending on the ırdness of the ground, since the fuze action is not in-antaneous; and, in general, they tend to be tilted to some ‹tent from a vertical position when they discharge their iemical contents to set up a high concentration of the ected charge.

In contrast to the scatter type of chemical bombs, there a far reaching distribution of the charge from the tail ection bomb over the surrounding area instead of a cra-ıring and excessive discharge within a limited area just round the place where bomb lands. Also, in contrast to :atter type bombs hitherto known, the tail ejection type omb of the present invention gives the more desirable rojection of the chemical filling without the need of a omplicated fuze or high explosive burster that requires large amount of critical high explosive, and is more uitable for clustering to obtain pattern bombing.

While this invention pertains to an assembly of co-perative components for accomplishing the objects set orth, it is not concerned specifically with any particular ype of fuze mechanism, fuze housing construction, tail as-embly construction, or manner of loading with a chemical iller. It has been indicated in the foregoing description hat each of these component parts of the tail ejection omb is subject to modifications.

The fuze construction illustrated in Figs. 1 and 6 forms ubject matter claimed in an application by Lyle M. Cooper, Serial No. 562,370, filed November 7, 1944, now Patent 2,666,389, granted January 19. 1945. The cloth ock loading of incendiary oil is subject matter claimed n an application filed November 7, 1944, by Francis R. Russell and William T. Knox, Jr., Serial No. 562,369. It is to be understood that other modifications and varia-ions may be carried out without departing from the spirit and scope of the invention as defined by the appended claim.

We claim:

A tail ejection bomb, comprising a thin-walled elongated casing hexagonal in cross-section with a length to width ratio of at least about 4 to 1, a relatively thicker wall cup hexagonal in cross-section brazed to the end of the casing, a combination percussion and time fuze pro-jecting into the nose cup with a safety-pin plunger pro-jecting outwardly therefrom, a propellant powder con-tainer holding from about 4 to 14 grams of black powder as a propellant charge adjacent the fuze in the nose cup, a rupturable sealing diaphragm closure for space confined surrounding the fuze and propellant powder container so that the volume of this space is no greater than 10 times the volume of the propellant powder, a thin-walled cup hexagonal in cross-section crimped at the edge of its side walls to the tail end of the casing to be released by development of up to about 150 lbs. per sq. inch pres-sure inside the casing by explosion of the propellant powder, an extensible flight stabilizing means attached to the tail cup and normally compressed therein, and a chemical agent filling in the casing between said sealing diaphragm and the tail cup.

References Cited in the file of this patent

UNITED STATES PATENTS

1,005,578	Schneider	Oct. 10, 1911
1,276,635	Foxworth	Aug. 20, 1918
1,305,751	Stearns	June 3, 1919
1,326,258	Graumann	Dec. 30, 1919
1,484,190	Ray	Feb. 19, 1924
2,119,697	Anderson	June 7, 1938
2,217,645	De Wilde et al.	Oct. 8, 1940
2,247,111	Batchelor et al.	June 24, 1941

FOREIGN PATENTS

18,569	Great Britain	of 1899
121,045	Great Britain	Dec. 5, 1918
307,149	Germany	Feb. 6, 1920
616,917	France	Nov. 6, 1926
711,463	France	June 30, 1931