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ENEMY CAPABILITIES FOR CHEMICAL WARFARE

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FOREWORD

Up to the present time, since the beginning of World War II, toxic gases have not been employed by the European Axis armies, but Japan has used such gases on a limited scale many times in China. However, in the field of chemical warfare, the employment of toxic gases represents only one phase of modern combat technique. The use of screening smokes, incendiaries, and flame-throwers has played an increasingly important role in the present conflict and may easily assume proportions never dreamed of in the last war.

The value of smoke for screening purposes in military operations has been demonstrated repeatedly. Early in the war, with the aid of this weapon, the Germans were enabled to capture the strategic Fort Eben Emael in Belgium and to penetrate the heavily fortified French Maginot Line with relatively few casualties. Aided by protective smoke screens, large numbers of Axis troops were dropped by parachute on Crete. That smoke is invaluable in landing operations was demonstrated by the British in the Dieppe raid and by U. S. troops in North Africa. In addition, screening smokes are being utilized advantageously to obscure harbors, docks, and industrial areas when they are subjected to bombing attacks.

Air raids upon London, Berlin, and other cities emphasize the importance of incendiary bombs. Especially when used together with aerial demolition bombs,

these incendiaries have caused widespread destruction of built-up areas.

The tactical value of the flame-thrower against pill-boxes and fixed emplacements is recognized. It is a particularly effective weapon when mounted on tanks. Also, the terrifying effect of the flame-thrower upon morale, when first encountered, cannot be overlooked.

It is therefore proposed to present an estimate of the capabilities of the Axis powers to wage chemical warfare in its principal phases, and without special emphasis on toxic gases, which may or may not be encountered.

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Section I. CHEMICAL TROOPS

1. GENERAL

As instigators of chemical warfare during World War I, it is to be expected that the German Army will be well prepared, both offensively and defensively, for the resumption of that type of warfare in the present conflict. Numerous enemy documents clearly show that various "smoke units," ostensibly organized for the sole purpose of making smoke warfare, are actually chemical troops, efficiently trained and well equipped to use toxic chemical agents at such time as the German High Command may deem advantageous.

2. ORGANIZATION

a. General

German chemical warfare units are part of the GHQ pool and may be alloted to corps and divisions as required.

b. Chemical (Smoke) Regiment (*Werferregiment*) [1]

According to reports, the chemical (smoke) regiment was formerly known as *Nebelwerferregiment,* but is now designated as *Werferregiment* (fig. 1).

This regiment is composed of a regimental head-

[1] Literally, *Werferregiment* means "projector regiment," and *Nebel (werfer) regiment* is sometimes translated as "smoke (mortar) regiment."

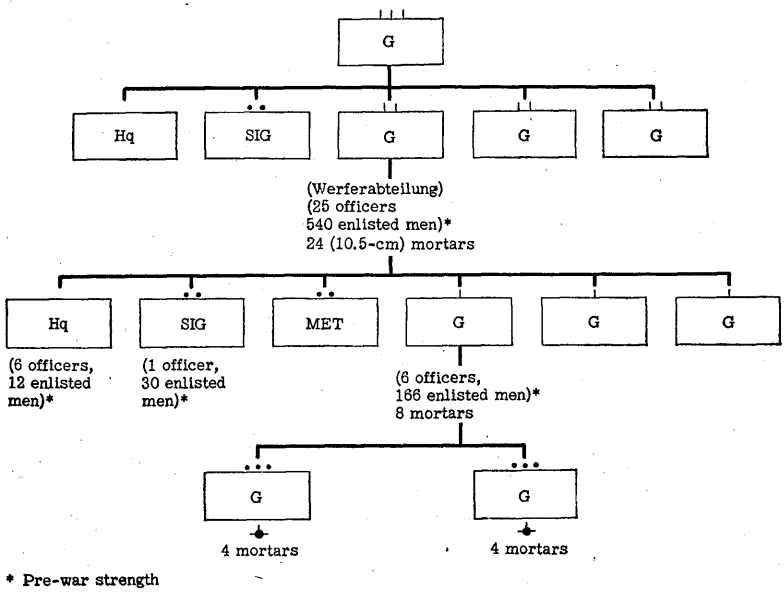


Figure 1.—Organization of the German chemical (Smoke) regiment (*Werferregiment*)

quarters, a signal section, and 3 battalions (*Werferabteilungen*), equipped with 10.5-cm. (4.14-inch) mortars and other weapons. Each battalion consists of a headquarters, signal and meteorological sections, and 3 companies of 2 platoons each. Reports indicate that the total armament of the regiment is 72 mortars. At least 10 such regiments (including 2 experimental regiments) have so far been identified, and 13 independent battalions (including 3 decontamination battalions) (see **d** (2), below) are also known. The battalions are trained to shoot gas as well as smoke from their mortars, no adjustment being necessary, and thus could be utilized for chemical warfare at any time.

c. Heavy Chemical (Smoke) Regiment (*Schweres Werferregiment*) [2]

Since the introduction of the sextuple rocket mortar, known as the *Nebelwerfer 41,* or *Werfer 41,* the organization of at least one heavy chemical (smoke) regiment (*schweres Werferregiment*) has been reported. This regiment is said to be organized like the normal chemical (smoke) regiment, except that its total armament consists of 54 six-barreled mortars.

d. Other Units

(1) *General.*—The chemical (smoke) battalion (*Werferabteilung*) (see **b**, above) and the decontamination battalion (*Entgiftungsabteilung*) exist as independent units in the GHQ pool. In addition, it is believed that the road decontamination battalion (*Strassen-Entgiftungsabteilung*) and motorized decontamination companies also exist as independent units.

(2) *Decontamination battalion.*—This unit consists of a headquarters, signal and meteorological sections, and three companies, with nine trucks, each carrying 1.2 tons of bleaching powder. Each company consists of two platoons, each equipped with six medium half-tracked trucks fitted with hoppers to scatter the bleaching powder.

Although the primary function of the decontamination battalion is to clear contaminated areas, it is said to be trained and provided with equipment for contaminating purposes, and thus would be available instantly for offensive chemical warfare. In this role,

[2] See note 1, above.

the unit would be known as *Vergiftungsabteilung* (contamination battalion).

(3) *Road decontamination battalion.*—Little is known relative to the organization and duties of this unit.

(4) *Motorized decontamination companies.*—These are composed of medical troops attached to the GHQ pool and would be sent wherever high gas casualties had occurred. No details are available concerning the organization of these troops, but they are said to be able to decontaminate and reclothe 150 men per hour.

e. Attached Units

Horse-decontamination sections are reported to be attached to each veterinary company and army veterinary hospital. These are motorized and can be sent wherever needed. Their capacity is said to be 10 to 20 horses per hour.

3. SCHOOLS AND TRAINING

Gas protective training is organized on a sound and efficient basis. Large-scale field exercises, or "gas war games," have been reported on a number of occasions.

Army antigas schools are located in Berlin, Celle, and Breloh, and the schools attached to the firms of Auer and Dräger also are extensively used for training both officers and noncommissioned officers.

Training of German troops in the use of the gas mask, in gas chamber exercises, and in identification of gases is generally along the same lines as in the U. S. Army. There is great insistence on the proper fit-

ting of gas masks and on correct breathing. Emphasis is placed on tactical exercises which involve movements over contaminated ground. The training of gas sentries (*Gasspürer*) is regarded as very important. The Army Gas Schools are reported to have a stock of instructional films which are extensively used.

Each infantry battalion (or equivalent unit) has an antigas officer, assisted by a noncommissioned officer, who, in addition to other duties, is responsible for antigas training and protective equipment, as well as for intelligence reports on enemy use of gas. In addition, each battalion (or equivalent unit) is said to have two squads, each consisting of a noncommissioned officer and six men. Squad No. 1 is believed to be trained in the offensive use of gas, while Squad No. 2 is trained in passive defense, decontamination, and methods of collective protection.

Each company has an antigas noncommissioned officer, and probably has two or more men trained as gas sentries, who are equipped with gas detectors and alarms.

Section II. MANUFACTURE AND STORAGE

A recent compilation of chemical plants in Germany and German-occupied Europe engaged in the manufacture of poison gases shows 19 such establishments in Germany proper, 12 in France, 11 in Poland, 7 in Czechoslovakia, 3 each in Austria and Belgium, and 1 each in Hungary, Rumania, and Holland. This list does not include 51 plants, in the same countries, engaged in the manufacture of chlorine, which may or may not be produced for gas warfare.

Section III. OFFENSIVE WEAPONS

1. AGENTS

a. General

German war gases, generally speaking, have retained their World War I classification, as shown in figure 2. (For a comparison of German gases with those of other nations, see the war gas comparison chart which faces p. 156.) However, "crosses" are believed to have been superseded by the terms "rings" or "bands" for purposes of nomenclature.

Recent information suggests that the Germans are familiar with the potentialties of arsine (AsH_3), and it has been found that their gas-mask canisters afford protection against this gas.

The Germans are known to favor the combination of gases. Thus, a vesicant toxic smoke is a combination of "blue"- and "yellow"-band gases, and the nature of the chemical filling would be indicated by two bands of the corresponding colors. "Green" and "yellow" bands would indicate a choking gas with vesicant properties. A double "yellow" band would indicate a vesicant gas of enhanced persistence.

b. Nitrogen Mustards

In addition to the more or less standard agents, there is documentary evidence to show that the Germans possess a nearly odorless gas designated as

COMMON NAME	GERMAN NAME
Blister Gases (Vesicants)—"Yellow Cross"	
1. Mustard (H)	*Lost; Senf; Gelbkreuz*
2. Lewisite (L)	*Gelbkreuz II (?)*
3. Ethyldichlorarsine (ED)	*Dick; Gelbkreuz III*

(Mixtures of mustard gas and Lewisite may be used in cold weather to reduce the freezing point. The mustard gas is likely to be an improvement on the 1914–18 German mustard; it is probably more persistent, and possibly more vesicant and more difficult to decontaminate.)

Choking Gases (Lung Irritants)—"Green Cross"	
1. Phosgene (CG)	*D-Stoff; Grünkreuz*
2. Diphosgene (DP)	*K-Stoff; Perstoff; Grünkreuz I, II*
3. Chlorpicrin (PS)	*Klop*
4. Chlorine (Cl)	*Chlor*

(There have been frequent references to mixtures of these choking gases.)

Nose Gases (Toxic Smokes)—"Blue Cross"	
1. Diphenylchlorarsine (DA)	*Clark I; Blaukreuz*
2. Diphenylcyanarsine (DC)	*Clark II; Cyan Clark*
3. Adamsite (DM)	*D.M. Adamsit*

(Germany shows a preference for DA and DC. DM was not used during 1914–18.)

Tear Gases (Lacrimators)—"White Cross"	
1. Chloracetophenone (CN)	*T-Stoff*
2. Brombenzylcyanide (BBC)	*T-Stoff*

(Neither of these gases was used by the Germans in the last war. They relied upon a number of bromide compounds, which are less powerful than the two substances listed. It is thought that Germany attaches little importance to tear gases alone, but the possible use of other gases camouflaged by tear gases must not be overlooked.)

Figure 2.—List of German war gases.

"Green Band I." It is only one of several gases with like characteristics that may be referred to as "nitrogen mustards."

Generally speaking, the nitrogen mustards are either liquids or low-melting solids, pale yellow to colorless, and are practically odorless. Their volatility varies, some being less volatile than mustard gas and some more volatile. They are fairly readily hydrolyzed by water, but the products of such hydrolysis are toxic.

Nitrogen mustard gas has a low freezing point, and might, therefore, be used for high-altitude bombing or spray (if thickened). It may be three or four times as volatile as mustard gas and therefore less persistent. Since higher concentrations are possible, it is more dangerous as a gas, though not so powerful in its vesicant effect. It would require special stabilization if used in hot climates.

The principal danger from the nitrogen mustards lies in the fact that their vapors are not easily detected by smell. Munitions which contain these gases and have a high bursting charge (20 to 30 percent HE) are indistinguishable from HE on detonation. Under such conditions, reliance must be placed on the usual U. S. detector methods: that is, (1) detector paint or paper; (2) vapor detector kit, M–4; (3) crayon vesicant detectors.

Nitrogen mustard is likely to be used to achieve surprise by being included in a normal HE bombardment in order to capture key positions. It is also possible that this gas would be used as a spray from airplanes, or in aerial bombs.

2. GROUND WEAPONS

a. Mortars

(1) *10.5–cm chemical mortar.*—The basic weapon of the German chemical troops is the 10.5-cm (4.14-inch) mortar, two models of which are known. Model 35 closely resembles a Stokes mortar [3] and fires a streamlined shell a distance of about 3,000 yards. The rate of fire and capacity of the projectile are not known, but it is probable that the rate does not exceed 20 rounds per minute. Few details are known of model 40, but its maximum range is said to be some 6,500 yards.

(2) *15-cm Nebelwerfer (Werfer) 41.*—Primarily a smoke weapon, this improved version of the *Nebelwerfer* "d" projector consists of six barrels, each of 15-cm (5.91-inch) caliber, arranged in a manner similar to the chambers of a revolver (fig. 3). It is mounted on wheels and fitted with a split trail. The range of the weapon is 6,600 yards. It is also reported to be mounted on an *L. K. W.* (*Lastkraftwagen*) towed by an *Opel Blitz* and manned by a noncommissioned officer and six men. The barrels are not rifled, but are provided with three guide rails about 8 mm in depth. The barrels are open at both ends, the rocket projectile being retained in position, after loading, by means of a spring-operated latch.

Firing is electrical and from a distance, because of a considerable initial flame effect from the projectile.

[3] The Stokes mortar is a smooth-bore, muzzle-loading weapon firing a cylindrical projectile which is unstabilized in flight and which therefore requires an "always" fuze, that is, a fuze designed to function upon impact regardless of the manner in which the projectile strikes. The Stokes mortar was used extensively by the British and U. S. forces during World War I.

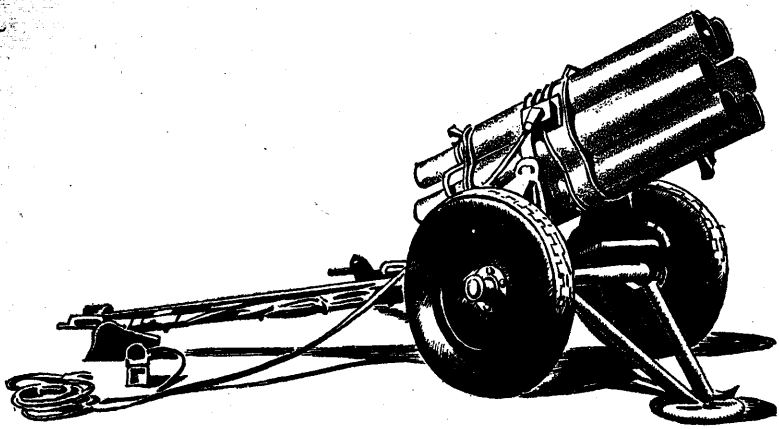


Figure 3.—*15-cm Nebelwerfer (Werfer) 41.*

The separate barrels fire at intervals of 1 second, the complete series of six rounds being fired over a period of 5 seconds. Including time to reload, this complete series can be repeated every 90 seconds.

The projectile consists of three portions: a ballistic cap screwed to a cylindrical portion containing the propellant, which in turn is screwed to the portion containing the HE or chemical filling, and an impact fuze. The portion containing the propellant is referred to as a "turbine," and the jets are arranged in such a way as to impart a rotating movement to the projectile. There are no fins.

The forward arrangement of the projectile is believed to have two advantages: increased accuracy of trajectory, and, as the portion containing the chemical filling is out of the ground at time of bursting, increased efficiency in dispersion.

Two types of projectiles are known. One, containing only HE, is 3 feet in length (fig. 4). The smoke

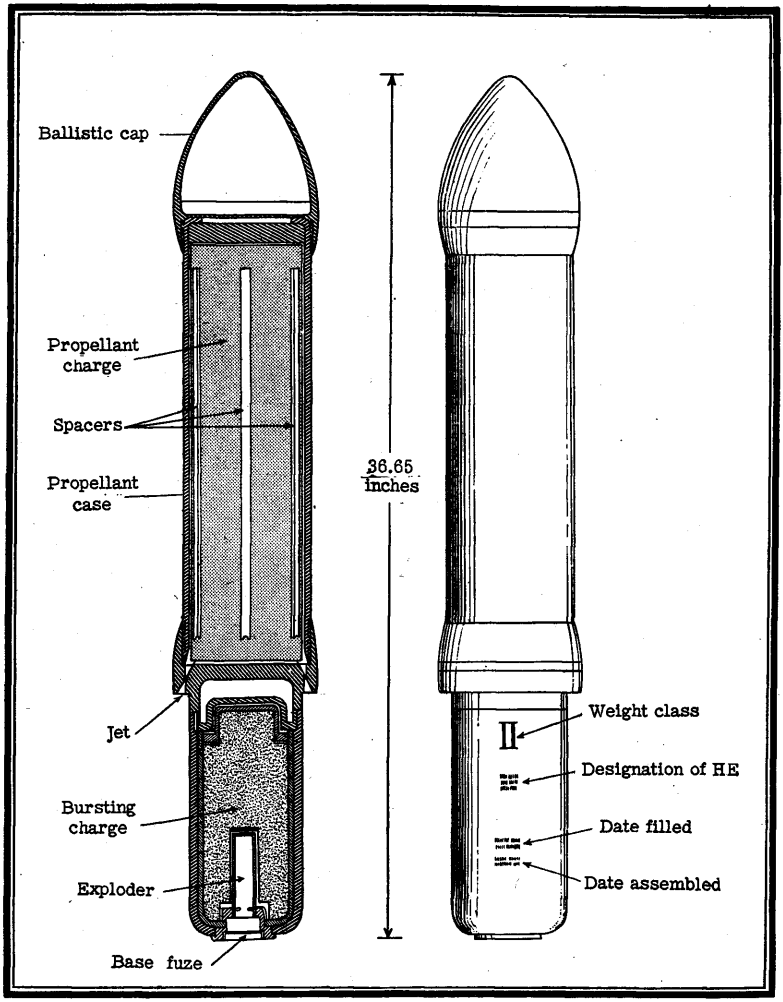


Figure 4.—German 15-cm HE rocket.

(or chemical) projectile (fig. 5), 40 inches in length, contains a large, central bursting charge of HE surrounded by smoke composition or chemical filling

(about one-half gallon). Its total weight is said to be approximately 70 pounds.

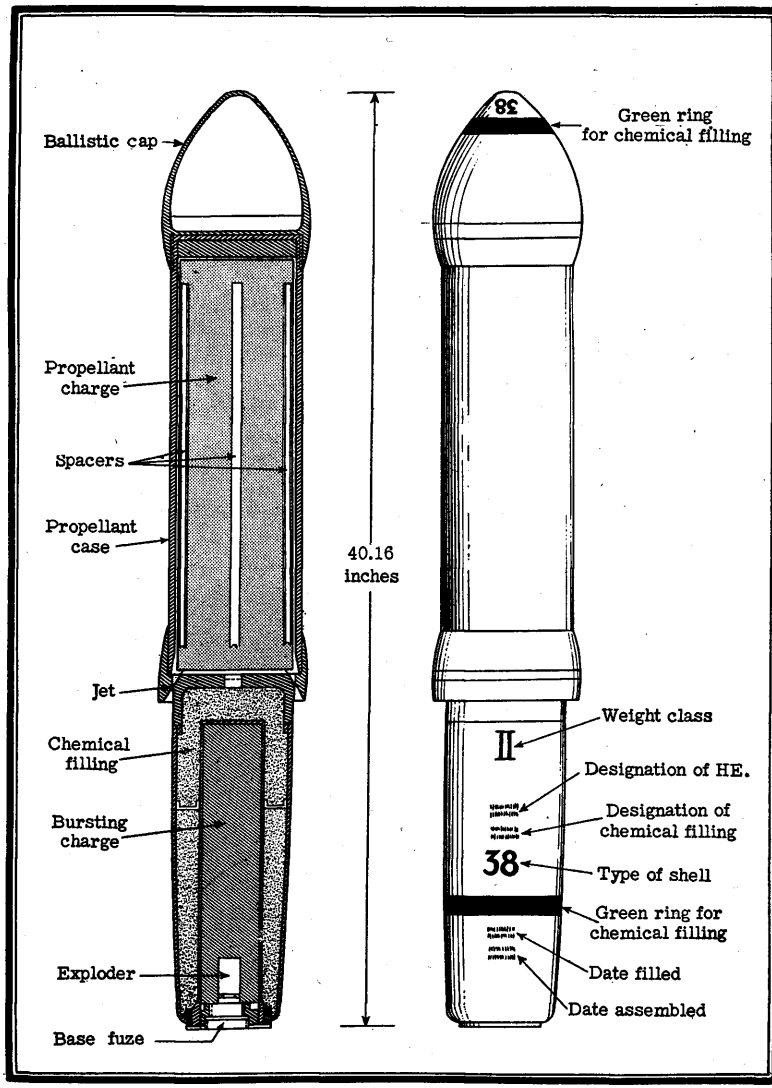


Figure 5.—German 15-cm chemical rocket.

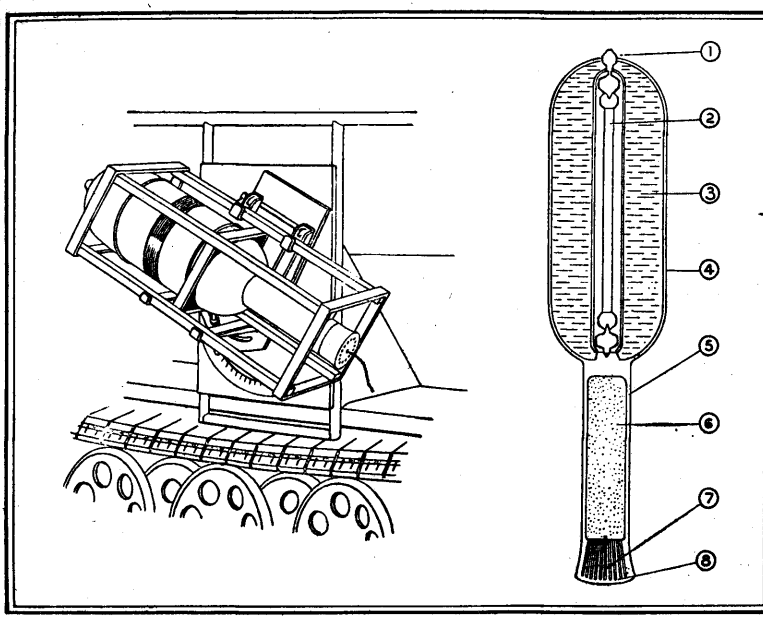
It has been reported that by means of the *Nebelwerfer 41* the Germans have fired HE shells with considerable effect against the Russians. In the event that gas warfare starts, there seems to be no doubt that this sextuple weapon would be very effective in laying down a high concentration of gas within a short period of time. Based on the rate of fire of 6 rounds per weapon each 90 seconds, it would be possible for 1 regiment to lay down 324 rounds every 90 seconds.

(3) *Schweres Wurfgerät.*—The Germans have developed a weapon for projecting 28-cm (11.02-inch) HE and 32-cm. (12.60-inch) incendiary rocket projectiles, known as the *schweres Wurfgerät* (heavy throwing apparatus). Three different types of this weapon have been reported, although the projectiles are the same in all cases.

The first type, known as the *schweres Wurfgerät 40* (static), consists of a stout wooden frame, or stand, to which four projectiles are mounted. The second type, known as the *schweres Wurfgerät 41,* is similar to the model 40, except that the stand is made of metal.

There is considerable evidence that these models have been abandoned in favor of the *schwerer Wurfrahmen*[4] *40* (fig. 6). Formerly issued only to smoke troops, this weapon is now also in the hands of motorized infantry and engineers. It has been made mobile by being mounted on a medium-armored half-track vehicle.

[4] Literally, "heavy throwing frame."



(1) Direct-action, nose fuze.
(2) Instantaneous detonating system.
(3) Main filling.
(4) Casing wall, 3 mm (⅛ inch) thick.
(5) Tail body.
(6) Propellant change.
(7) Socket for electric primer.
(8) Nozzle apertures.

Figure 6.—*Schwerer Wurfrahmen 40* (heavy throwing frame 40).

Attached to the sides of the vehicle are six projectors. Each consists of a carrier plate, pivotally mounted so that it can be elevated from 5 to 42 degrees, to which is clamped a skeleton framework to hold the rocket projectile. The projectiles are transported in, and fired from, the framework, or "packing case."

The weapon is manned by a crew of four, consisting of a noncommissioned officer, two gunners, and a driver. It is prepared for action by unloading the projectiles (in their cases) from the vehicle and clamping

them on the carrier plates. The vehicle is then driven into its firing position, moving in along the line of fire. The projectiles are discharged electrically at intervals of 2 seconds, beginning from the left rear and working forward on alternate sides.

Six rounds of ammunition are carried on the vehicle; five rounds are 28-cm HE, and the sixth is a 32-cm incendiary. The 28-cm HE projectile weighs 82 kg (181 lbs), contains 50 kg (110 lbs) of TNT, and is designed for demolition of field defense works. It has a maximum range of 2,080 yards and is identified by a pink band approximately 3 cm (1.2 inches) wide.

The 32-cm incendiary projectile weighs 79 kg (174 lbs) and contains 50 liters (13 gals) of oil. It is used to fire buildings, woods, dry grass, fields, etc., and a single round will spread fire over an area of 200 square yards. It has a maximum range of 2,180 yards and is identified by means of a green and yellow band.

Although the only ammunition so far reported is HE or incendiary, the fact that this weapon was originally a weapon of the smoke troops makes it highly probable that gas- and smoke-charged projectiles for it also exist. As a chemical-warfare weapon, it would be very efficient for the creation of crash concentrations of lethal gas even if the surprise effect is somewhat reduced because of the considerable noise and smoke during firing and the flight of the projectile.

(4) *Miscellaneous rocket weapons.*—Two new rocket weapons have now been identified. The 21-cm (8.26-

inch) *Nebelwerfer 42,* for which only HE ammunition now seems to be available, is probably a larger version of the *15-cm Nebelwerfer 41.* A 28/32-cm smoke mortar (*28/32-cm Nebelwerfer 41*) fires the same ammunition as the heavy projector. The suggestion that it works on the same principle as the *15-cm Nebelwerfer 41,* with an arrangement of six barrels, is questionable.

(5) *Spigot mortar.*—Revolutionary in design is the 20-cm (7.87-inch) spigot mortar (*leichter Ladungswerfer*) recently adopted by the Germans. While this mortar is primarily intended for the destruction of obtacles, minefields, and gun emplacements, there is apparently no reason why a smoke or incendiary filling could not be substituted for HE. The egg-shaped nose-fuzed projectile, to which a long tubular tail having eight stabilizing fins at the base is attached, weighs 21.27 kg (46.8 lbs) and has ranges up to 766 yards, depending upon the three propellant charges. The fuze can be set for instantaneous or delayed action.

b. Artillery

(1) *General.*—It is believed that the Germans consider as uneconomical the dispersion of smoke by artillery weapons, as the latter are thereby prevented from carrying out their primary role. Smoke shells, however, are still carried by artillery units and comprise approximately 25 percent of the total ammunition carried. The limitations of gas shells for artillery are clearly recognized. Nevertheless, reports suggest that the Germans for some time have been building

up extensive stocks of gas-filled shells. They appear to favor the 10.5-cm and 15-cm shells. When these shells are filled with lung irritants, they use small bursters; when they are filled with vesicants, they use larger bursters in order to scatter the liquid over a considerable area. The area of contamination is given as about 60 square yards for the 10.5-cm, and 120 square yards for the larger shell. A highly sensitive percussion fuze would be used to minimize crater formation and thereby prevent the loss of the gas filling in the soil.

(2) *12-cm (4.72-inch) mortar.*—Recent reports indicate that the artillery has adopted a 12-cm (4.72-inch) mortar, identical with or based on the Finnish 12-cm mortar. This weapon is muzzle-loaded and is fired by means of a trigger. Its most effective angle of fire is 45 degrees, and its range is controlled more by variation of the propellant charges (five in number) than by variation of the angle of fire.

Smoke projectiles, of the same weight as HE, may be fired. The light projectile contains 2¾ pints of smoke-producing compound, whereas the heavy projectile contains 1 gallon. The Finnish mortar has a maximum range of 7,546 yards with a 27.5-pound projectile, and a range of 4,921 yards with a 47.5-pound projectile. Its rate of fire is six rounds per minute.

c. Infantry

Infantry weapons that may be used for gas warfare include the following:

Weapons	Caliber	Maximum range	Rate of fire	Type of filling	Weight of projectile
Light infantry gun.	7.5 cm	3,800 yds	15 to 20 rpm	Smoke and lacrimators	14.25 lbs.
Mortar	8.1 cm	2,100 yds	6 rounds in 8 to 9 secs.	Smoke and lacrimators	7.75 lbs.
Heavy infantry howitzer.	15 cm	6,000 yds	4 to 6 rpm	Lung irritants and vesicants.	80 lbs.

(The *Pz. Kw. IV* medium tank, equipped with a 7.5-cm gun, carries 15 smoke, 55 HE, and 10 AP hells.)

d. Candles and Grenades

(1) *Candles.*—(a) *Smoke candle 39 (Nebelkerze 39).*—This candle (*Nb.K–39*), as well as model S, consists of a green painted cylinder, 88 mm (3.46 inches) in diameter and 146 mm (5.75 inches) high weighing 1.8 kg (4 lbs). Filled with a Berger-type mixture [5] composed of two parts of zinc dust to three parts of hexachlorethane, it burns from 4 to 7 minutes. Model 39 may be fitted with a 30-cm (11.75-inch) stick for throwing.

(b) *Smoke candle 34.*—This candle, of which few details are known, as well as the *Nb.K–39,* is projected up to a distance of 550 yards by means of the improvised smoke projector (see (2) (a), below).

(2) *Smoke-candle projectors.*—(a) *Improvised type (Nb.K–34).*—This weapon consists of a steel barrel 94 mm (3.7 inches) in diameter, 4 mm (0.157 inch) thick, and 66 cm (23.62 inches) long, to which a base plate 20 cm (7.8 inches) square and 1 cm (0.39 inch)

[5] The "Berger mixture," a smoke agent named after its French inventor, had the following composition (by weight) in World War I: 25% zinc dust, 50% carbon tetrachloride, 20% zinc oxide, 5% kieselguhr.

thick is welded. A bipod is attached to the barrel by a ring just behind the muzzle. Best results are produced by using an elevation of about 45 degrees, which gives a maximum range for any of the three propellant charges that may be used. The charges are made up of 25, 50, and 100 grams, respectively, of the propellant explosive in small packets of gauze or cellophane. The method of operation is to insert the charge into the barrel and drop in the smoke candle with the safety pin withdrawn. This ignites the charge, and the candle is projected to a distance which depends upon the charge, the angle of projection, and the wind. The average ranges attainable are as follows:

With 25 grams propellant	110 yards.
With 50 grams propellant	220 yards.
With 100 grams propellant	550 yards.

The most effective use of this projector is said to be in the engagement of entrenchments and dugouts and in carrying out river crossings. For the latter purpose, it can be mounted in the assault boat issued to engineer units.

(b) *Tank-mounted rack.*—Reports from the Middle East state that a smoke-candle rack is mounted on German tanks, *Pz.Kw. II, III,* and *IV*. The smoke candles are projected downward by a strong spiral spring, and the five compartments of the complete rack are controlled by a single whipcord.[6] This apparatus is obviously intended for the protection of the indi-

[6] According to recent reports, the *Pz.Kw. III* now has three smoke candles arranged on each side of the turret instead of a rack of five or six on the back of the tank. It is understood that the candles on the *Pz.Kw. IV* are similarly arranged.

vidual tank, and it is extremely doubtful if it could be used for the support of other arms.

(3) *Grenades.*—(a) *Smoke hand grenade 39 (Nb. Hgr. 39).*—This weapon, weighing 0.85 kg (1.75 lbs), is similar to the normal stick grenade. Filled with a Berger-type mixture,[7] it burns from 1 to 2 minutes, after a 7-second delay.

(b) *Smoke hand grenade 41.*—This weapon, consisting of a small smoke generator in a cylindrical metal casing weighing about 1¼ pounds, is also reported.

(c) *Gas grenades.*—Gas grenades having twice the capacity of World War I designs are said to be available in Germany. These may be thermal toxic generators made by a private firm (Stoltzenberg) and containing DA (diphenylchlorarsine), DC (diphenylcyanarsine), and diphenylarsenic acid, which are reported to be very effective although their storage properties are not good.

(4) *Smoke generators.*—The French had a large number of arsenical smoke generators which are now presumed to be in German hands. They are large in size, contain DM (diphenylaminechlorarsine), and function for about 8 minutes. They are intended to be used in groups of four, arranged to function one after the other so as to give a total emission period of about 30 minutes.

e. Bulk Contamination

The Germans have developed light and medium bulk-contamination vehicles (*Sprühbuchsen*), mounted

[7] See p. 19, note 5, above.

on 1-ton chassis. Both have a crew of one in addition to the driver.

The medium-type vehicle is reported to have a capacity of 1,200 kg (2,640 lbs) of vesicant gas, which is ejected under an excess pressure of 2 atmospheres through a nozzle at the rate of 1.4 kg (3.08 lbs) per second. The nozzle is mounted on a swiveling arm, which can be adjusted in height, and is fed by a flexible hose of small diameter hung on support arms. The spray is operated from a panel behind the driver's compartment. One such vehicle can contaminate a strip 30 by 400 meters to a density of 100 grams per square meter.

As previously stated, the decontamination battalion of the smoke regiment may be quickly converted into a contamination unit (see sec. I, par. **2d** (2), above). For such purposes, the battalion would be equipped with 6 trucks, each carrying 100 portable sprayers, and each platoon would have 6 medium bulk-contamination trucks.

f. Miscellaneous

(1) *Gas-cloud cylinders.*—Germany was the first country to use cylinders for gas-cloud attack and is certainly familiar with this weapon, although reports concerning its existence are vague.

(2) *Rifled projector.*—A rifled projector (Livens type [8]) of 16-cm (6.30-inch) caliber, with a range of

[8] The Livens projector is a simple device for projecting a gas container into the enemy's area and then releasing the gas by an explosive charge. It consists of a smooth-bore tube fixed to a base at a 45-degree elevation; the tube is approximately 8 inches in diameter and fires electrically one gas cylinder or shell. The projector fires but one shell per projector per installation. Usually from 25 to 200 Livens projectors are set in a line and fired simultaneously in order to give a dense gas concentration.

3,600 yards, had been developed at the close of the last war, but it is questionable if this weapon is still in use.

(3) *Contamination and gas mines.*—There are reports of contamination mines, designed to be sunk at the sides of roads. They are actuated by a time mechanism or by the passage of vehicles, or are fired electrically. Gas mines are also mentioned in reference to frontier fortifications and to tidal beaches (for harassment of landing parties).

3. AERIAL WEAPONS

a. Spray

(1) *General.*—The Germans have devoted considerable research to aerial sprays. They regard low-altitude spraying (below 1,000 feet) as an effective weapon both against personnel and for ground contamination. A number of trials have been carried out in which as many as six aircraft have been employed, together or in relays.

The Germans have been conspicuously silent as to the possibilities of high-altitude spraying, and although the weight of evidence suggests that its use is unlikely, it would seem unwise to assume that they have overlooked this potentiality.

It is assumed that mustard gas, including the so-called nitrogen mustards, will be the agent which the Germans will use in the event of gas warfare, but Lewisite and mixtures of mustard gas and Lewisite, likewise, are to be expected.

(2) *Spray apparatus.*—(a) *Nebelgerät V. 200.*—This spray apparatus, suitable for use with either smoke

or gas, is reported to approximate a 250-kg (550-lb) bomb in size and weight. Its capacity is stated to be 25 gallons of smoke liquid or vesicant gas.[9] At 200 miles per hour a strip about 660 yards in length may be contaminated during the emission period of 6 to 7 seconds.

(b) *Nebelgerät S. 300.*—A larger apparatus, the *S. 300,* while intended primarily for the laying of smoke screens, presumably may be used for spraying vesicant gases. It is pressure-operated and consists of a cylindrical 60-gallon tank, magnetic control valves, and an emission pipe. The emission is operated electrically from a switch-box near the observer's seat and can be interrupted at will. In the Dornier 217 E–1, it is carried in the bomb storage compartment where it may be jettisoned at any time.

A German document states that a minimum altitude of 30 meters (100 feet) is necessary for cloud emission.

A number of reports mention experiments conducted at Wiener Neustadt, 30 miles south of Vienna, with gas spray apparatus installed in the Dornier 217 airplane. Other reports state that a squadron of Dorniers is equipped for gas spray and that such equipment might be installed on other types of airplanes, especially the Heinkel 111.

(c) *Chemá Fuma L. 90 and L. 190.*—Two types of gravity-operated spray apparatus, developed by the Czech firm of Chema, are available to the enemy. These may be used either for gas or smoke by a simple

[9] This apparatus has previously been reported as having a capacity of 44 gallons.

change of nozzles, and the size chosen probably depends upon the speed of the airplane. Their general characteristics are as follows:

	Fuma L.90	*Fuma L.190*
Capacity [10] 90	90 liters (23.8 gals)	190 liters (50.2 gals).
Weight empty	97 pounds	132 pounds
Weight charged (smoke liquid)	440 pounds	880 pounds

It is reported that about 1,000 of these spray apparatuses had been produced at the time the Germans occupied Czechoslovakia.

b. Gas Bombs

Marked attention has been given by the Germans to aerial gas bombs. The figures given below probably indicate the size rather than the weight of the bomb. Gas bombs may be lighter than HE bombs of the same size.

(1) *10-kg chemical-fragmentation bomb (K.C.*[11] *10).*—This is primarily an antipersonnel bomb, in which a small amount of toxic smoke agent may be incorporated. It is similar in appearance to the *S.C.*[12] 10-kg antipersonnel bomb and probably has the same type of mechanical nose impact fuze. In addition to the chemical effect within a radius of about 22 yards from point of impact, the splinters are effective up to 45 yards.

(2) *50-kg mustard gas bomb (K.C.*[11] *50).*—This bomb is about the same size as the *S.C.*[12] 50-kg HE bomb. Equipped with a highly sensitive electrical im-

[10] These spray apparatuses have previously been reported as having capacities of 20 and 42 gallons, respectively.

[11] *K.C., Kampfstoff, cylindrisch,* gas, thin-walled bomb.

[12] *S.C., Sprengbombe, cylindrische,* thin-walled general-purpose bomb.

pact fuze, an area of about 22 yards radius from point of burst is contaminated. It is provided with a small burster for ground contamination and with a larger burster for personnel effect.

(3) *250-kg mustard gas bomb (K.C.*[13] *250).*—With a time fuze to operate when within several hundred feet of the ground, this bomb will contaminate an area of 5,000 to 6,000 square yards. It is about the same size as the *S.C.* 250-kg HE bomb. The *Flam C. 250* incendiary bomb case may be used as the gas container (see **c** (5), below).

(4) *1,000-kg gas bomb (K.C.*[13]*1000).*—Phosgene or other lung gases are likely to be used in this bomb. There may be an impact fuze and a small bursting charge, or the bomb may be designed to break upon impact.

c. Incendiary Bombs

The principal incendiary bombs known to have been used by the Germans are listed in figure 7.

Type	Body		Tail		Total length	Remarks
	Over-all length	Maximum diameter	Over-all length	Maximum diameter		
1-kg magnesium	9.8	2	4.7 to 4.9	2	13.8	Four types in use.
1-kg (explosive nose)	16.7	2	4.7	2	20.7	Weight, 2.2 kg.
Flam C. 250 (oil)	45¼	14½	25	20	62¼	Not identified recently.
Flam C. 500 (oil)	62½	18½	24½	25	69½	
Sprengbrand C. 50	23½	8	24½	11	42½ to 43	
Phosphorus and oil	23½	8	24½	11	42½ to 43	

Figure 7.—List of German incendiary bombs (with dimensions in inches).

[13] *K.C., Kampfstoff, cylindrisch,* gas, thin-walled bomb.

(1) *1-kg magnesium bombs.*—These are of the following types:

(a) The normal type with or without explosive charge.
(b) The type with steel nose instead of ordinary electron.
(c) The bomb with six steel tail vanes.
(d) The bomb with eight light alloy tail vanes.

(2) *1-kg explosive-nose bomb.*—The so-called 1-kg incendiary explosive-nose bomb actually weighs 2.2 kg (4.84 lbs) (fig. 8). With the ordinary 1-kg incendiary bomb used as a base, the explosive charge has been removed from the tail, and a steel extension, containing a powerful explosive charge, is added to the nose. This explosive charge is fitted with a time fuze set to explode from 1 to 6½ minutes after the bomb reaches its objective. Frequently, the bomb separates its incendiary and explosive components, and because of the danger of the explosive charge, lethal at a point 50 feet from the point of explosion, defensive measures against the incendiary are delayed as long as 5 to 7 minutes.

(3) *50-kg phosphorus and oil bomb.*—The actual weight of this bomb (fig. 9) is approximately 90 pounds, the designation of 50 kg being intended to indicate the size and shape of the bomb. The filling, weighing approximately 30 pounds, is composed of 86 percent benzene, 4 percent phosphorus, and 10 percent rubber.

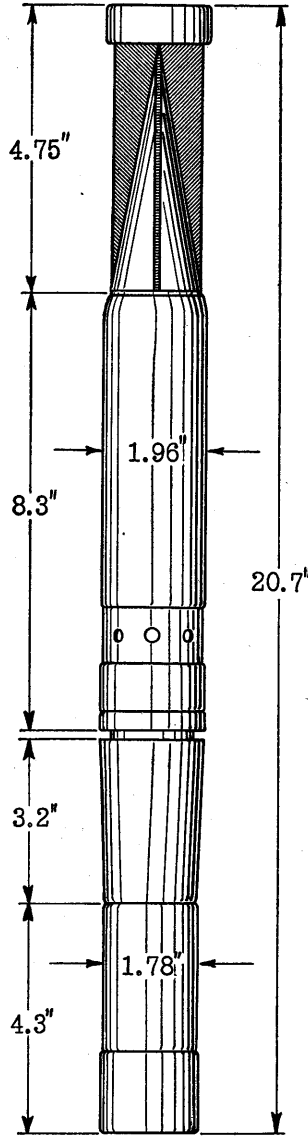


Figure 8.—German 2.2-kg antipersonnel incendiary bomb. (This bomb is also referred to as the 1-kg incendiary explosive-nose bomb.)

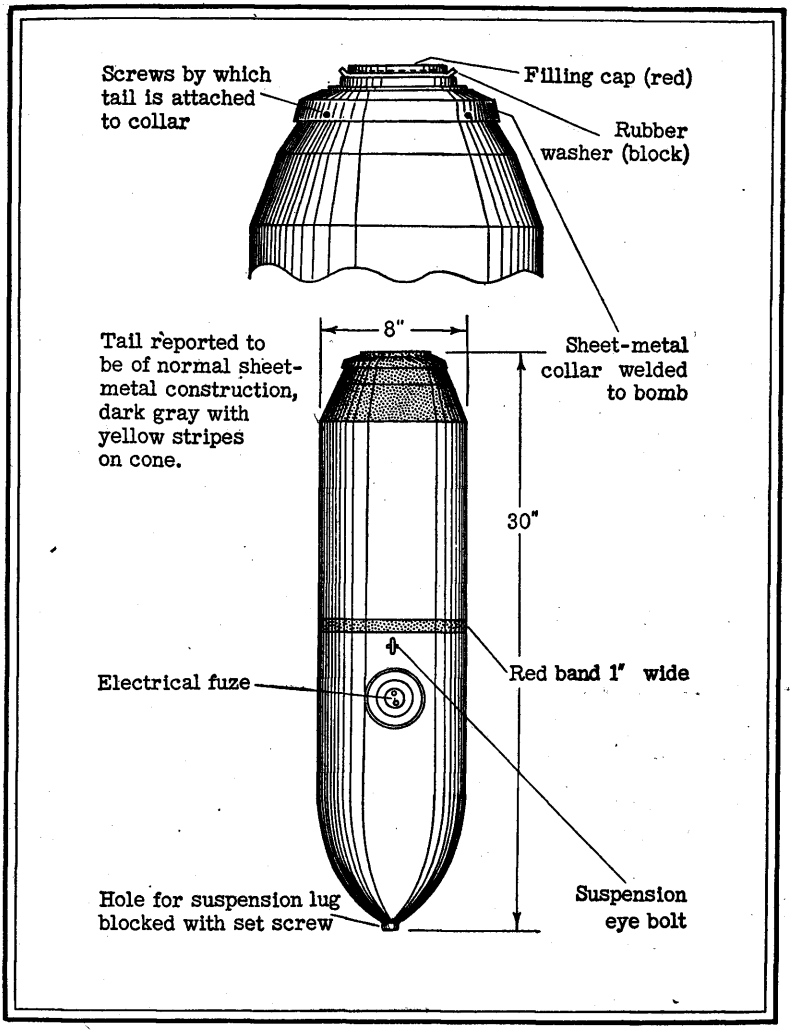


Figure 9.—German 50-kg phosphorus and oil incendiary bomb.

(4) *Sprengbrand C.50 (Combination incendiary bomb.)*—This bomb (fig. 10), weighing 50 kg, of fairly recent development, presents several novel features. Upon impact, the bomb case is ruptured and ejects 6 pre-ignited fire pots of the magnesium-incendiary type and 60 odd small incendiary units of the thermite type. This is followed almost immediately by the detonation of a 12-pound charge of TNT in the nose of the bomb. The fire pots are shaped like a large tumbler, 2¼ inches in diameter at the base, 3¾ inches in diameter at the top, and 5¾ inches long. The small metal containers of thermite are 2¼ inches to 3 inches long, with a triangular cross section having 1-inch sides.

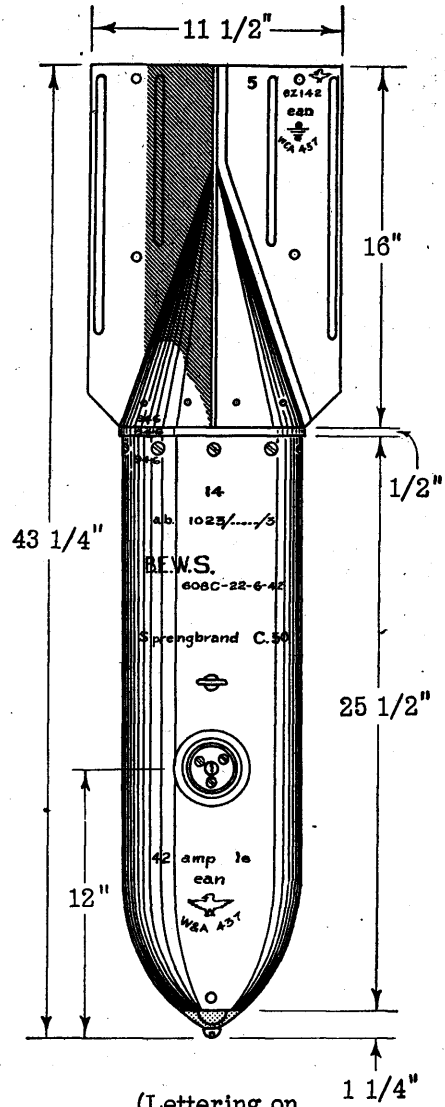
(5) *Oil bombs.*—The designations *Flam C. 250* and *Flam C. 500* indicate the type rather than the weight of these oil bombs. Neither has been reported in use during recent months.

4. FLAME-THROWERS

a. Portable Flame-Throwers

Two general types of portable flame-throwers (*Flammenwerfer*), similar to those developed in the last war, are assigned to engineer units (see also **b** (2), below):

(1) *Light-weight Kleif.*—This type (fig. 11) is carried by one man who is assisted by a second, and produces a jet of flame 28 to 33 yards in length lasting about 10 seconds. Two to fifteen bursts of shorter duration are normally used. The apparatus consists of



(Lettering on both sides of bomb)

Figure 10.—*Sprengbrand* C.50 (combination incendiary bomb).

Figure 11.—Light-weight *Kleif* in action. (The soldiers on the left and right are equipped with the standard German gas-mask carriers.

a cylinder containing 10 liters (2.6 gals) of creosote or petroleum oil, a small bottle of hydrogen, a cylinder containing 5 liters (1.3 gals) of nitrogen compressed at 25 atmospheres[14] pressure, an ejection tube, and an ignition device. When filled, the apparatus weighs 36 kg (79.2 lbs). A fuel cart with a four-man crew is said to carry 10 refills for this flame-thrower.

(2) *Medium-weight Grof.*—This type (cf. figs. 12 and 13) weighs 102 kg (224.4 lbs), and is mounted on a two-wheeled undercarriage with two tow straps. It produces a jet of flame of the same length as does the

[14] Approximately 368 pounds to the square inch.

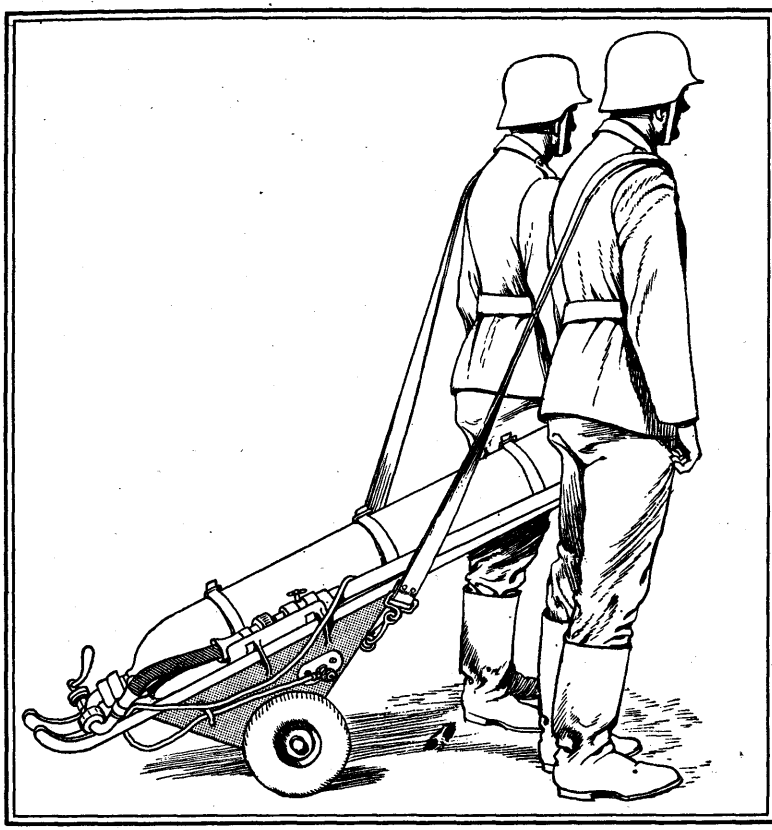


Figure 12.—German medium-weight flame-thrower (*mittlerer Flammenwerfer, m.Fm.W.*).

smaller model, but by reason of the larger fuel capacity of 30 liters (7.8 gals) of oil and a 10-liter (2.6-gal) charge of nitrogen compressed at 30 atmospheres [15] pressure, the flame lasts 25 seconds. By interruption of the jet, 2 to 50 single bursts of flame are possible. In action, one man carries the fuel tank and another the nitrogen tank, while a third operates the valve and

[15] Approximately 441 pounds to the square inch.

directs the flame. A fuel cart with a four-man crew is said to carry 3 refills for this flame-thrower.

b. Miscellaneous Flame-Throwers

(1) *General.*—Unsubstantiated reports refer to one type of flame-thrower with two jets, manned by a crew of eight; another with four jets; and one captured by the Russians which is reported to have six jets.

(2) *Model 41.*—A new type of German portable flame-thrower (*Flammenwerfer 41*) has an over-all weight of 47 pounds when charged and 32.2 pounds when empty. The weight of the pack is 19.6 pounds. This flame-thrower has a maximum range of 25 yards, and the duration of continuous discharge is 7 to 8 seconds. The main advantage of this model over earlier light types is a reduction of the over-all weight by 32 pounds while decreasing the time of continuous discharge by only 2 to 3 seconds.

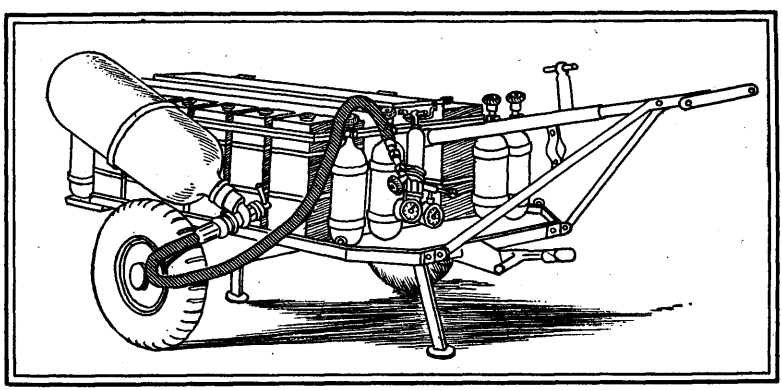


Figure 13.—Recharging trailer (*Flammenwerfer Füllwagen, Fm. W. Füllwg.*) for German medium-weight flame-thrower. (See fig. 12.)

c. Flame-Thrower Tanks

Krupp-type Mark I tanks fitted with flame-throwers have been reported captured in Libya. The small-size flame-thrower is fitted in place of the port light machine gun, and three fuel reservoirs, containing a reserve of 300 liters (79¼ gals) of oil, are located on the tank.

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Section IV. DEFENSIVE EQUIPMENT

1. GAS MASKS

a. Basic Type

The gas mask now issued to the German armed forces is based on the S mask, model 30/31, essentially a somewhat rigid facepiece with a snout-type (screw-in) drum canister. The cylindrical sheet-metal carrier, approximately 11 inches in height, is carried by a web sling from the shoulder (see fig. 11). A compartment on the underside of the hinged lid holds spare antidimming disks. (For one type of German gas mask, see fig. 14.)

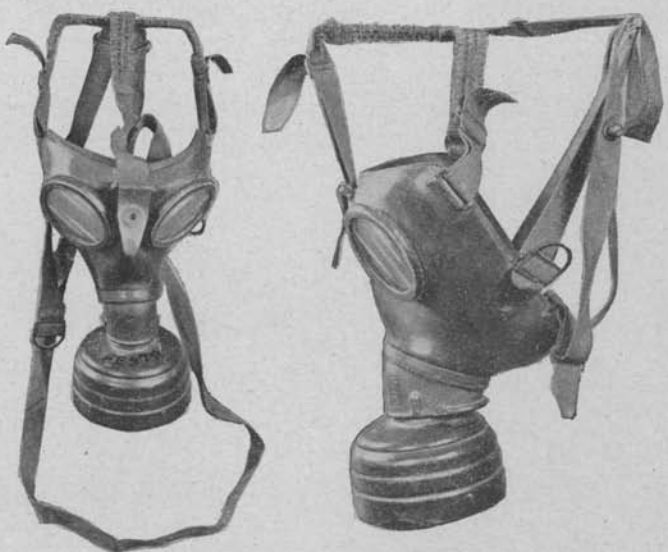


Figure 14.—German military gas mask.

(1) *Facepieces.*—Two types of facepieces are now in use. The *Gm. 30* consists of layers of canvas, rubber, and cotton fabric, with a fitting band of suede leather and an adjustable head harness of cotton webbing and a coiled steel spring. The eyepieces are of cellulose acetate in removable brass rims. A rubber-disk inlet valve and a spring-loaded mica-disk outlet valve, together with a protective grid, are housed in the canister attachment piece, which is threaded to receive the neck of the canister. The canisters are gray-painted tin-plated drums. Facepieces are available in three sizes, and special spectacle frames with flat side pieces and antidimming compound for the lenses are likewise provided.

The *Gm. 38* facepiece, intended to replace the *Gm. 30*, is an all-rubber molded facepiece similar in design and shape to the earlier model, except that the eyepieces are non-removable. The old mica disk has been replaced by a rubber outlet valve of the same design.

(2) *Canisters.*—*FE 37* and *FE 37R* (non-magnetic type) canisters contain a filling consisting of a layer of impregnated, extruded charcoal, a layer of highly activated nut-shell charcoal, and the mechanical filter. It is reported that these canisters are now being replaced with the *FE 41* canister and a non-magnetic equivalent, presumably made of an aluminum alloy, for issue to parachutist units.

A carrier of gray canvas with an aluminum zipper fastened to open at the side is also in use, but probably is intended only for parachute or air-landing

troops. The spare antidimming disks are carried in a pocket on the side of the carrier.

b. Pioneer Helmet

Some pioneer troops are issued a leather helmet having under the front brim a rolled-up piece of rubber in which eyepieces are set. This may be rolled down quickly over the face and fastened by a band around the head and neck. A flat-appearing filter covers the nose and mouth. The purpose of this piece of equipment may be protection against incendiary or corrosive materials, or against transient high concentrations of lethal gas.

c. Special Helmet for Wounded

This is a device intended for the use of patients suffering from head wounds and unable to use the standard mask. It is made of sheet-rubber material with an oval window of cellulose acetate, and is provided with inlet and outlet valves, and a fitting to take the standard German gas-mask canister. When in use, the window is bent to conform to the patient's face, and the hood is drawn over the bandaged head and made gas-tight at the neck with a tape crossed under the chin and over the crown of the head.

2. GAS DETECTORS

a. Gas-Detector Set

German gas sentries (*Gasspürer*) are provided with a gas-detector set consisting of a metal container with 5 pairs of indicator phials, or test tubes (each

containing a different reagent), a suction pump for drawing air through the tubes, and a box of spares containing 200 of each of the 5 types of reagents. The total equipment weighs about 16 pounds. When the presence of a gas is suspected, a phial is selected from the container, and the end is broken off and connected to the pump. The reagents in the phials are tried in turn until a color reaction is obtained. It is claimed that almost every known gas can be detected with the exception of Lewisite, which can be recognized, however, by its characteristic odor.

b. Gas-Detection Powder

Gas-detection powder consists of finely ground, almost pure silica, with 0.5 percent red dye giving it a pink tint. This powder gives a red color with liquid mustard, a purplish red color with phenyldichlorarsine, and a blue color with Lewisite. Recent reports indicate that this gas-detection powder has been replaced by a yellow powder, about which little is known.

c. Other Detectors

Spray detector cards are said to be issued in packs of 20, together with a detection card which shows the color changes to be expected with gases and other chemicals that may be encountered. These cards are of thick cardboard, 8 by 10 inches in size.

A gas-detection vehicle is believed to be in use. It is a 5-ton open, half-track, cross-country truck, manned by a crew of seven men and intended to carry one or two gas-detection units and equipment.

3. PROTECTIVE CLOTHING

Considerable attention has been devoted by the Germans toward the development of gas protective clothing, which consists of three general types.

a. Light Clothing

A suit of light antigas clothing, captured in the Middle East, consists of a one-piece suit with short legs and an open back, thigh boots, gloves, and a hood. The material of the suit is described as having an external fabric layer, the inner layer consisting of hardened gelatine. Penetration of vesicants through seams and creases is almost immediate, but unworn portions resist mustard gas up to 3 hours.

The gloves and hood are described as having an external fabric surface with an inner synthetic-rubber lining. The seams appear to offer little resistance to penetration by vesicants. The legs of the boots appear to be of material similar to that of the gloves and to give similar resistance to penetration. The soles of the boots are of thick vulcanized rubber and resist penetration of mustard gas for 14 hours or longer. The complete outfit weighs roughly 3½ pounds.

The light protective clothing is believed to be intended for single use only, chiefly by gas-detector personnel.

b. Heavy Clothing

The heavy antigas clothing consists of a jacket with hood attached and a pair of trousers and gloves, the three pieces weighing 7¾ pounds. The loose-fitting

jacket, worn over the trousers, is provided with a substantial rubber belt at the waist. The hood, attached to the jacket at the neck band, carries two flaps which join under the chin. When used in conjunction with the gas mask, these flaps form a vapor-tight joint. The sleeves are provided with fitting bands of rubber-covered steel wires at the wrist; these wires fit under the gauntlet of the glove to form a vapor-tight joint.

The trousers are of ample proportions and allow bending with slight movement of the material. The legs terminate in moulded-rubber fitting bands, of such size as to permit a tight joint over half-length rubber boots.

The material of all three garments consists of a mercerized cotton fabric heavily covered on both sides with a gray rubber substance. It is evident that this clothing furnishes a high degree of protection from both liquid and vapor vesicants for a reasonable length of time. However, the suit is completely lacking in ventilation, and this, coupled with its weight, would restrict the time of wearing, particularly in hot climates, to comparatively short periods. Because of the expense of this clothing, its issue is thought to be limited.

c. Parachute Clothing

During the Battle of Crete, some parachute troops carried suits of protective clothing consisting of an oilskin jacket, shorts tying above the knees, and long boots, the uppers of which were also of oilskin. (In addition to the standard military gas mask in a special

canvas carrier, these troops carried gas-warning signs painted yellow, with the inscription *Achtung—Gas,* and other gas signs consisting of triangular pieces of yellow cloth attached to a wire frame with a black skull and crossbones).

d. Protective Cape

In addition to the above-described protective clothing the Germans have developed for general issue the *Gastilt,* a gas protective cape, which has successively replaced the expendable wax-paper type, the coated, double-crepe paper type, and the black rubberized-fabric type.

The *Gastilt* consists of a rectangular sheet of rubberized fabric approximately 4 by 6½ feet in size, which is treated with *Oppanol,* a synthetic substance highly resistant to mustard gas and Lewisite. It is folded and carried in a canvas pouch attached to the web gas-mask sling. Including the pouch, the outfit weighs about 2 pounds. In case of a sudden airplane spray attack, the *Gastilt* is thrown over the head from a crouching position, completely protecting the body from drops of vesicant liquid. Decontamination of the *Gastilt* is accomplished by immersion in boiling water.

It should be noted that German regulations require regular quarterly inspections of antigas equipment by the unit gas noncommissioned officer.

4. COLLECTIVE PROTECTION

Gas protective curtains are presumably available in the German army. It is reported that the artillery makes a practice of gas-proofing its gun positions, and

mention has been made of experiments and tests in gas-proofing tanks and armored cars. It is believed that many of the fixed fortifications in Germany are equipped with filtered ventilation.

To aid in crossing contaminated ground, troops are provided with a roll of impregnated paper (waterproof as well as gas-proof) approximately 40 inches wide and 55 yards long, known as the *Gasläufer*. This can be unrolled at a moment's notice, and permits up to 200 men to pass in file with minimum danger of contamination.

A German document describes the decontamination plough 41 (*Entgiftungspflug 41*) as consisting of two ploughshares mounted on a rubber-tired, single-axle carriage, weighing approximately 1,800 pounds. It is drawn by a medium decontamination truck, and turns the ground over in opposite directions to form a shallow trench about 20 inches wide. The plough is steered from the towing truck by compressed air.

5. DECONTAMINATION

a. Personal Decontamination

All German troops are equipped with 4 small bakelite boxes, each containing 10 tablets of *Losantin,* a high-quality, stabilized bleaching powder. The method of use is to mix 1 of the tablets with water or saliva and apply the resulting paste to the affected parts of the body.

Troops are forbidden to carry *Losantin* tablets in their gas-mask carriers because of the corrosive effect of the slowly leaking chlorine upon the rubber parts of the mask.

b. Ground Decontamination

Bleaching powder (chloride of lime) is the usual material for ground decontamination. According to a German manual of 1941 (*Manual on the Crossing of Contaminated Ground*), heavily contaminated ground will be cleared by the decontamination battalion (see sec. I, par. **2d** (2), above).

As previously mentioned, each platoon of the decontamination battalion is equipped with six medium (3-ton) half-track trucks fitted with hoppers to scatter the bleaching powder, which is distributed by movement of the vehicle. Each of these trucks carries approximately three-quarters of a ton of bleaching powder, which will decontaminate a strip roughly 5 feet wide and seven-eighths of a mile long, and sixteen 22-pound boxes of bleaching powder for decontamination of isolated areas by hand. The crew of each vehicle numbers three.

There are also an indeterminate number of light (1-ton) half-track cross-country trucks provided with distribution hoppers at the rear, the loading space being packed with drums of the decontaminating material.

c. Decontamination of Personnel and Clothing

Large (10-ton) six-wheeled trucks are provided for decontamination of personnel and clothing. For the latter, it is thought that mobile laundries are available, consisting of a water tube boiler for the rapid generation of steam, a steam chamber, and a drying chamber mounted on a large truck. Special decontamination in

back areas is carried out by steaming, hot air, boiling, and airing, and by the use of various solvents.

d. Decontamination of Equipment

Decontaminant 40 (*Entgiftungstoff 40*), a white powder with a penetrating odor of chlorine, is apparently intended for use on equipment contaminated with *Stickstofflost* (presumably nitrogen mustard gas), against which *Losantin* is not sufficient even on the scale of 1,000 grams per square meter. It is supplied in 66- and 110-pound metal drums, painted a red-brown and bearing the inscription "Ent. 40" in white on the lid.

Instructions for use state that this material should be stored in a dry, cool place. It should be used dry, and rubbed over the article to be decontaminated. After 5 minutes the decontaminant should be brushed off or washed away with water.

Troops are issued small pocket flasks of small-arms decontaminant. In addition, there is a decontaminating set issued for use on machine guns and larger weapons.

6. HORSE ANTIGAS PROTECTION

Much attention is given by the Germans to the protection of horses. Equipment reported as provided for that purpose includes a gas mask (model 41); goggles to protect the eyes from spray; a set of hoof covers, in three sizes, to protect the lower part of the legs; and a decontamination box, the contents of which are unknown.

Section V. CIVILIAN PROTECTION

During the first two years of World War II, the Germans gave only limited attention to the protection of their civilian population against air attack. Such training as they received was upon a voluntary basis. However, since September 1941 the Air Protection League (*Luftabwehrdienst*) has been responsible for the most thoroughly trained civilian population on the continent. Civil defense activities, including antigas measures, are organized on a compulsory basis under control of the police.

When an alarm is sounded, civilians are trained to go to gas-proof shelters, which are required in all buildings. These include all types from the massive air protection towers (*Luftschutztürme*), holding up to 500 persons, or the bell-shaped concrete shelters with deep foundations and thick walls, accommodating 250 persons, to individual homes with gas-proofed rooms.

An adequate organization appears to have been built up to handle civilian defense. Air-raid wardens, fire watchers (or spotters), bomb-removal and decontamination squads are all trained to combat raids on the larger cities. Blackouts are normal every night and are carried out with orderly and organized efficiency.

In regard to gas masks, the picture is rather obscure. Early in 1942, authorities were reported as diligently pushing forward a program whereby every civilian

would possess a gas mask, even to the extent of making house to house canvasses. Later information disclosed that gas masks were being collected and shipped to the armed forces at the front, together with Czech and French masks, leaving only the civilian-defense personnel with masks. However, it is probable that in towns where chemicals and war gases are manufactured and stored, gas masks are provided for local residents and war workers as a precaution against results of bombing raids.

Section I. CHEMICAL TROOPS

1. GENERAL

No doubt the almost total unpreparedness of the Italians for gas warfare in the last war, which resulted in many thousands of deaths and casualties, prompted them to establish a Military Chemical Service (*Servizio Chimico Militare*) in July 1923. Serving both the Navy and Air Force as well as the Army, this service is responsible for chemical warfare in all its forms. A directorate was set up at the Ministry of War, and a number of experimental centers established. Later developments included establishment of the chemical regiment and the mixed chemical group.

2. ORGANIZATION

a. General

The peacetime organization of chemical troops called for a chemical regiment, and a number of separate chemical companies and platoons assigned to army corps and divisions as follows:

One mixed chemical company to each army corps, composed of headquarters, one flame-thrower platoon, and as many chemical platoons as there are divisions in the corps;

One chemical platoon to each "rapid" (*celere*), or mobile (cavalry), division, Alpine division, and motorized division.

It is considered doubtful that each corps and division had a chemical company or platoon attached, but at

least 11 chemical companies have been definitely identified.

b. Chemical Regiment

An official Italian publication in 1940 stated that the chemical regiment, commanded by a colonel, consisted of the following:

Headquarters,
One chemical battalion, composed of
    Three chemical companies,
One mixed battalion composed of
    Two chemical companies,
    One officers' training company,
    One noncommissioned officers' training company,
One flame-thrower battalion, composed of
    Two flame-thrower companies,
One chemical depot.

It is uncertain whether this peacetime organization still exists intact, inasmuch as the chemical regiment has been reported, since 1938, to have assumed the functions of a central training school for chemical troops. In wartime the regiment, or parts of it, presumably operates as GHQ or army troops, and it may provide the chemical battalion of the mixed chemical group.

c. Mixed Chemical Group

The nucleus of the war organization appears to be the mixed chemical group, assigned to GHQ, which is reported to consist of the following units:

Chemical battalion,
Chemical company battalions,
Flame-thrower battalions,
Chemical mortar group.

(1) *Chemical battalion.*[1]—This battalion, only one of which is known to exist, consists of two heavy companies and one light company. The heavy companies are said to be provided with large stocks of toxic gases, together with the equipment and protective clothing necessary for their dispersion, as well as meteorological apparatus. The light company, on the other hand, is provided with a large stock of toxic smoke and tear-gas generators. It is possible that this battalion could function as a depot for issuing and filling chemical weapons, but, from the nature of its equipment, it appears more likely that it is an offensive unit.

(2) *Chemical and flame-thrower battalions and chemical mortar group.*—The chemical and flame-thrower battalions provide companies, and the chemical mortar group provides batteries on the scale of one for each army corps. Thus, whereas in peacetime each army corps possessed a mixed chemical company composed of chemical, smoke, mortar, and flame-thrower sections, in wartime it possesses one chemical company, one flame-thrower company, and one mortar battery. These units presumably may be assigned to divisions as required.

The chemical company is believed to consist of two platoons, one of which is trained and equipped for both contamination and decontamination, the other for smoke generation. Apparently, these chemical companies have replaced the smoke companies described in the Italian *Smoke Training Manual* (1933), inasmuch

[1] Some documents refer to this battalion as *nebu*, but this may possibly be a typographical error for *nube* (smoke—literally "cloud"). See p. 61, sec. III, par. 2e (4), below.

as enemy documents examined in January 1941 contain no mention of the existence of any smoke units other than the smoke platoons of the chemical companies.

d. Alpine Chemical Company

Little is known of the Alpine divisional chemical company, except that it has 4 platoons, with a total strength of 5 officers and 223 enlisted men, and carries larger stocks of mustard gas and chemical mines than the ordinary chemical company.

e. Regimental Antigas Units

Antigas platoons are provided on the scale of one per regiment in peacetime and one per battalion in wartime. The platoon, composed of 1 officer and 46 enlisted men, is organized in sections, which can be assigned to companies. They are equipped to assist in antigas measures, and to carry out immediate repairs to gas masks and protective clothing.

Decontamination sections are allotted on the scale of one to each GHQ, army, corps, and division. Each section consists of—

Headquarters platoon (1 officer and 12 enlisted men),
Two decontamination platoons (1 officer and 18 enlisted men each),
One repair and supply platoon.

The personnel of the section are equipped with protective clothing for their task of protecting and decontaminating headquarters and other important areas.

It is probable that these platoons and sections are not special chemical units, but that they consist of

regimental personnel who have received special training in antigas duties.

3. SCHOOLS AND TRAINING

The Italian Military Chemical Service, established in 1923, includes in its activities the study of gases which might be used in chemical warfare, and of processes and plants necessary for their manufacture, of protective equipment and measures, and of supervision of the training of troops. From headquarters in Rome, where a research and experimental center was located in the suburbs, direction was given to research activities in the Universities of Florence and Naples, as well as in the experimental station of the Engineer Corps in Pavia. After further antigas studies were made, a gas troop section of two companies was located in Rome for the purpose of carrying out military tests.

Large-scale chemical warfare maneuvers were conducted with troops in combination with the Air Force in 1937. In 1940, it was announced that the research center was to be moved from Rome, owing to the absence of adequate space for expansion in the capitol. The new site, to be known as the "Chemical City," was to house the whole of Italy's chemical warfare research, training, and manufacturing facilities, and when completed was to cover an area of 1,730 acres and have a permanent peacetime population of about 400. The location of this site is believed to be about 37 miles northwest of Rome.

In 1930, the Military Chemical Service issued a manual of instruction on defense against war gases.

This manual describes sound, if rather elementary, methods of gas protection, both individual and collective. It is not known, however, whether the standard of training in gas protection is very high in the Italian Army. While little is known regarding present facilities for training officers and troops in antigas measures, there is evidence that the special chemical companies are trained for protection against gases as well as for offensive operations, but the defensive side of their work appears to be rather limited in nature.

Section II. MANUFACTURE AND STORAGE

The Italian chemical industry has developed to a considerable extent in recent years, and there is evidence of a number of factories in Italy for the manufacture of war gases. According to rough estimates the following maximum quantities of chemical agents could be produced:

Mustard gas	5,000 to 10,000 tons per year
Phosgene	5,000 to 10,000 tons per year.
Chlorpicrin	1,000 to 2,000 tons per year.
Diphenylchlorarsine	1,000 tons per year.
Chloracetophenone	500 tons per year.
Lewisite	Very much limited.

(The limiting factor for the above output would be the supply of chlorine.)

In Italy there is a general shortage of coal, coal tar products, chlorine, arsenic, bromides, and fluorides, but this shortage could no doubt be met in part by supplies from Germany, Hungary, and other Axis powers.

While it is generally believed that Italy does not possess large stocks of war gases, at least six storage points have been definitely located and others are thought to exist.

Section III. OFFENSIVE WEAPONS

1. AGENTS

a. General

Should Italy resort to gas warfare, it is believed that mustard gas, phosgene, chlorpicrin, and arsenical smokes are the principal agents that would be used. Tear gases, it is also believed, would be used only to a limited extent and principally in combination with toxic gases. (For a comparison of Italian gas with those of other nations, see the war gas comparison chart which faces p. 156.)

The following markings are used by the Italians to indicate the classification of their war gases:

Blister gases (vesicants)	Geneva Cross in green.
Choking gases (lung irritants)	Geneva Cross in white.
Nose gases (toxic smokes)	Geneva Cross in black.
Tear gases (lacrimators)	Geneva Cross in red.

It has been reliably reported that the Italians in the Abyssinian war of 1935–36 used many 10.5-cm artillery shells filled with DA (diphenylchlorarsine) and nearly 5,000 air-burst aircraft bombs filled with mustard gas. Among the chemical warfare stores found in Libya were drums of mustard gas, but none of the other gases mentioned above. The Greeks, however, reported the capture in December 1940 of drums of blister gas of which the composition was approximately equal parts by weight of mustard gas and phenyldichlorarsine.

In a list of smoke and chemical shells for artillery, among the documents captured in Libya in January 1941, mention was made of shells filled with phosgene and also with a mixture of 80 percent chlorpicrin and 20 percent chloracetophenone. That the Italians regard chlorpicrin as a lacrimator as well as a lung irritant is shown by the fact that containers of chlorpicrin are marked with both white and red crosses.

b. Peril No. 1

Italian documents of undetermined date reveal that research and field trials in Libya had been made with "Peril No. 1—a new gas, very persistent and toxic; a blistering gas with an arsenic base causing painful and even mortal sores." The report continues: "A few centigrams are sufficient to kill a man." Responsible authorities discount the existence of such a new gas and believe that the document refers to Lewisite, which reports indicate has been manufactured only in small quantities in Italy.

2. GROUND WEAPONS

a. 8.1-cm Chemical Mortar

The basic weapon of the Italian chemical troops is the 8.1-cm (3.19-inch) mortar. Model 35 is described as a smooth-bore, muzzle-loading, high-angle fire weapon of the Stokes-Brandt type,[2] being similar to

[2] The Stokes-Brandt mortar contains all the principles of the original Stokes (see p. 10, note 3, above), but fires a projectile that is stabilized in flight throughout its trajectory. This stabilization is accomplished through the design of a shell of a torpedo or dart shape with a fin tail. In flight the shell travels nose-on through the entire trajectory, thus eliminating

the British 3-inch mortar. Its total weight is only 129 pounds and it fires both chemical and HE shells at the rate of 18 to 20 rounds per minute. The chemical shells, of 2 types, weigh approximately 8½ pounds. A "short" type has a maximum range of 1,980 yards, whereas the range of the "long" type is said to be limited to 1,420 yards. No information is available concerning the nature of the chemical fillings of either type.

Reports have been received to the effect that model 35 is being replaced by a new and improved model, with a heavier shell and an increased range.

b. Artillery

Italian documents refer to gas shells of a wide variety of calibers as being standard in the Italian army. In addition to the fillings previously discussed, two types of smoke shells are reported in use by the artillery. One, called *fumogeno incendiario* (smoke incendiary), is filled with white phosphorus and the other, called *fumogeno* (smoke), with a smoke mixture, probably oleum and sulfur trioxide. Ammunition of both types is said to be provided for the 7.5-cm, 10-cm, and 10.5-cm guns.

c. Infantry

In addition to a number of hand grenades and candles, the Italian infantry is provided with a short bomb-thrower weighing 2 kg (4.4 lbs), which projects

the need for the "always" fuze required by the Stokes shell. Instead of the "always" fuze, a point-detonating type of fuze with bore-safe characteristics is used.

all types of hand grenades a distance of 330 yards. In the many Italian documents available, no specific mention is made of the guns or howitzers employed by the infantry.

d. Candles and Grenades

(1) *Toxic smoke candles.*—Italian toxic smoke candles are reported to be of the following types:

(a) *Small candle.*—This small candle (*candelotto*) contains 50 percent DA (diphenylchlorarsine), 25 percent kieselguhr, and 25 percent nitrocellulose (and acetone), and weighs 380 grams (13½ oz). The weight of the filling is 220 grams (7¾ oz). This candle is probably intended for use as a hand grenade.

(b) *2-kg candle.*—This candle (*candela*) has the same composition as that above, weighing 2.8 kg (6.16 lbs). The filling weighs 2.2 kg (4.8 lbs) and burns 2 minutes.

(c) *4-kg candle.*—This candle (*candela*) contains 54 percent DA (diphenylchlorarsine), 16 percent kieselguhr, and 30 percent T4 (hexagene).

(d) *5-kg candle.*—This candle (*candela*), with the same composition as above, weighs 6.5 kg (14.3 lbs). The weight of the filling is 5.5 kg (12.1 lbs).

(2) *Lacrimatory candles.*—Lacrimatory candles are of the same sizes and weights as above. The small tear-gas generator, which also may be used as a hand grenade, and the 2-kg and 5-kg candles contain 50 percent CN (chloracetophenone), 50 percent nitrocellulose (and acetone). The small candle burns 1 minute, whereas the 2-kg candle burns 2 minutes.

(3) *Smoke candles.*—Smoke-screen generators or candles include the *candela fumogena* (smoke generator) and the *candelotto fumogeno* (smoke candle). Both have bodies of tin plate equipped with zinc igniter caps. They are filled with a Berger-type mixture,[3] consisting of approximately 50 percent carbon tetrachloride, 35 percent zinc powder, 5 percent zinc oxide, and 10 percent kieselguhr. The candles are painted dark green and have labels giving the name of the generator and the directions for use, together with the marking "F/ZN."

(a) *Candela fumogena* (*smoke generator*).—This candle is 9¾ inches long by 3 inches in diameter, with a 9/16-inch recess at the bottom housing the igniter pellet and striker and closed by a lid. The filling weighs 2 kg (4.4 lbs) and burns 3¼ minutes.

(b) *Candelotto fumogeno* (*smoke candle*).—This small candle is 3½ inches long by 2½ inches in diameter, with the ignited pellet housed in the cap. The filling weighs 450 grams (1 lb) and burns 1 minute.

(c) *Small smoke and incendiary grenade.*—This grenade weighs 0.48 kg (1.05 lbs) and contains 0.3 kg (⅔ lb) of WP (white phosphorus), with a burster charge of 10 grams of black powder ignited by a Bickford fuze.[4]

e. Bulk Contamination

Italian spray apparatus appears to have been designed from the point of view of using toxic gas or

[3] See p. 19, note 5, above.

[4] A commercial type of powder-train fuze.

smoke in all types of country. The following equipment is described in Italian documents:

(1) *Knapsack sprayer (irroratore spalleggiato).*—This apparatus, while adaptable for producing smoke, is primarily designed for spraying mustard gas. It consists of a 12-liter (3-gal) container, with compressed-air bottle and discharge jet, all carried on the back by means of straps. When filled, it weighs 32 kg (70.4 lbs). The time of emission is 5 minutes, and it may be completely refilled in 8 minutes.

(2) *Portable smoke generator (cloramma barellato).*—This spray apparatus, designed for producing smoke, consists of two containers and a compressed-air cylinder mounted on a handbarrow or carried by a stretcher. It is reported that one container was designed for chlorsulfonic acid and the other for ammonia, but both containers are now filled with 24 liters (6 gals) each of chlorsulfonic acid. The time of emission with one nozzle is 50 minutes; with two nozzles, 25 minutes. Six minutes are required for refilling.

(3) *Mobile smoke generator (cloramma carrellato).*—This name is given to the above-described smoke apparatus when it is mounted on a two-wheeled handcart. There seems to be no reason why both types could not be used for spraying blister gas.

(4) *Six-wheeled cross-country mustard-gas truck (autodovunque yperite).*—A standard cross-country truck carries four drums containing 800 liters (211 gals) of mustard gas, compressed air cylinders, and perforated piping for ground contamination. The time

of emission is 9 minutes and the drums may be refilled in 30 minutes. When used as a smoke weapon, the vehicle is known as *autodovunque nube* (cross-country smoke truck). It then carries 500 liters (132 gals) of chlorsulfonic acid in two drums. With two nozzles its time of emission is 100 minutes; with four nozzles, 50 minutes.

(5) *Four-wheeled mustard-gas truck* (*autocarretta yperite*).—This light truck carries two drums (400 liters) of mustard gas, a compressed air cylinder, and perforated piping for ground contamination. Its time of emission is 6 minutes and the drums may be refilled in 15 minutes. When used as a smoke weapon, the vehicle is known as *autocarretta nube* (four-wheeled smoke truck). It then carries one 250-liter (66-gal) drum of smoke liquid (probably chlorsulfonic acid), with an emission time of 60 minutes from two nozzles or 30 minutes from four nozzles.

(6) *Light tank with trailer* (*carro veloce con rimorchio*).—A light tank (Fiat-Ansaldo C.V. 3) draws a trailer with 240 liters (63 gals) of mustard gas or smoke liquid in two containers. When mustard gas is to be used, the equipment includes a cylinder of compressed air and perforated piping, which disperses the contaminating agent in 5 minutes. With smoke acid as the agent, the time of emission is 17 minutes from four nozzles. Both types of agents require 30 minutes for refilling.

f. Miscellaneous

A simple apparatus, which may be used either as a portable sprayer or as a chemical mine, consists of a

tin-plate cylinder with a capacity of 6 liters (1.6 gals) of mustard gas. It may be used like a garden watering can by screwing in a tube with a sprinkler at the end, or it may be burst by an explosive charge.

3. AERIAL WEAPONS

a. Spray

Reports regarding the use of vesicant gases by means of aerial sprays in the Abyssinian campaign are conflicting. There is no direct evidence that Italian land planes are equipped with spray apparatus, but Italian documents describe a spray apparatus, *irroratore B,* two of which are carried outside the fuselage of the seaplane Cantiere Z. 501. Each tank has a capacity of 180 liters (47.5 gals) of mustard gas or smoke liquid, with a total emission time of 20 seconds. When used for producing smoke screens, the following results are claimed from a height of 30 meters (100 feet):

Initial thickness of cloud	40 meters (44 yards).
Thickness after 15 minutes	80 meters (88 yards).
Length of curtain	1,200 meters (1,300 yards).

b. Gas Bombs

Gas-filled aircraft bombs, as listed in figure 15, have been identified from enemy documents and other reliable sources.

According to a recent report, these bombs are painted yellow with the usual Geneva Cross to indicate the filling (see par. **1a**, above). With the exception of type *500 C.* and the *bomba furetto,* these bombs are filled with DA (diphenylchlorarsine). They have a

New designation	Old designation	Nature and weight of filling	Weight of complete bomb	Diameter of bomb body	Over-all length
Bomba	*Bomba*	*Kg*	*Kg*	*Inches*	*Inches*
500 C.	*C. 500 T.*[1]	HE (?) Mustard 210	280 (or 298)	18.0	96.6
100 C.	*C. 100 P.*[2]	HE 28.7 DA 14.3	101.9	10.7	50.2
40 C.	*C. 40 P.*	HE 13.0 DA 6.5	47.0	9.0	32.3
15 C.	*C. 15 P.*	HE 3.65 DA 1.7	16.0	4.7	31.0
4 C.	*Doppio Spezzone C.*	HE 0.67 DA 0.33	2.8 (?)	2.7	12.2
2 C.	*Spezzone C.*	HE 0.29 DA 0.14	1.55	2.7	6.1
———	*Furetto*	Lacrimator 10	25	6.3	32.7

[1] *T.* probably is an abbreviation for *tempo* (time).
[2] *P.* probably is an abbreviation for *percussione* (percussion).

Figure 15.—List of Italian gas bombs.

bursting charge approximately double the weight of the gas fillings and are fitted with percussion fuzes. The *500 C.* has a time fuze and a relatively small bursting charge, indicating that it is filled with blister gas and is designed for air bursting. The *bomba furetto* is obviously filled with tear gas and is described as a vaporizing percussion bomb.

Other than in the case of the *500 C.* bomb, the weights of these bombs roughly correspond with their nomenclature. No doubt the *500 C.* is so named because it has the same external dimensions as the 500-kg HE bomb and would fit the same bomb racks. Naturally, a gas-filled bomb of the same dimensions, having a thinner metal case, would be considerably lighter in weight.

Not included in figure 15 is a smoke (*vento*), bomb having a body diameter of 5.2 inches and an over-all length of 17.3 inches. The nature and weight of the smoke mixture is not indicated.

c. Incendiary Bombs

The Italians are reported to have used incendiary bombs on relatively few occasions to date. Those known to exist are listed in figure 16.

New designation	Old designation	U. S. equivalent	Nature and weight of filling	Weight of complete bomb	Diameter of bomb body	Over-all length
Bomba	*Bomba*	*Bomb*	*Kg*	*Kg*	*Inches*	*Inches*
100. S. P. I[1]		Combined antipersonnel and incendiary.	(See note)	89.1	10.7	53.2
70. I. P			Thermite 24.5	62.0	9.9	47.2
20. I	*da Kg. 20. I*	Incendiary	Thermite	19.4	6.3	34.0
7. I	*Bombetta incendiaria mista da Kg. 2*	Incendiary	Thermite/oil mixture.		2.7	12.2
1. I		Incendiary	Thermite		2.7	6.1

[1] Contains sixteen 2-kg or thirty-two 1-kg incendiary bombs.

Figure 16.—List of Italian incendiary bombs.

4. FLAME-THROWERS

It has been learned from a reliable source that the Italians have made extensive use of flame-throwers on the Russian front as supporting weapons for infantry action. In practice they have considered it inadvisable to operate flame-throwers in units smaller than the "group," which consists of one leader, one assistant, and six squads of two teams each, the latter being composed of one operator and one assistant. The known types of Italian flame-throwers are as follows:

a. Portable, Model 35

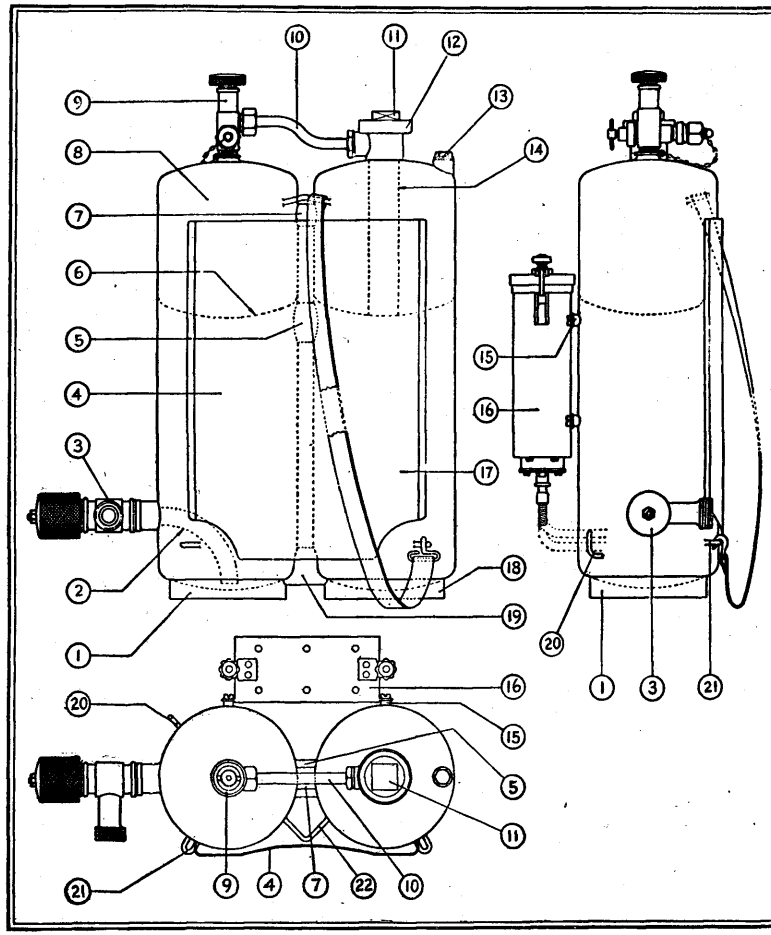
This apparatus (fig. 17) consists of two cylinders carried on the back of the operator, a length of flexible tubing, and a jet tube, which carries the trigger and ignition arrangement, the whole weighing 27 kg (59.4 lbs) when filled.

The two cylinders are identical and each contains nitrogen under pressure and fuel oil, which is taken off from the lower end through a connecting piece and valve. Ignition is effected by a battery coil and a spark gap with or without a wick, or on some models by means of a friction tube and wick, which burns for 2 minutes.

The fuel is a mixture of benzene and light oil having a flash point of 10° C. The apparatus is capable of throwing a flame 25 yards and making untenable a zone 35 yards long by 15 yards wide. It can produce 10 intermittent bursts of flame or one continuous jet of 20 seconds, and should not be used in a head wind of more than 12 miles per hour.

b. Portable, Model 40

This apparatus (fig. 19) is similar in appearance to the model 35, differing mainly in the ignition system and in the insertion of a pressure gauge in the connecting tube between the heads of the two cylindrical containers. The fuel passes to the rubber hose and discharge piece through a small turbine driving a high-tension magneto for ignition purposes. Control of the fuel passing from the discharge piece to the nozzle is effected by a cone valve in the nozzle operated by a hand lever.



1. Diaphragm
2. Fuel take-off tube
3. Main fuel control valve
4. Elastic carrier
5. Gas transfer tube
6. Diaphragm
7. Gas transfer tube
8. Gas compartment
9. Gas transfer valve
10. Gas transfer tube
11. Threaded plug
12. Charging nipple
13. Cylinder plug
14. Charging tube
15. Threaded lug
16. Battery and transformer case
17. Liquid fuel compartment
18. Supporting ring
19. Liquid transfer tube
20. Securing hook
21. Lower support stirrup
22. Upper support stirrup

Figure 17.—Italian portable flame-thrower, model 35.

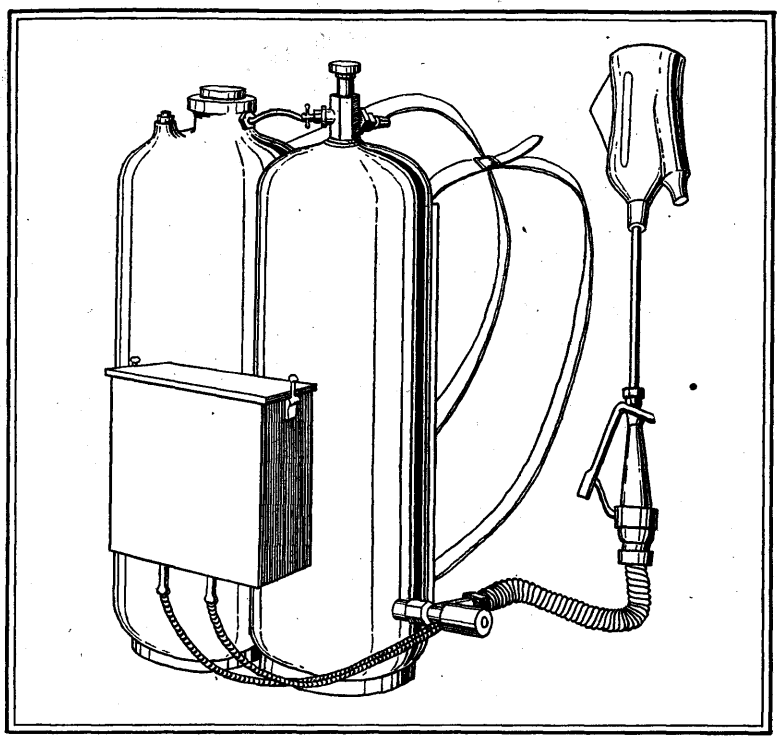


Figure 18.—Italian portable flame-thrower, model 35, showing nozzle.

Figure 19.—Italian portable flame-thrower, model 40.

After the fuel has passed the cone valve, a small proportion is diverted through two filters and atomizing sprays adjacent to the main jet. Both the main jet and the sprays discharge into the ignition chamber, where a standard automobile spark plug ignites the spray, which in turn ignites the main jet. The spark plug is actuated by the turbine-driven magneto.

The fuel used in this flame-thrower is a medium petroleum distillate containing about 15 percent gasoline.

It is reported that while the impeller-driven magneto gives 100-percent positive ignition, the use of the impeller in the oil stream so disturbs it that the maximum range attainable is only 18 yards.

c. Motorized

It is also reported, but not confirmed, that the Italians have a motorized flame-thrower for which a maximum range of 75 yards is claimed. Fuel for this apparatus is carried in a separate armored trailer. No other details of this weapon are available. (See fig. 20 for an illustration of a flame-thrower tank.)

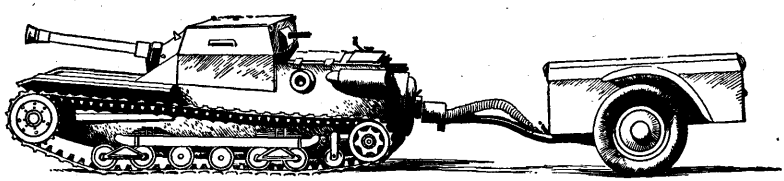


Figure 20.—Italian flame-thrower tank (L 3/35) with trailer.

Section IV. DEFENSIVE EQUIPMENT

1. GAS MASKS

Italian service gas masks are of two general types. Group A is like the U. S. Army service mask, with separate canister and corrugated rubber connecting tube; group B is similar in appearance to the U. S. training mask, with a drum canister attached directly to the facepiece.

a. Facepieces of Group A

These facepieces (separate canister type) are of three types:

(1) *P (Penna)*.[5]—This facepiece is an obsolete model (fig. 21) still in use and is made in three sizes of green press-moulded rubber, with inlet and outlet valves contained in a holder of aluminum alloy fastened to the chin part of the mask. A rubber baffle just below the eyepiece is intended to prevent exhaled breath from reaching the eyepieces. The latter are of splinterless glass and are held in place by crimping rims.

(2) *M (M. 31 and M. 33)*.—This facepiece is similar to the earlier model, but is gray or brown in color (fig. 22). Instead of the rubber baffle, this type has an inner secondary mask of black rubber wired to the valve holder. A considerable improvement over model

[5] This mask is undoubtedly named after Col. L. Penna, the first chief of the Italian Military Chemical Service.

P is effected by a change in the position of the eyepieces so as to give a better field of vision.

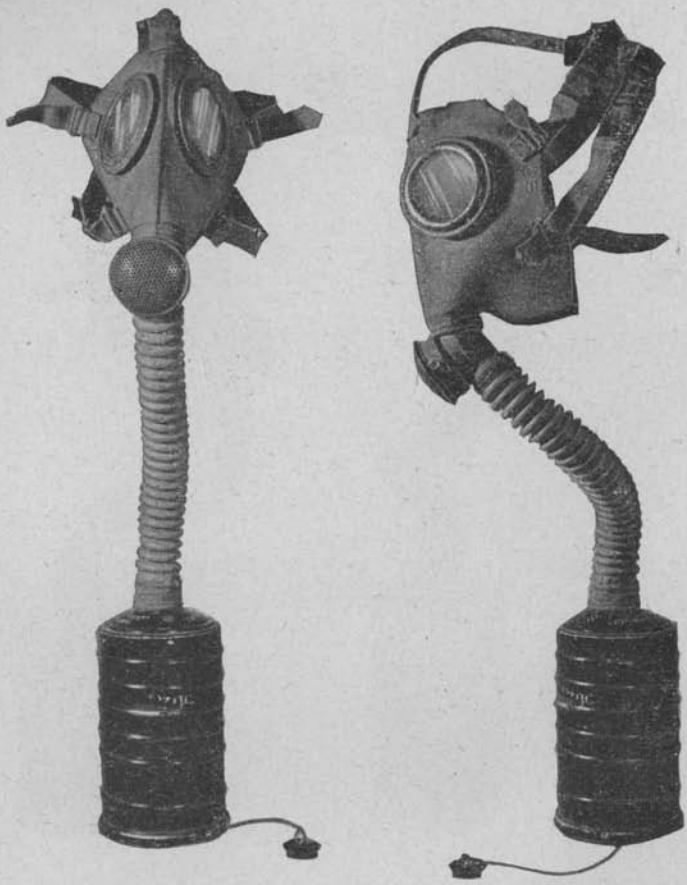


Figure 21.—Italian military gas mask, Penna type. (The separate-type canister is attached.)

(3) *Naval (R.M. and R.M.F.).*—This differs from model M chiefly in that the facepiece does not have an inner secondary mask. Prevention of dimming is

sought by providing a forked rubber tube to lead incoming air over the eyepieces. This model is designated *R.M.F.* (*Regia Marina, fonica*—Royal Navy,

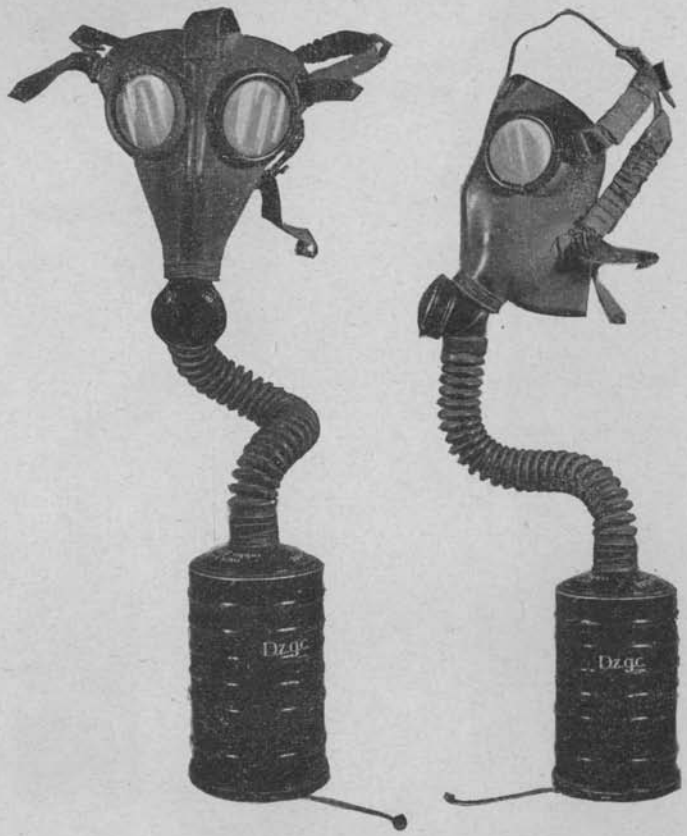


Figure 22.—Italian military gas mask, M. 31. (The separate-type canister is attached.)

phonic type) when provided with a special outlet valve carrying a short trumpet-shaped attachment, consisting of three concentrated horns on the outside. This

attachment improves the speech characteristics of the mask.

The haversacks for the *R.M.* (*Regia Marina*—Royal Navy) type are of rubberized fabric, with two external pockets carrying a spare outlet valve and a tube of anti-dimming soap. They may be carried either on the chest or at the side in the manner customary for naval personnel.

b. Facepieces of Group B

These facepieces (attached canister type) are of two types:

(1) *T. 35.*[6]—This facepiece (fig. 23) is made of moulded rubber in four sizes. The outlet valve is opposite the mouth, and the inlet valve is contained in

Figure 23.—Italian military gas mask, T. 35.

[6] *T. 35, tipo 35* (type 35).

the adaptor, in which the canister is screwed, below the outlet valve.

(2) *F.T. 35.*[1]—This facepiece is the Navy version of the *T. 35.* It is provided with a voice-amplifying device similar to that attached to the *R.M.F. type.*

c. Canisters

The separate-type canister (originally flat in shape) consists of a cylindrical container made of an aluminum alloy, approximately 8 inches long and 4 inches in diameter. It is filled with a thick central layer of activated charcoal, a layer of granules of zinc carbonate intimately mixed with charcoal fines, and a filter pad of wool and viscose rayon impregnated with resin. In late models the filter pad (particulate filter) is contained in a separate metal holder. Tests indicate that this canister will afford adequate protection against all of the common types of war gases.

The attached drum canister, 3½ inches high (excluding the neck) and 4½ inches in. diameter, is likewise made of aluminum alloy. The filling is the same as that contained in the larger cylindrical container, but possibly the charcoal used is of a higher grade. Tests indicate that this type canister affords protection over considerably shorter periods than does the larger type. (See figs. 21–22, and 23 for illustrations of two types of Italian canisters.)

2. GAS DETECTORS

The only gas detector mentioned in Italian documents is the "Alfa Detector," issued to the Air Force

[1] *F. T. 35, fonica tipo 35* (phonic type 35).

to determine whether decontamination of aircraft is complete. A cherry red liquid, contained in a bottle, is packed with a number of strips of absorbent cardboard. The test is carried out by pouring three or four drops of the liquid on one of these strips and placing it on the object to be tested. If the strip turns pale blue, or is decolorized, blister gas is still present and further decontamination is necessary. It is not known if Army units are equipped with this detector.

3. PROTECTIVE CLOTHING

Among stores captured in Libya were a number of antigas suits made of a rubberized fabric, probably Pirelli cloth, type C, which consists of two light-weight fabrics proofed with a green rubber composition and cemented together with a glue-like adhesive. When tested, this fabric resisted liquid mustard for more than 2 days and Lewisite for more than 7 hours.

A decontamination suit (*S.C.M.*[8] *36*) made of Pirelli cloth, type D, likewise has been reported. This material is lighter in weight than the type C fabric, and upon test resisted liquid mustard over 24 hours and Lewisite over 7 hours. This garment may be decontaminated by immersion in boiling water for 30 minutes.

An Italian naval manual describes the protective clothing used in the Navy. A one-piece outfit in the form of a diving suit, with separate hood and gloves, and the heavy combination suit of apron, overshoes, hood, rubber gloves, and oversleeves, are made of rub-

[8] *S. C. M., Servizio Chimico Militare* (Military Chemical Service).

berized fabric, probably Pirelli cloth, type C. Also described is an overall suit, made of a thick cotton impregnated fabric, with hood, socks, rubber shoes, and heavy rubber gloves. Wearing of the one-piece and heavy combination suits would be limited to 15 to 20 minutes in hot weather or 1 hour in cold weather; the overall suit could be worn for somewhat longer periods.

An Italian document listing antigas equipment issued to units reveals that 10 complete antigas suits, each consisting of an overall suit with hood, gloves, and overshoes, were issued to the headquarters of artillery battalions, but none was issued to other units. This document also shows the issue of a limited number of antigas gloves to various units. It is assumed that the Army would have protective clothing for decontamination squads similar to that described for the Navy, and this assumption appears justified upon careful scrutiny of the protective clothing worn by Italian chemical warfare units, as shown in figure 24.

Pre-war reports mentioned that cellophane garments for crossing contaminated ground, to be destroyed after use, were being considered by the Italians. Likewise, it was reported that antigas clothing was being made of an impregnated silk, a complete suit weighing not more than 1¾ pounds. Neither type of garment, however, has been seen to date.

4. COLLECTIVE PROTECTION

An Italian document (*Manual for the Infantry Officer,* July 1940) describes various types of shelters to provide protection, against chemical agents, for a num-

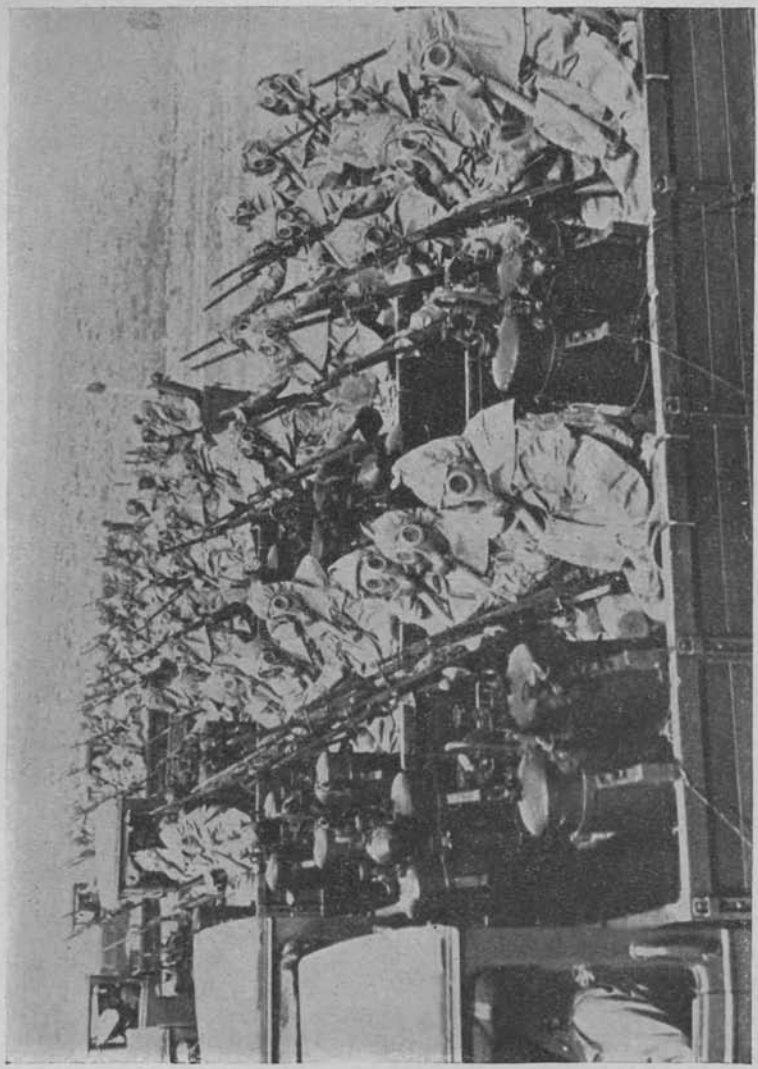


Figure 24.—Italian protective clothing.

ber of persons in such places as command posts, telephone exchanges, and dressing stations.

Airtight shelters are provided with curtains, preferably attached to a frame in an inclined position. These curtains are to be kept dampened continuously during a gas attack. The number of hours this type of shelter may be used without change of air is calculated by means of the formula $T=\frac{G}{N}$ where G represents the cubic content (in meters) of the shelter and N represents the number of persons sheltered.

The air-filtered type of shelter must be installed by technical troops. Purified air is admitted by means of a collective filter apparatus contained in five crates and weighing 270 kg (600 lbs). Normally, the quantity of air necessary is that which allows 1 cubic meter per person per hour, but in exceptional cases and in periods lasting not over 1 hour, the air may be reduced by 50 percent. The infantry shelter of this type is designed for 30 men at rest.

A box of chloride of lime is always placed before the entrance of the shelter for decontaminating shoes that may have come into contact with mustard gas.

5. DECONTAMINATION

a. Personal Decontamination

Pre-war literature on the subject of individual protective measures recommended that parts of the skin touched by liquid mustard gas, after removal of the liquid, be covered with calcium chloride, sodium bicarbonate, or any other absorbent powder with which the soldier might be provided. China clay, talc, and

magnesia alba, particularly the latter, were also mentioned as being satisfactory. The use of ashes or dried earth was recommended as a makeshift.

An Army pamphlet (*First Aid for Gas Casualties,* 1934) mentions the removal of liquid mustard gas from the skin by means of absorbent blotting paper contained in the first-aid "packet," or by washing with gasoline for 3 to 5 minutes, followed by application of a special "decontaminating powder" also contained in the packet. This powder was to be renewed two or three times at a few minutes' interval. For a complete personal decontamination, bathing in a warm solution of 0.4-percent solution of potassium permanganate and washing the eyes, mouth, and throat with sodium bicarbonate solution are prescribed.

The decontaminating powder mentioned above may be *Mixture M,* a white powder contained in a soldered tin box, which upon analysis was found to consist of chloramine T (8.6 percent), magnesium carbonate (70.3 percent), alkaline salts (14.4 percent), and undetermined matter (6.7 percent).

An item of Italian decontamination equipment recently examined by the British consisted of sealed glass ampoules, each containing 7½ to 8 cc of a solution of chlorine in carbon tetrachloride containing 2.7 percent free chlorine.

b. Ground Decontamination

Ground decontamination is effected by means of standard Army trucks fitted with a hopper at the back from which chloride of lime may be distributed on the ground. They are of two types, the heavy six-

wheeled cross-country truck (*autodovunque*), and the light four-wheeled truck (*autocarretta*). (Cf. pp. 60 and 61, sec. III, par. **2e** (4) and (5), above.)

The trucks carry drums of bleaching powder from which the hoppers are filled. Details of these trucks and their equipment are as follows:

	Heavy truck	*Light truck*
Capacity of hopper	1,100 pounds	440 pounds.
Number of drums of bleaching powder	24	14.
Weight of bleaching powder	2,640 pounds	1,540 pounds.
Weight of apparatus (without drums)	660 pounds	220 pounds.
Time required to empty hopper, traveling at 2 miles per hour	1 minute	1 minute.

The heavy truck distributes its hopper content over an area approximately 5 yards wide and 55 yards long, at the rate of (roughly) 3⅔ pounds per square yard. The light truck presumably distributes its hopper content over an area of approximately 100 square yards at the same rate.

A handcart apparatus, weighing 230 kg (500 lbs) when filled, is also provided for decontamination purposes. It consists of a container holding 60 kg (132 lbs) of chloride of lime, which is ejected through a nozzle by compressed air during a period of 2 minutes. Thirty minutes are required to recharge the compressed air cylinder (20 liters at a pressure of 150 atmospheres [9]), which is said to be able to discharge six containers of bleaching power. It is not stated whether the bleaching powder is dry or in solution.

c. Decontamination of Personnel

No recent information is available regarding the facilities provided for decontamination of personnel.

[9] Approximately 2,205 pounds to the square inch.

An official Army manual (*Defense against Gas,* 1930) describes the *formazione automobile di bonifica truppa* (motorized unit for the decontamination of personnel), consisting of 1 *autobagno* (mobile bathing unit) carrying a tank of approximately 530 gallons capacity, a pump for filling this in 15 minutes, and a boiler; a second truck carrying 2 tents; and a third with clothes and equipment. For use the 2 tents are set up, 1 at each side of the *autobagno*; personnel undress in the first tent, pass under the 12 showers of the *autobagno,* and put on fresh clothing in the second tent.

d. Decontamination of Clothing

The above-mentioned Army manual did not mention field laundries for decontamination of clothing. It merely stated that "articles of clothing, if very heavily contaminated (that is, if they have been splashed with mustard gas), must be destroyed (burnt or buried). If they are slightly contaminated, they may be washed with soap and water, well rinsed, and wiped. In every case it is necessary to have changes of clothing."

An Army pamphlet on decontamination, published in 1934, describes very clearly the usual methods of decontamination of clothing by washing with soap and water, but does not imply that special laundries would be provided for that purpose. Nor does it mention the use of steam for decontaminating clothing.

A Naval manual, published in 1939, also makes no mention of special laundries for decontaminating clothing except by implication. It states that if protective clothing becomes contaminated, the use of soap and

water will not be sufficient to cleanse it, it being necessary to send it to a gas protective center where special means are provided for doing the work.

6. GAS ALARMS

Gas alarms to be employed in the event of gas attack consist of sirens or klaxons, sounding three short notes and one long note, repeatedly.

Section V. CIVILIAN PROTECTION

The UNPA (*L'Unione Nazionale per la Protezione Anti-Aerea*) corresponding to the Air Protection League of Germany, undertook the matter of assisting air defense organizations, disseminating information, and cooperating in the execution of air defense measures. In some cases, especially in the larger Italian cities, good results were obtained, but from prisoners of war it has been learned that the smaller towns had practically no air defense organization. Children in particular were trained in air raid conduct. Air-raid warning sectors were established, wardens appointed, and blackouts held, but apparently interest lagged.

From a commercial source, it is learned that only about 1 million gas masks have been sold to the public. The Pirelli company, which has a government franchise to manufacture masks, is said to have about 2½ million unsold. It is assumed that recent raids on Genoa, Milan, Naples, and other centers have stimulated the public's desire to own and carry gas masks.

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Section I. CHEMICAL TROOPS

1. GENERAL

For some years past, the Japanese have been engaged in developing the means of employing chemical warfare in their Army and Air Forces. They are known to have organized a Chemical Warfare Department with a technical research branch and to have established units of chemical warfare troops. They have constructed factories for the manufacture of poison gas, worked out a system of gas protection, and provided their troops with an efficient type of gas mask. They have also undertaken some of the measures necessary for the protection of the civilian population against gas from the air. In short, the Japanese appear to be capable of conducting chemical warfare should they decide that it would be to their interest to do so.

It should be remembered that Japan did not ratify the Geneva Protocol of 1925, prohibiting the use of gases in war, and is, therefore, under no obligation to refrain from their use. Furthermore, there is definite evidence that the Japanese have employed toxic gases in limited quantities against the Chinese upon numerous occasions.

2. ORGANIZATION

Chemical warfare organization in the Japanese Army is of comparatively recent growth. While detailed information on the subject is meager, there is definite information of undoubted reliability that the Japanese Army is provided with some chemical troops. The following units have been reported:

a. Infantry (Regimental) Temporary Smoke Companies

Temporary smoke companies of infantry regiments are formed from regimental personnel trained in chemical warfare duties. These have been employed for local operations where the use of toxic smoke candles has been contemplated. It has been reported that such companies are organized into a headquarters section (similar to that of an infantry company), composed of 1 officer and 13 men, and 3 platoons with a strength of 1 officer and 50 men each. The platoon is made up of 4 sections of 11 men each, plus 6 drivers provided for the 6 horse-drawn carts carrying 540 candles packed in 36 boxes. The total strength of the company thus numbers 4 officers and 163 enlisted men, equipped with 18 vehicles carrying 1,620 candles.

b. Field Gas Companies

Field gas companies are nondivisional units allotted to divisions for specific operations. Two such companies, the 5th and the 18th, have been positively identified. It has been reported that these companies consist of a headquarters section and 3 platoons, each of 3 sections. Each section consists of 1 noncommis-

sioned officer and 23 men, 7 of which are drivers, with 6 horse-drawn carts. The section works in 4 groups of 3 men each, the remaining 4 men being used for intercommunication and protective duties. Four of the 6 carts carry 6 boxes of "smoke" candles each, while the remaining 2 carry rations and forage for 10 days.

The total number of candles carried by the company is 3,240, but it is not certain whether this number applies only to toxic smoke candles, or to ordinary smoke and tear-gas candles as well.

c. Independent Gas Companies

An independent gas company, the 34th, has been definitely identified, but no information is available concerning the organization, equipment, or function of such a unit.

d. Gas Battalions

The identity of the 3d Gas Battalion has been definitely established, but no other information regarding such a unit is available.

e. Temporary Smoke Battalions

Unconfirmed information indicates that when gas is to be used on a large scale, temporary smoke battalions may be formed from field gas companies. There may be 3 such companies (each about 220 strong) and a headquarters, divided into executive, meteorological, signal, and first-aid sections.

f. Chemical Warfare Regiments

In January 1941 the existence of the 5th and 6th Chemical Warfare Regiments, comprising approximately 1,500 men each, was reported. This is the only report of chemical warfare units being organized into regiments, and it remains unconfirmed.

g. Miscellaneous Units

A Chinese communiqué (19 August 1942) quotes a Japanese prisoner as saying that each division was equipped with a chemical warfare unit of 50 men with 20 poison-gas containers, and also that each division was allotted 250 shells containing sneezing, suffocating, tear, and mustard gas.

3. SCHOOLS AND TRAINING

Up to about 1926 the study of chemical warfare was confined to protective measures, and research and experiments in such problems were carried out by a special department of the Army Medical School in Tokyo. Since 1928, chemical warfare research appears to have been centered in the Army Scientific Research Institute in Tokyo, where modern facilities were installed for extensive research on chemical warfare agents, materials, explosives, and other military supplies.

The principal chemical warfare school is located at Narashino and is attended by officers selected from all arms and services. Troop training has been carried out largely by line officers who have studied at this school and who then spread their training through-

out the units to which they were assigned. A recent report of the appointment of a lieutenant general as the head of this school may well indicate its importance.

In addition to the Army Chemical Warfare School at Narashino, recent reports place two other schools in Nagano Prefecture and an experimental school at Nagoya.

The training of troops in defense against gas appears to be well organized and executed. All troops are sent through gas chambers, and large numbers of reservists have been given gas training. Gas masks are frequently worn, tear and irritant gases are frequently used in maneuvers, and troops also receive training in clearing paths through supposedly contaminated areas.

Section II. MANUFACTURE AND STORAGE

The Japanese chemical industry shows a number of points of resemblance to the Italian. Both have developed mainly since 1918, and under strong impulses toward self-sufficiency, particularly for war preparedness.

Experiments on phosgene manufacture were started in 1924 by the Hodogaya Chemical Company with the aid of a government subsidy. By 1933, the plants of this company at Hodogaya in Yokohama and Oji in Tokyo had an estimated monthly capacity of 20 tons of phosgene, 150 tons of chlorine, 3 to 4 tons of bromine, and 10 tons of benzoic acid. Two companies with plants located at Omuta City and Osaka had developed estimated monthly capacities of 45 tons of phosgene, 30 tons of benzoic acid, and 50 tons of arsenic trioxide, while a third company at Sakai City was believed to be manufacturing 5 tons of phosgene per month. Further manufacture of arsenic trioxide at two additional plants was estimated to total 130 tons monthly. The Sumitomo Chemical Company was reported to be manufacturing poison gases of arsenic derivatives at Niihama under the supervision of a German chemist loaned by the *I. G. Farbenindustrie.*

Apart from phosgene, only intermediates for poison-gas manufacture were produced by the chemical industry; the actual gases are believed to have been made at the various arsenals. Phosgene supplied by industry

was reported to have been filled into shells at the Army arsenals at Osaka and Kokura and at the Navy arsenals at Maizuru and Kure. Mustard gas was probably manufactured at the Army arsenals at Osaka and Oji and at the Navy arsenals at Maizuru and Hiratsuka. It was reported that lacrimators were manufactured at Oji and Maizuru and that smoke chemicals were produced at the Oji, Iwahana, and Hiratsuka arsenals. In addition to those previously mentioned, arsenals manufacturing war gases are reported to exist at Nagoya, Uraga, Yokohama, and Tadanoumi (Tadami).

The poison-gas factory at Himeji, consisting of 4 buildings and employing about 1,600 workmen, was formerly the largest in Japan. It is reported that gas shells filled in this plant were shipped by way of Kobe to China, and that aircraft bombs manufactured at this plant were sent to the Kwantung Army for testing in Manchuria. However, a large explosion partially destroyed this plant during 1941, and the newly built plant at Odamura is now believed to be the largest poison-gas factory in Japan.

A poison-gas factory at Akashi, 12 miles west of Kobe, is reported to employ 1,200 men and to utilize materials largely imported from Germany. There seems to be no doubt that the Germans have greatly assisted Japan in developing their war-gas industry, as evidenced by extended visits of some of Germany's leading authorities on poison gases.

No attempt will be made to list the chemical plants scattered over the Japanese Empire that may be equipped for the manufacture of poison gases or

their intermediates. It is sufficient to state that the Japanese appear to be adequately supplied in both the raw chemicals and equipment necessary to manufacture war gases upon a large scale.

(The only storage depot mentioned in reports is located at Kisarazu, on the eastern shore of Tokyo Bay some 30 miles south of Tokyo).

Section III. OFFENSIVE WEAPONS

1. AGENTS

The Japanese did not use gas in World War I, and for several years afterwards studied the problem only from the point of view of defense. After 1926, they began to give serious consideration to the development of war gases, but indications are that their attention has been confined largely to the well-known blister, choking, nose, and tear gases shown in figure 25. (For a comparison of Japanese gases with those of other nations, see the war gas comparison chart which faces p. 156.)

In addition, agents for producing screening smokes are available. The Japanese, however, distinguish between ordinary smoke or tear gas and toxic smoke by referring to the latter as "special smoke."

2. GROUND WEAPONS

a. Mortars

(1) *90-mm chemical mortar, model 94.*—The principal Japanese weapon for the employment of chemical munitions is the 90-mm chemical mortar, the characteristics of which are reported to be as follows:

Type of gas	Gases	Whether reported as having been		Marking	Weapons	Remarks
		Manufactured	Actually used			
1. Blister (vesicant).	Mustard gas	Yes	Probably	1 white and 2 yellow bands	Aircraft bombs and spray, shells, mines, and bulk contamination.	Any of these gases might be used in any of these weapons.
	Lewisite	Yes	Probably	1 white and 2 yellow bands.	Shells	
	Mustard gas/Lewisite mixture.	Yes	Probably	?	Aircraft bombs	
2. Choking (lung irritant).	Phosgene/chlorine mixture.	Yes	No	Yellow band (?)	Cylinders	Now improbable.
	Phosgene	Yes	Possible	1 yellow band	Shells, aircraft bombs	May also have been used in projectors (now improbable).
	Diphosgene	Probably	No	Yellow band (?)	Aircraft bombs	
	Chlorpicrin	Yes	Yes	Yellow band (?)	Shells; perhaps also aircraft bombs.	Chlorpicrin/stannic chloride mixture.
3. Nose (toxic smoke).	Diphenylchlorarsine	Yes	Yes	1 red band	Shells, candles, mortar bombs, aircraft bombs, hand grenades.	Crude.
	Diphenylcyanarsine	Yes	Yes			
	Adamsite	Probably	Yes			
4. Tear (lacrimator).	Chloracetophenone	Yes	Yes	?	Shells, hand grenades, candles.	In CCl_4 solution.
Other	Hydrocyanic acid	Yes	Yes (imminent).	1 brown band	Shells, hand grenades	None yet used in shells; ready for use against armored vehicles.
	Arsenic trichloride	Yes	Yes	1 green band		May be used only as an intermediate in manufacture.

Figure 25.—List of Japanese war gases.

Caliber	90.5 mm (3.5 inches).
Length of barrel	49.68 inches.
Length of recoil	5.04 to 7.92 inches.
Elevation	45 to 85 degrees.
Weight of barrel	75.2 pounds.
Weight of mount	106 pounds.
Weight of base plate	90.2 pounds.
Weight of sight	2.97 pounds.
Total weight	349.8 pounds.
Maximum range	4,155 yards.

Two types of projectiles for this weapon are known. Figure 26 shows the normal *burster container type,* which contains a relatively small burster charge as compared with the chemical filling. In addition to lung irritants and toxic smokes, this type of projectile has an incendiary filling composed of 40 cylindrical rubber pellets immersed in a solution of white phosphorus and carbon disulphide.

The *annular cavity type,* shown in figure 27, contains a relatively large bursting charge in proportion to the chemical filling. In a projectile of this type captured by the Chinese, there was a bursting charge of TNT (stabilized with naphthalene) weighing 590 grams (20.76 oz), surrounded by an annular cavity containing 236 grams (8.32 oz) of crude diphenylcyanarsine.

It will be noted that the tail arrangement of these projectiles is designed for 1 primary charge and 6 secondary charges.

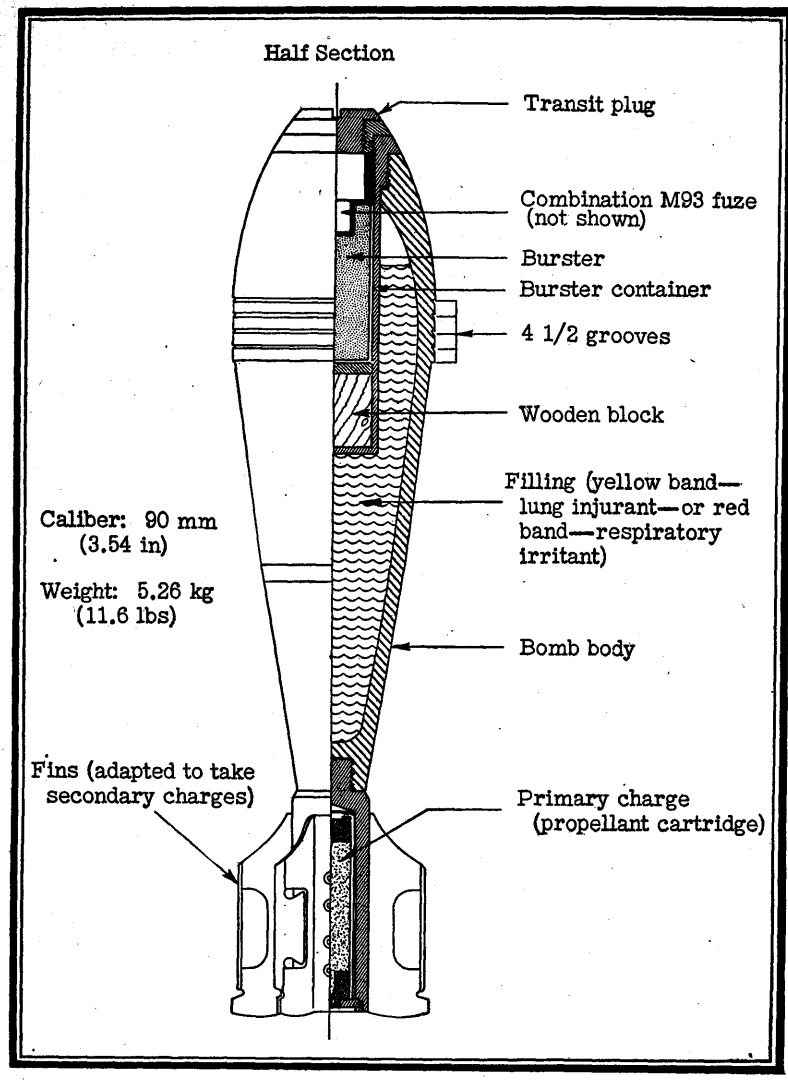


Figure 26.—Japanese 90-mm mortar gas bomb, burster container type.

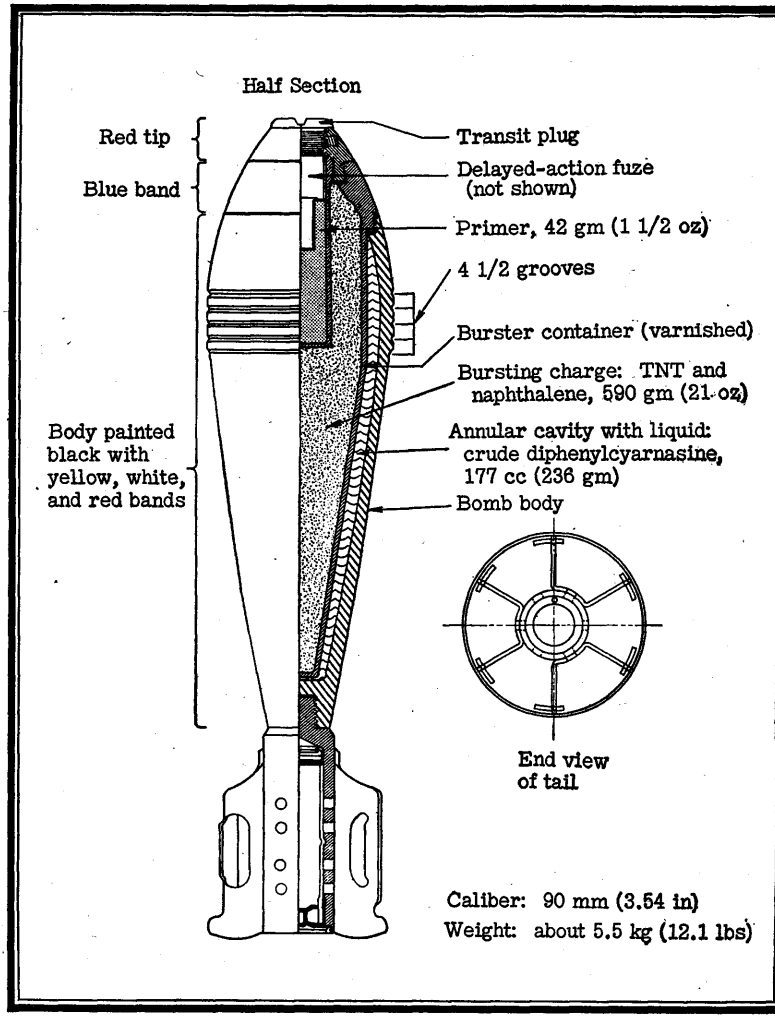


Figure 27.—Japanese 90-mm mortar gas bomb, annular cavity type.

(2) *81-mm infantry mortar.*—The characteristics of the standard infantry mortar (Stokes-Brandt type[1]) (fig. 28), which has been captured, are as follows:

Caliber	81 mm (3.19 inches).
Total weight	129 pounds.
Weight of projectile:	
Light	7.2 pounds.
Heavy	14.3 pounds.
Maximum range:	
Light projectile	3,280 yards.
Heavy projectile	1,310 yards.

The existence of gas and smoke ammunition for this weapon has been reported, but not confirmed.

(3) *100-mm chemical mortar.*—A Russian article published in 1936 gave the following characteristics of a Japanese 100-mm chemical mortar:

Caliber	100 mm. (3.93 inches).
Weight of mortar	286 pounds.
Weight of projectile	22 pounds.
Weight of filling	4.4 pounds.
Maximum range	3,610 yards.
Rate of fire	15 rounds per minute.

The existence of this weapon has not been verified.

b. 160-mm Gas Projector

The armament of the Japanese chemical troops is reported to include a gas projector of the Livens type,[2] which consists of a barrel with a fixed attachment at the muzzle end on which the sighting device is fitted, and a support plate. It is fired by means of an electric

[1] See p. 56, note 2, above.
[2] See p. 22, note 8, above.

primer. The characteristics of this weapon are reported to be as follows:

Caliber	160 mm (6.3 inches).
Length of body	100 cm (39.4 inches).
Total weight	330 pounds.
Weight of projectile (filled)	48.4 pounds.
Weight of chemical filling	25.1 pounds.
Weight of explosive charge	0.66 pound.
Maximum range	2,725 yards.

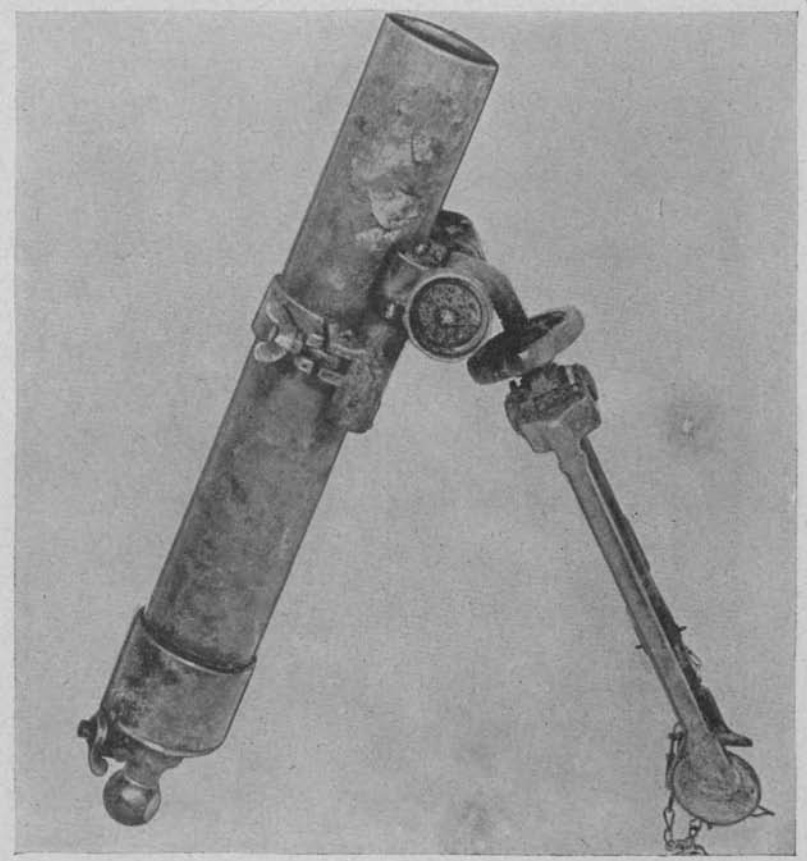
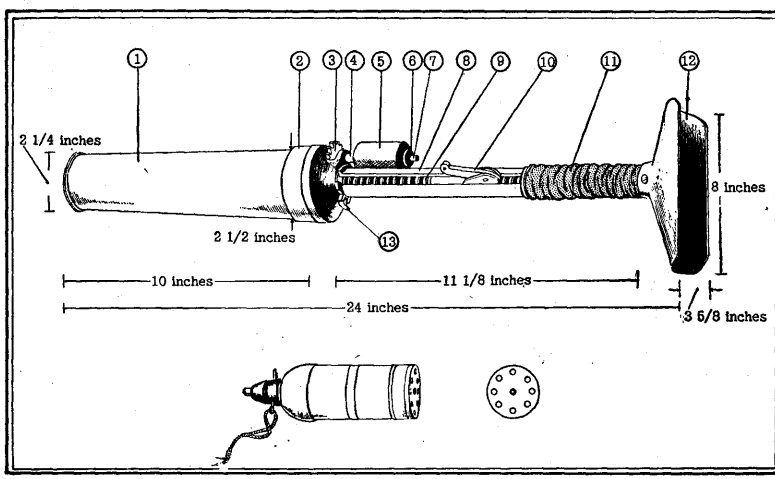


Figure 28.—Japanese 81-mm infantry mortar.

By using fillings of blister gas, considerable areas of ground may be heavily contaminated. Fillings of phosgene or diphosgene might also be expected. The projector is a simple weapon and not very accurate, and firing at night is probably accompanied by a vivid flash.

c. Grenade Dischargers

(1) *50-mm, model 89.*—This infantry weapon (fig. 29), known as the model 89 grenade discharger (also erroneously as "knee mortar"), weighs 5.67 kg (10.25 lbs) and has an over-all height of 24 inches. The barrel, 10 inches in length, is rifled with eight grooves.



1. Barrel
2. Base cup
3. Range-adjusting cogwheel
4. Screw bushing
5. Range-adjusting knob
6. Nut
7. Adjusting shaft
8. Trigger housing
9. Range-adjusting worm
10. Trigger
11. Spring sleeve
12. Base plate
13. Barrel lock

Figure 29.—Japanese 50-mm grenade discharger, model 89.

The small artillery-like shell is projected 65 to 700 yards, depending upon the adjustment of the weapon.

There is no mechanical elevation, the projector being held by hand at an approximate elevation of 45 degrees. Different ranges are obtained by altering the chamber capacity by means of a knurled screw attached to the lower right of the barrel.

The projectile is hand-fired by means of a short leather thong attached to a trigger, located in front of the base of the barrel, which cocks and operates a firing pin in one downward movement (trip-action firing mechanism).

This weapon also projects smoke and time-fuzed grenades from 45 to 206 yards, and three signal flares 100 yards vertically. It is carried and operated by one man.

(2) *50-mm, model 10 (1921).*—An older type of grenade discharger (model 10) was used by the Japanese in the Malayan campaign. This type is also of 50-mm caliber and has a range of from 65 to 250 yards. Its over-all length is 20 inches; it has a smooth-bore barrel 10 inches long and weighs 5½ pounds unloaded.

The discharger is muzzle-loaded and is fired by a striker which is operated by a lever outside the discharger body. The range is regulated by a gas port similar to that of a British rifle-grenade discharger. The weapon is fired from the ground, where it rests on a small base plate. It is used mainly for firing signal pyrotechnics, but also fires a grenade weighing a little less than 1 pound.

d. Artillery

Artillery gas shells are reported to be available for the 75-mm and 105-mm guns and for the 150-mm howitzer. Fillings are reported to be phosgene, mustard gas, hydrocyanic acid (unconfirmed), and a mixture of mustard gas and Lewisite.

A distinction is made between "gas shell," in which the explosive charge is relatively small and serves only to burst the body of the shell, and "combined HE and chemical shell," in which the explosive charge comprises about 30 percent of the combined filling.

Combined HE and mustard-gas shells are provided for all three calibers. However, combined HE and phosgene shells are available for the 150-mm howitzer only.

Among some shells captured by the Chinese and examined at Hong Kong was a 75-mm shell weighing about 12.5 pounds and filled with approximately 1.4 pounds of crude Lewisite. The propellant charge (13.3 pounds) was in a silk bag in a cartridge case (2.85 pounds) which was a push fit over the base of the shell up to the driving band.

The color and markings of this shell correspond to that of a single 75-mm shell recently found in New Guinea, which was filled with a mixture of mustard gas and Lewisite. This shell was painted gray with a red tip and blue band on the nose. Six inches down the body was a white cross over the number "132." Immediately above the rotating band were white and yellow bands. A dark double cross appeared near the base of the shell.

Both toxic and non-toxic smoke fillings are believed to be provided for the three calibers mentioned. A French report in 1939 refers to artillery shells filled with DA (diphenylchlorarsine) and DM (diphenylaminechlorarsine), and a Russian report (1936) mentions a CN (chloracetophenone) filling.

White phosphorus (WP) appears to be the filling preferred by the Japanese for ordinary smoke shells. In 1941, the Chinese reported a 75-mm field-gun shell, weighing 11 pounds, which contained 1.1 pounds of a 50:50 mixture of chlorpicrin and stannic chloride, with a central conical container holding the explosive charge of black powder. Though this could not be considered purely as a smoke shell, it would give a considerable amount of smoke, and the rather unusual design of the shell may be standard for shells containing other smoke-producing liquids.

As compared with other types of ammunition, the proportion of chemical shells (including smoke) carried by the artillery is said to vary from 20 to 25 percent.

e. Infantry

Infantry troops form the backbone of the Japanese Army and are entrusted with many duties usually performed by specialized troops in other armies. It is believed that gun companies of infantry regiments carry smoke shells, and there is concrete evidence that some infantry units carry both toxic and non-toxic smoke candles and grenades.

f. Candles and Grenades

A wide variety of candles and grenades have been reported, many of which have been captured and examined by the Allied forces. The three types—toxic, lacrimatory (tear gas), and smoke—are described as follows:

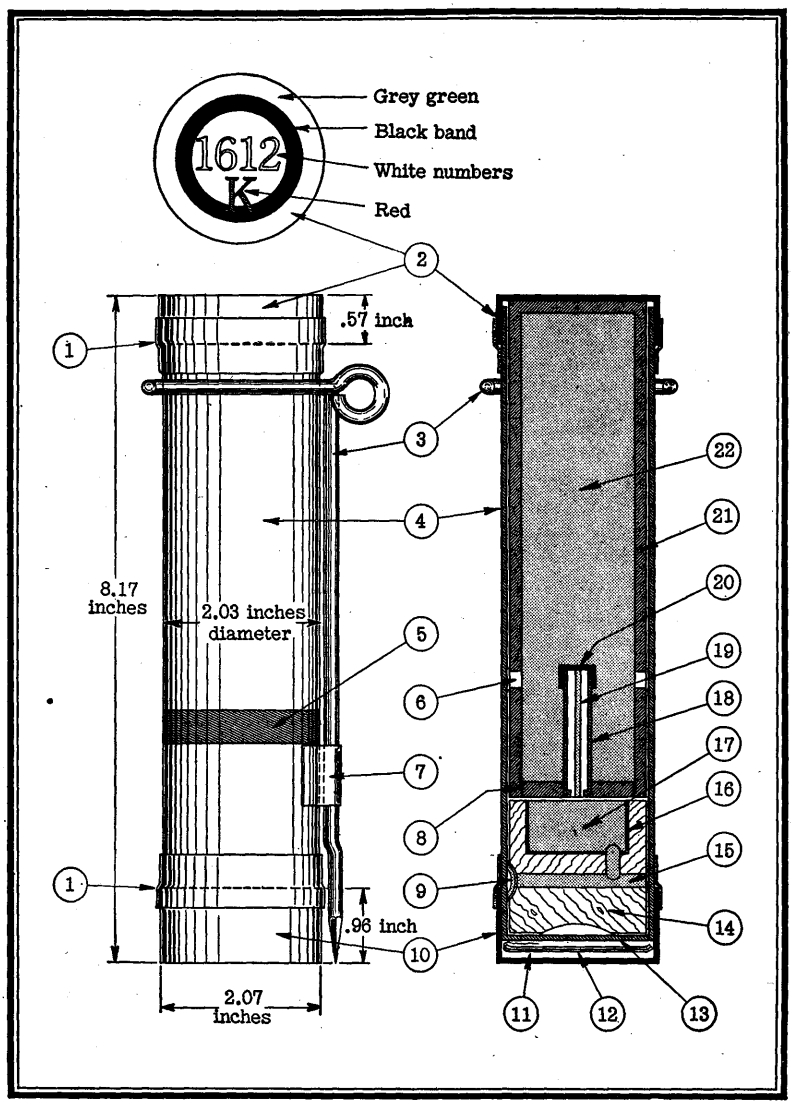
(1) *Toxic smoke candles and grenades.*—(a) *Self-projecting smoke candle, model 1612–K.*—This candle (fig. 30), captured by U. S. troops in the Southwest Pacific, consists of an outer, light steel cylinder approximately 8 inches long and 2 inches in diameter, and is painted a brown color, with a .39-inch red band about 3 inches from the bottom. On the top there is a large black circle and the number "1612" in white, beneath which there is a red letter "K." Along the side of the candle there is a white sighting line. The candle is equipped with a sliding pointed rod to hold the candle in an inclined position when the spiked point is inserted into the ground.

The candle weighs 958 grams (2.1 lbs) and contains an inner light steel cylinder containing 151 grams (5.3 oz) smoke mixture of the following composition:

Nitrocellulose	50.4 percent.
Ash	4.9 percent.
Diphenylcyanarsine	40.0 percent.
Moisture	3.0 percent.
Camphor	1.7 percent (by difference).

DA (diphenylchlorarsine) and CN (chloracetophenone) fillings are also reported for this candle.

To fire, the sheet-metal slip-on covers (sealed with adhesive tape) are removed from both ends of the candle, and the rod is extended and inserted into the



1. Adhesive tape.
2. Top lid with lettering "1612 K" sealed with adhesive tape.
3. Spike used to set up the candle.
4. Outer container, wall thickness.
5. Painted red band.
6. Smoke vent.
7. Clip securing spike to candle.

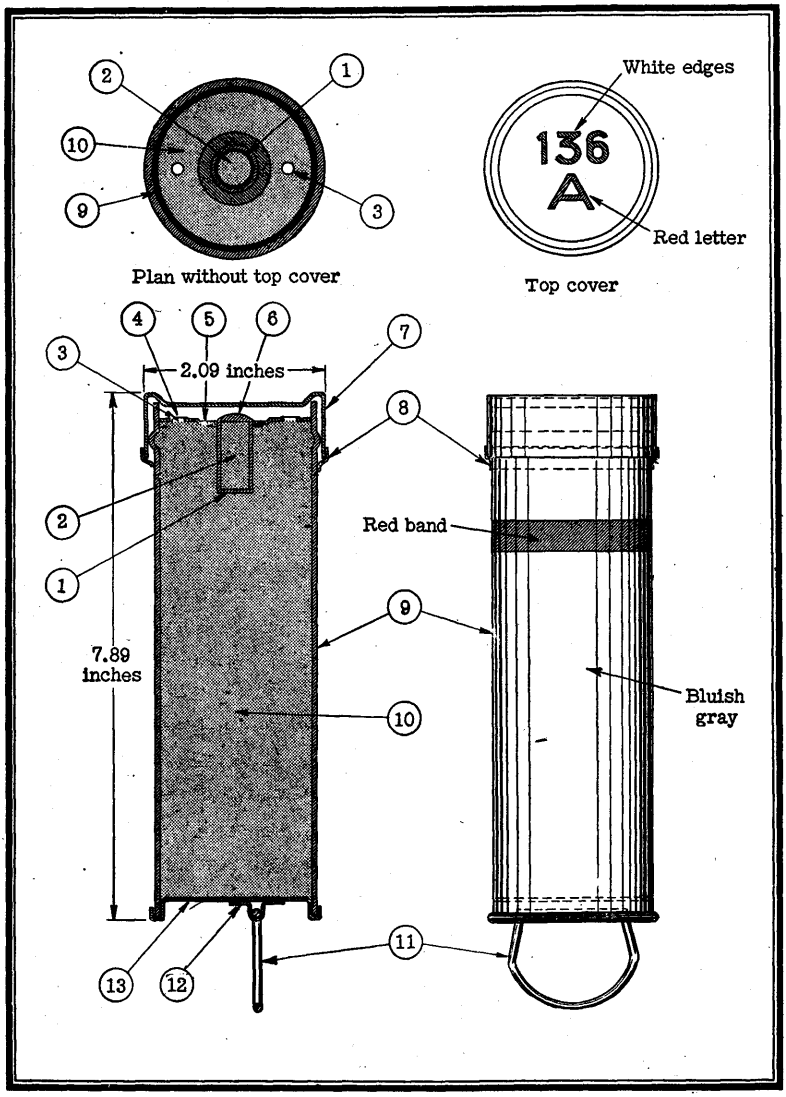
8. Screwed base of inner container.
9. Ignition cap.
10. Bottom lid sealed with adhesive tape.
11. Wooden disk with abrasive edging.
12. Two cardboard packing disks.
13. Bottom of outer container with slot at center for positioning wooden block.
14. Wooden block drilled for fuze with positioning slot at bottom.
15. Fuze.
16. Cylindrical steel pan for powder propellant.
17. Propellant.
18. Fuze tube.
19. Fuze.
20. Lead cover.
21. Inner container, wall thickness about 2.5 mm (0.098 inch).
22. Charge.

Figure 30.—Japanese self-projecting smoke candle, model 1612–K.

ground at the desired angle. A match head at the base of the candle is ignited by a scratch block contained in the cover of the candle. This ignites a delay fuze, which in turn sets off the propellant charge at the base of the cylinder. This charge propels the inner cylinder containing the smoke mixture a distance of 130 to 305 yards, according to the angle at which the candle is placed, at the same time igniting a delay fuze that in turn ignites the smoke mixture.

(b) *Toxic smoke candle, hand-thrown type.*—This candle (fig. 31), captured in Burma, is cylindrical in shape, about 7 inches long and 2 inches in diameter. It is a bluish-gray in color, with a red band one-third of an inch wide about 1½ inches from the top. Its total weight is approximately 9 ounces, and its filling is reported to be the same as that contained in the self-projecting type. The smoke mixture is ignited by means of a match head and friction striker, and after a delay of 3 to 4 seconds the toxic smoke is evolved.

(c) *Toxic smoke candle (large).*—This candle, cylindrical in shape, is approximately 4¼ inches in diameter by 8 inches long. It is painted a greenish-



1. Leadfoil cover.
2. Fuze.
3. Smoke vent.
4. Tinfoil covering for vent.
5. Tinplate diaphragm.
6. Ignition cap.

7. Lid with lettering "136 A."
8. Adhesive sealing tape.
9. Cylindrical container, wall thickness 0.0124 inch; painted a bluish-gray color.
10. Charge.
11. Handle, diameter 0.116 inch.
12. Handle clip.
13. Bottom of container.

Figure 31.—Japanese toxic smoke candle, hand-thrown type.

gray color, with a red band several inches from the top.

After removal of the top cover, the fuze is ignited by means of a match head. This fuze ignites a primary combustible compound, which in turn ignites a slow-burning compound. This in turn heats a pumice impregnated with diphenylcyanarsine, and the resulting toxic smoke is emitted through a number of smoke vents.

The candle, weighing approximately 4½ pounds, is believed to be the type provided for the field gas companies and infantry (regimental) temporary smoke companies (see p. 85, sec. I, par. **2a** and **b**, above).

(d) *"T. B." hand-thrown HCN grenade.*—While no definite reports have been received concerning the actual use of this weapon (fig. 32) by the Japanese, it has been confirmed that several cases of these grenades were washed up on the beach in the beginning of the Malayan campaign.

The grenade consists of a spherical glass flask about 3½ inches in diameter containing about 1 pint of hydrocyanic (prussic) acid, sealed with a crown cork. The sediment observed at the bottom of the flask is finely divided metallic copper, which acts as a stabilizer for the acid.

The fragile flask is packed in a mixture of sawdust and sand in a cylindrical tin canister lined with

ribbed cardboard packing, which is impregnated with sodium carbonate as a neutralizing agent. An outer tin container measuring 5¼ inches in depth by 5½ inches in diameter, khaki in color, has a ¾-inch red band 3½ inches from the bottom. Three carrying handles are provided, one on the lid and the other two on the side. The total weight is 4.6 pounds.

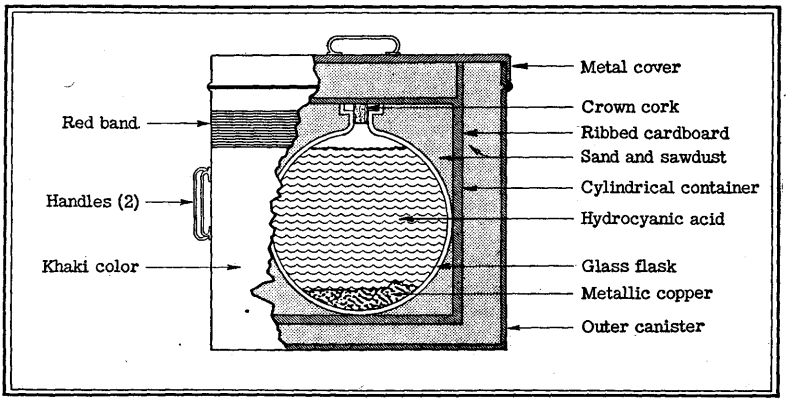
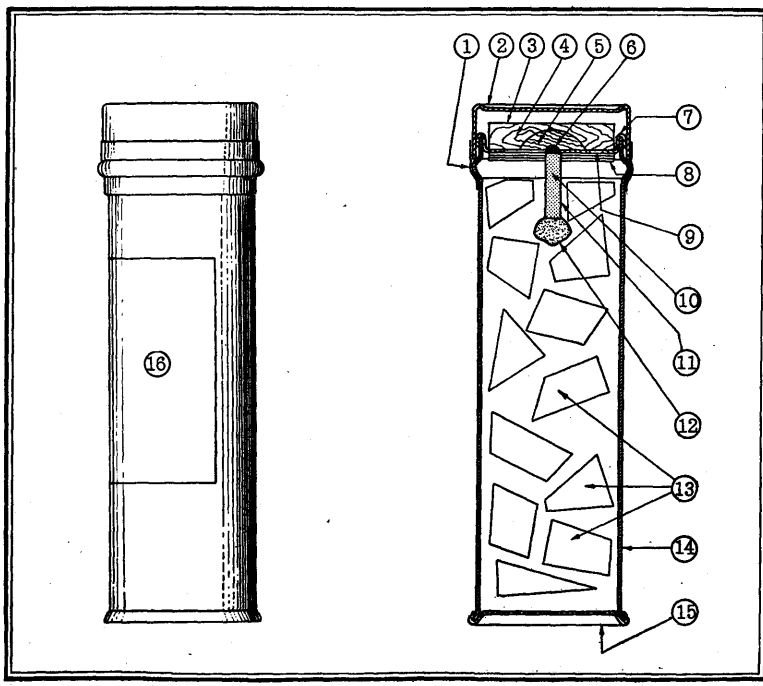


Figure 32.—Japanese "T. B." hand-thrown HCN grenade.

The flask is thrown by hand, 10 yards being the practical range. It is intended for use against tanks, pillboxes and small enclosed spaces, where a lethal concentration of the acid would be produced upon vaporization. Tests conducted with duplicates of the Japanese grenade indicate that if a tank were hit by one of them at vulnerable openings, the grenade would create a concentration of the gas 20 times that necessary to kill the occupants unless they were wearing adequate gas masks. However, the gas, which has a characteristic odor of bitter almonds, is highly vola-

tile and is not considered very dangerous outdoors or in a large open space.

(2) *Lacrimatory candles and grenades.*—(a) *Lacrimatory candle, model 89.*—This lacrimatory candle (fig. 33), $7\frac{1}{16}$ inches long, weighs approximately 8.5 ounces, including the chemical filling weighing 4.6



1. Adhesive tape
2. Lid (metal)
3. Abrasive surface
4. Scratch block (wood)
5. Cotton wad
6. Match head
7. Inner cover
8. Gauze
9. Vents
10. Fuze
11. Fuze tube (copper)
12. Starter mixture
13. Impregnated flakes
14. Container
15. Base
16. Label

Figure 33.—Japanese lacrimatory candle, model 89.

ounces. The lacrimatory filling consists of collodion flakes impregnated with CN (chloracetophenone). The container is painted a greenish-gray color.

The label (16) indicates that the candle has two chief uses: to enable police to disperse crowds, riots, etc., and, on maneuvers, to represent non-persistent gas.

Instructions for use state that the candle may either be placed on the ground or be thrown, the gas being emitted approximately 4 seconds after ignition. It should not be used near inflammable objects, and if any part of the body or hands comes into contact with the filling, it should be washed immediately with soap and water. The effective life is stated to be 1 year after manufacture; thereafter, the candle is to be examined for effectiveness every 6 months.

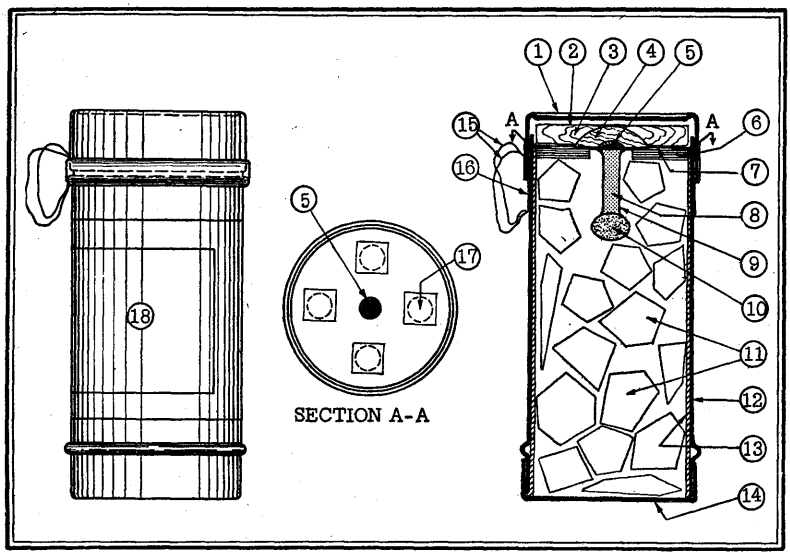
To use, the waterproof adhesive tape (1) is torn off and the lid (2) removed. The fuze (10) is ignited by rubbing the scratch block (4) against the top of the match head (6).

(b) *Green lacrimatory candle, model A.*—The total weight of this candle (fig. 34) is 5.9 ounces, including the chemical filling which weighs 1.9 ounces. It is 2.3 inches in diameter and 5.2 inches long. The lacrimatory filling consists of collodion flakes impregnated with CN (chloracetophenone).

The instructions for use are essentially the same as given for lacrimatory candle, model 89, except that the period of effective life is 6 months after the date of manufacture.

(c) *Lacrimatory grenade, model C.*—The total weight of this grenade (fig. 35) is approximately 11

ounces, including the lacrimatory filling, which weighs 4.84 ounces. It is 2.1 inches in diameter and 5.1 inches long. The label (17) on the body gives the details of its use and the method of operation. It is painted a silver-gray color.

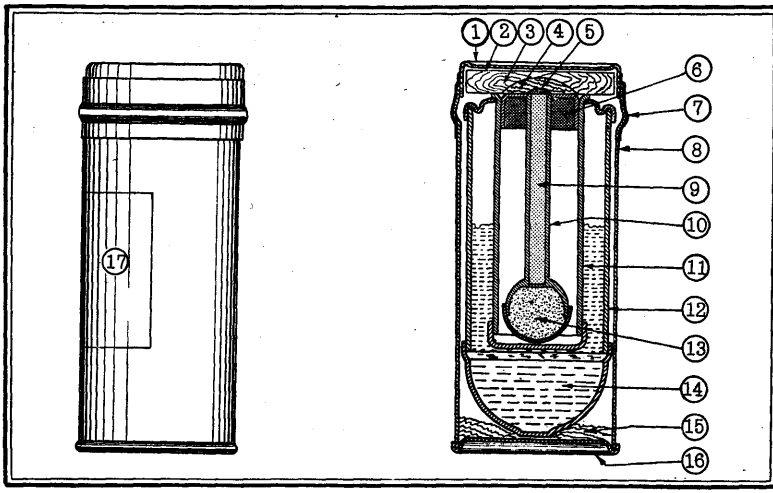


1. Lid (metal)
2. Abrasive surface
3. Scratch block (wood)
4. Cotton wad
5. Match head
6. Three layers of gauze
7. Vents
8. Fuze
9. Fuze tube (brass)
10. Starter mixture
11. Impregnated flakes
12. Outer container
13. Inner container (cardboard)
14. Base
15. Cord for removing tape
16. Adhesive tape
17. Vents (sealed with oil paper or tinfoil)
18. Label

Figure 34.—Japanese green lacrimatory candle, model A.

When the grenade is removed from the outer container (8), a match head (5) forming the top of the fuze (9) is exposed. This is ignited with the abrasive

surface (2) of the scratch block (3), and after a delay of 4 to 5 seconds the burster charge (13) becomes ignited. On exploding, the grenade is shattered and the lacrimatory filling (14) scattered. The filling is CN (chloracetophenone) dissolved in carbon tetrachloride.



1. Lid (metal)
2. Abrasive surface
3. Scratch block (wood)
4. Cotton wad
5. Match head
6. Cement stopper
7. Adhesive tape
8. Outer container (metal)
9. Fuze
10. Container for fuze
11. Insulating tube
12. Container for lacrimator
13. Burster (gun powder)
14. Liquid lacrimator
15. Cotton packing
16. Base
17. Label

Figure 35.—Japanese lacrimatory grenade, model C.

The container for the fuze (10), the insulating tube (11), and the container for the lacrimator (12) may be vulcanite, celluloid, or some plastic material which would not be corroded by the liquid filling.

(3) *Smoke candles and grenades.*—(a) *Self-pro-*

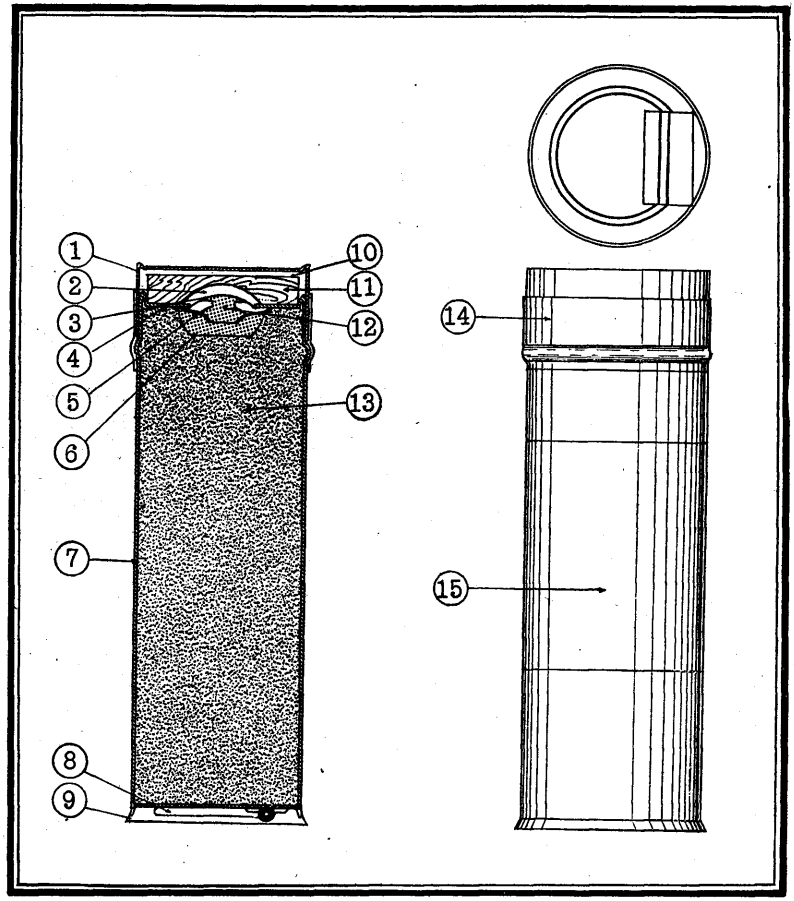
jecting smoke candle, model 99.—This candle is almost the same in size and construction as the self-projecting toxic smoke candle previously described. One report states that the candle is light gray in color with a white sighting line along its side, whereas another report states that it is olive drab in color. Both reports give the total weight as 1,283 grams (2.82 lbs) including the smoke mixture, weighing 643 grams (1.41 lbs), which has the following composition:

Hexachlorethane	56.5 percent.
Zinc dust	30.0 percent.
Zinc chloride	2.8 percent.
Zinc oxide	10.7 percent.

(b) *Smoke candle (small), model 94.*—The container of this candle (fig. 36) is green in color and the markings show the usual date and place of manufacture. It is 2.1 inches in diameter and 7.25 inches long. The total weight is given as 2.17 pounds, including the Berger-type smoke mixture [3] weighing 1.87 pounds, which consists mainly of carbon tetrachloride, zinc dust, and zinc oxide.

(c) *Smoke candle (large).*—This candle appears to be a larger model of the model 94 smoke candle (see fig. 37). It differs mainly in the method of ignition, which apparently is effected by means of a cord attached to the igniting apparatus. Its diameter is approximately 3⅓ inches and its length 31½ inches. The total weight is given as 16½ pounds, including the Berger-type smoke mixture [3] weighing 15 pounds.

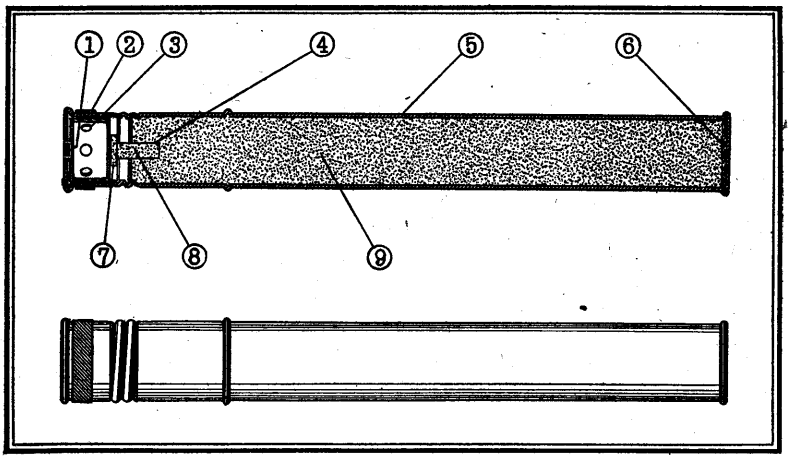
[3] See p. 19, note 5, above.



1. Top cover.
2. Cotton wad.
3. Tin-foil cover.
4. Inner lid (sheet iron).
5. Lead seal.
6. Sheet-iron cup.
7. Body.
8. Handle.
9. Base.
10. Abrasive surface.
11. Ignition block.
12. Igniter.
13. Smoke-producing mixture.
14. Adhesive band.
15. Markings, etc.

Figure 36.—Japanese smoke candle (small), model 94.

(d) *Floating smoke candle, model 94–B.*—This candle (fig. 38), examined by U. S. troops in the Southwest Pacific, is supported by a rubber tube at-



1. Connection for cord to ignite fuze.
2. Adhesive band.
3. Smoke vents (eight in number).
4. Fuze tube.
5. Body.
6. Cardboard.
7. Ignition cap.
8. Igniting powder.
9. Smoke-producing mixture.

Figure 37.—Japanese smoke candle (large), model 94.

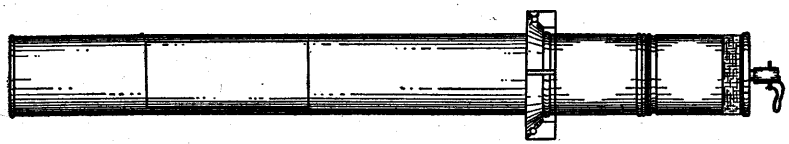


Figure 38.—Japanese floating smoke candle, model 94–B.

tached to two lugs on the supporting ring. It is dark gray in color and 31.2 inches in length by 3.1 inches in diameter.

The total weight of the candle is 12.47 pounds and the filling, weighing 10.8 pounds, has the following composition:

Hexachlorethane	50.0 percent.
Zinc dust	23.5 percent.
Zinc oxide	26.5 percent.

The inner match head is ignited by a point flash from the igniter fuze located in the top of the candle. The inner match head then sets off the inner igniter, which in turn ignites the main filling.

(e) *10-kg naval smoke candle.*—Also reported as used in the Southwest Pacific is the 10-kg naval smoke candle, which weighs 9.3 kg (20.5 lbs). It is 24 cm (9.45 in) long and 15 cm (5.9 in) in diameter, is provided with a hinged carrying handle, and is painted a battleship gray.

Printed instructions for use are found on a 7- by 10-inch yellow label pasted on the side of the candle. The Berger-type smoke mixture,[4] which burns from 3 to 4 minutes, is ignited by an ignition implement supplied separately.

(f) *Grenade-discharger smoke grenade.*—This smoke grenade, approximately 2 inches in diameter by 6 inches in length is used with the 50-mm grenade discharger, model 89. Only the weights of the propellant (4.24 oz) and the detonator (0.25 oz) are given. The smoke mixture consists of hexachlorethane and zinc powder.

In operation, the grenade is removed from the outer cover. A delayed-action fuze becomes ignited from

[4] See p. 19, note 5, above.

the explosion of the propellant and in turn sets off the powder charge, which ignites the smoke compound.

(g) *Rifle smoke grenade.*—This grenade (fig. 39) is used with a special adapter which fits over the end of the rifle barrel. The motive force and primary ignition are furnished by a standard .256-caliber Japanese rifle cartridge loaded with 1.927 grams of powder and fitted with a wooden pellet. This cartridge is wrapped in paper and stored in the grenade tube.

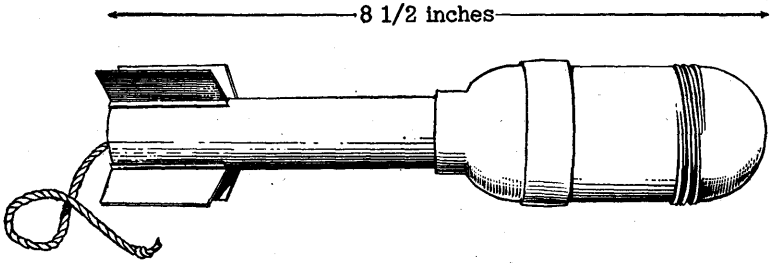


Figure 39.—Japanese rifle smoke grenade.

The grenade, weighing 583 grams (1.29 lbs) and 8½ inches in length, is painted a silver color and is thoroughly waterproofed with coats of heavy lacquer and paraffin. The nose and body proper, 2 inches in diameter, are made of No. 23 gauge (B & S) tin plate (.0226 inch thick). The base, stamped from No. 18 gauge (B & S) sheet steel (.0403 inch thick), is screwed onto the body by means of rolled threads. Four smoke ports are placed at 90-degree intervals around the base and are covered with light, sheet-metal disks, which are held in place by waterproof cement covered with paraffin. There are three flash ports spaced at 120-degree intervals in the bottom of the base.

The four fins, made of No. 24 gauge (B & S) tin plate (.0201 inch thick) eleven-sixteenths of an inch wide and 2⅜ inches long, are soldered to and equally spaced around the grenade tube, which is 1 3/16 inches in diameter.

The smoke mixture, weighing 273 grams (0.6 lb) has the following analysis:

Hexachlorethane	56.1 percent.
Zinc dust	27.6 percent.
Zinc chloride	2.9 percent.
Zinc oxide	13.4 percent.

(h) *Frangible smoke grenade.*—This frangible smoke grenade, not to be confused with the HCN (hydrocyanic acid) toxic grenade, was captured in the Southwest Pacific. It consists of a flat-bottom spherical glass flask, partially filled with a smoke liquid, packed in sawdust in a tin cylinder.

The metal container is approximately 4 inches high and 3⅓ inches in diameter. The lid is removed by turning the top slightly in a counterclockwise direction and lifting. The locking device consists of two diametrically opposite indentations in the lid fitting into L-shaped grooves in the sides of the container.

The flask has a short neck with a 0.63-inch opening, and is sealed with a rubber stopper held in place by a double crown top. The grenade examined weighed 354.8 grams (0.78 lb) and contained 188 grams (0.4 lb) of a clear light yellow liquid. The filling had the following composition:

FM (titanium tetrachloride)	59.2 percent.
Silicon tetrachloride	40.8 percent (by difference).

Both titanium tetrachloride and silicon tetrachloride are smoke agents which in their liquid state are fairly

corrosive to metals and irritating to the skin. In ordinary field concentrations the smoke would not be sufficiently irritating to the respiratory system to cause coughing.

These smoke grenades should be fairly effective in screening a gun port of a pillbox or tank.

A translation of the directions on the label of the container reads as follows:

"Instructions—Experimental Hand-Thrown Smoke Grenade

Tokyo No. 1 Army Arsenal

"1. USE

1. Carry grenade in this can and just before attack remove the lid and take it out.

2. Approach objective; (about 8 meters away from objective) locate a spot where a 'blinder' would be most effective; throw it with enough force to break the glass on impact.

3. If two or three are thrown, the effect is great.

"II. PRECAUTIONS

1. Do not drop on solid object.

2. Should the liquid touch any part of the clothing or skin, wash the part with alcohol or water.

3. Do not breathe the smoke. (Damage is not too great if inhaled only for a brief moment.)

4. Those which do not break can be used again; so be sure to pick up any lying around."

g. Incendiary Grenades

(1) *½-kg incendiary grenade.*—This grenade (fig. 40), approximately 5.3 inches long and weighing 1.1 pounds, may be thrown by hand or projected with the 50-mm grenade discharger, model 89. The incendiary filling (white phosphorus) is contained in a brass

body. An attachment consisting of a propellant and percussion cap is screwed into the base of the grenade for projection with the grenade discharger. When the grenade is thrown by hand, this attachment is removed.

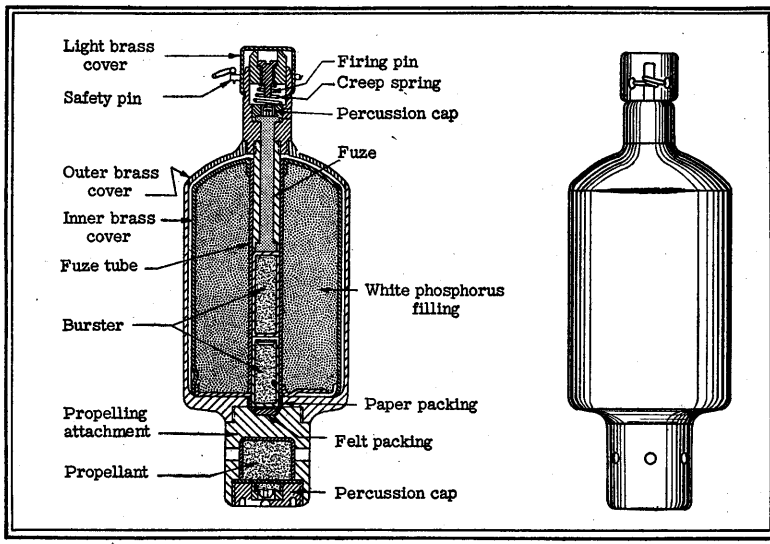


Figure 40.—Japanese ½-kg incendiary grenade.

Before use, a safety pin, which serves the double purpose of holding a light brass cover in place and preventing downward movement of the striker onto the percussion cap, is withdrawn. The striker is then held off the percussion cap by a creep spring, upward movement being prevented by the light brass cover, which is crimped in the middle and engages in a **V** groove cut around the ignition tube.

When used by hand, the head of the ignition tube is given a sharp tap, driving the striker onto the

percussion cap. After a delay of 4 to 5 seconds a delay fuze detonates the burster, scattering the white phosphorus. When used with grenade discharger, the shock of discharge has the same effect as tapping the grenade when thrown by hand.

(2) *Incendiary hand grenade.*—The body of this grenade (fig. 41) has a diameter of 2.2 inches, and its over-all length is 13.5 inches, including the wooden handle 5.3 inches long. Its weight is not given.

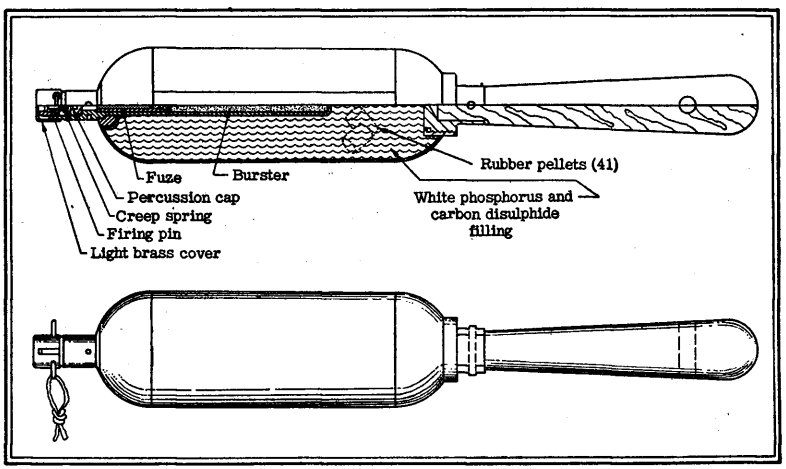


Figure 41.—Japanese incendiary hand grenade.

The incendiary filling of the grenade is composed of phosphorus and carbon disulphide with 41 cylindrical rubber pellets. Upon explosion, these pellets are scattered and bounce about, igniting any inflammable matter with which they may come in contact.

The detonating apparatus for this grenade is similar to that of the ½-kg incendiary grenade previously

described (see (1), above), except that the time fuze is set for 6 seconds.

(3) *Molotov cocktails.*—A number of Molotov cocktail containers were captured in New Guinea. As found, there were 24 empty greenish glass bottles packed in a wooden case. The bottles were of about 1-pint capacity, similar in shape to an ordinary beer bottle, and had a label pasted on their sides giving directions for use.

The bottle cap was of brass with a female-threaded coupling and had a quarter-inch hole in the center. Packed separately at one end of the case were a small wooden funnel and two wooden trays, each containing 12 small aluminum cans 2¼ inches high and 1¼ inches in diameter. The funnels were obviously intended for use in filling the bottles. Each aluminum can contained a small brass burster of a percussion type, consisting of a hemispherical brass head containing a safety pin to which a short piece of string is tied. The lower part of the brass head has a male thread for screwing it in the bottle cap, a rubber gasket, and a brass detonator about 1 inch long and a quarter of an inch in diameter. When assembled, this detonator projects into the bottle. A small firing pin is held away from the detonator.

This weapon is not considered particularly effective, to judge by trials with three of these grenades. The first was exploded by throwing the empty bottle against a coconut tree. The first throw fell in a bush at the foot of the tree and did not cause detonation. The

second throw struck the trunk of the tree, explosion shattering the bottle.

In the second trial the bottle was filled with a 50:50 mixture of gasoline and lubricating oil. Upon striking the tree trunk, the explosion blew the top off the burster, thus failing to break the bottle or ignite its contents.

In the third trial, the bottle was filled with gasoline and thrown about 10 yards. The explosion broke the neck of the bottle, but failed to ignite the gasoline.

h. Gas Cylinders

Little information is available concerning the gas cylinders available for use by Japanese troops. A Russian article, published in July 1936 and confirmed by a French report in 1939, mentions the two following types:

(1) *Heavy.*—The heavy cylinder weighs 50 kg (110 lbs) and contains a mixture of chlorine and phosgene. This cylinder would be used in position warfare only.

(2) *Light.*—The light cylinder weighs 20 kg (44 lbs) and, likewise, contains a mixture of chlorine and phosgene. Groups of these cylinders would be used in mobile warfare against enemy support posts.

i. Gas Mines

The above-mentioned sources report chemical mines of 5 kg (11 lbs), 10 kg (22 lbs), and 20 kg (44 lbs) for contaminating strips of ground just prior to their occupation by the enemy. Mustard gas is thought to be the agent provided.

j. Bulk Contamination

The same sources report portable sprayers and contamination tanks mounted on trucks and trailers.

(1) *Portable sprayers.*—These are of two types, one weighing 20 kg (44 lbs) with a capacity of 10 kg (22 lbs) of chemical, and another weighing 6 kg (13.2 lbs) with a capacity of 4 kg (8.8 lbs) of toxic liquid.

(2) *Bulk contamination vehicles.*—These include a heavy truck equipped with a tank carrying approximately 1 ton of chemical for contaminating a strip about 20 yards wide, and a trailer carrying approximately half a ton of toxic liquid. The trailer would be towed by armored force vehicles, tractors, etc. Both types of vehicles would require compressed air to eject the gas in the form of a spray.

3. AERIAL WEAPONS

a. Spray

Other than a report of an aircraft spray that is spread from leakproof tanks behind the engine cowl, there has been no definite information regarding the design, capacity, or chargings of spray apparatus in use. It is probable, however, that the Japanese would duplicate German apparatus as they do in some other matters pertaining to chemical warfare.

b. Gas Bombs

(5) *50-kg gas bomb, model 92.*—During bombing operations in China the Japanese used upon some occasions a 50-kg (110 lb) gas bomb, filled with a mixture of equal parts by weight of mustard gas and

Lewisite. The chemical filling weighs 23 kg (50.6 lbs). This is reported to be the chief Japanese chemical bomb.

The bomb consists of a steel nose, cylindrical casing, and tail assembly, with an over-all length of 45 inches. The steel body has a wall thickness of three-sixteenths of an inch and is 26.4 inches in length by 7.5 inches in diameter. A cast-steel nose is attached to the body by three quarter-inch grub screws. The sheet iron tail assembly, consisting of four vanes welded to the tail cone, with two sets of box-type struts, is welded to the body.

On impact the nose fuze functions, and the flash from the detonator cap ignites the first detonator to initiate the picric-acid pellet. The main filling in the bomb nose then detonates to shear the grub screws and eject the body of the bomb from the shaft of entry. At the same time, the second striker is forced upward to overcome the creep spring and to pierce and ignite the second detonator, which in turn ignites the booster charge. The detonation of the picric-acid is then initiated in the exploder pocket, fracturing the bomb and spreading the blister gas.

The bomb is grayish green in color with a red and blue band at the nose. There are two yellow bands at opposite ends of the body and a white band in the center.

(2) *Miscellaneous gas bombs.*—Details of a 15-kg (33 lb) combination HE and toxic smoke bomb (possibly of the nose-gas variety) are also reported. The construction and operation of this bomb are similar to that of the 50-kg bas bomb.

A French report (July 1939) mentions 25-, 50-, 100-, and 200-kg gas bombs filled with mustard gas, Lewisite, phosgene, and diphosgene.

c. Incendiary Bombs

(1) *1-kg combination incendiary and antipersonnel bomb.*—This bomb consists of the following parts:

(a) A conical tail portion of aluminum alloy, to which are welded the tail fins.

(b) A cast-iron body, which contains the fuze mechanism, to which the tail portion is fastened by means of bayonet joints.

(c) A rubber hemispherical nose-piece, resembling half a tennis ball.

The bomb has an over-all length of 10.5 inches and is 3 inches in diameter. The tail portion is 4.3 inches long and 3.1 inches wide. The cast-iron portion of the body is painted black, while the tail piece and fins are painted white. Red phosphorus is the main filling, and the burster tube is filled with picric powder.

(2) *50-kg (or 70-kg) incendiary bomb.*—This bomb consists of a cylindrical steel body, to which a cast-steel nose is riveted. A tail cone, with four fins, is riveted to a collar, which fits into the body of the bomb and is held in place by two rows of screws. Inside the body there are four electron (magnesium alloy) inserts filled with thermite.

The bomb is 40 inches long and 7.9 inches in diameter. It weighs 70-kg (156 lbs), including the filling weighing 32 kg (70 lbs). The bomb is painted light gray, with the struts on the tail vanes painted red.

On impact a "97"-model nose fuze fires a magazine, which ignites a length of fuze passing down the center of the bomb. This fuze ignites the electron containers, and a black-powder charge in the nose is exploded, bursting the bomb and scattering the four inserts. Vents in the electrons allow burning thermite to be thrown in the air, increasing the incendiary effect.

Because of its weight, this bomb is sometimes referred to as a 70-kg incendiary. It is also described by the Chinese as a 63-kg incendiary bomb (thermite-filled). No doubt its nomenclature as a 50-kg incendiary results from its use in the 50-kg bomb rack.

(3) *50-kg (or 60-kg) "dual-purpose" incendiary bomb.*—This bomb consists of a 1/8-inch cylindrical steel body, to which is welded the conical-shaped tail piece. Four vanes, braced by 1 3/8-inch box-type struts are welded to the tail piece. A cast-steel nose cap is fitted to the body by three dowel pins. These pins are located in a steel disk welded to the nose and perpendicular to the axis of the bomb. This disk houses the central exploder tube.

The nose cap of the bomb and the exploder tube passing down the length of the bomb are filled with picric acid. The space between the exploder tube and the bomb casing is packed with a large number of cylindrical rubber pellets, 1 1/16 inches in length by 1 inch in diameter, impregnated with phosphorus and suspended in a solution of phosphorus and carbon disulphide.

On explosion, a high fragmentation effect is obtained and the shell fragments have a very low tra-

jectory. The phosphorus-impregnated pellets are scattered as far as 50 yards from the point of impact. The pellets ignite immediately or within 1 or 2 minutes after falling, each pellet giving a flame 4 to 6 inches high and burning at a comparatively low temperature. The pellets burn for 5 to 7 minutes, giving off a gray smoke and smelling slightly of burning rubber. The pellet should not be touched by any part of the body or by inflammable material, and the shell fragments are also dangerous, since they are often coated with phosphorus. The fire can be put out with water, but upon drying out the pellets will rekindle and burn.

The general description and method of operation of this bomb corresponds with data obtained by the British from the examination of incendiary bombs dropped by the Japanese over Rangoon. These bombs were 40 inches long and 7 inches in diameter, with a nose 7¼ inches in diameter and a tail 15 inches long and 9 inches wide. The total weight of the bomb is 60-kg (132 lbs), and it is blue-gray in color with a white band in front of the slinging band and a red band on the nose.

Because of its weight, this bomb is sometimes referred to as a 60-kg incendiary. No doubt its nomenclature as a 50-kg incendiary results from its use in the 50-kg bomb rack.

(4) *60-kg incendiary bomb.*—This bomb consists of a cylindrical steel outer casing enclosing a cylindrical inner casing. The nose of the outer casing is welded to the body, to which a conical-shaped tail unit is secured by 32 screws. Four vanes, braced with box-type struts, are welded to the tailpiece.

The inner casing has a steel central tube filled with thermite through which extends a copper tube containing a length of quick match. This runs to a black powder and thermite charge in the end of the tube. Around the central tube there are six steel compartments filled with paraffin wax mixed with kerosene.

On impact the magazine initiates a black-powder charge, which forces the steel inner casing from the outer casing. Simultaneously, the length of quick match is ignited and initiates the black-powder charge and thermite in the tail of the central tube. The thermite and paraffin wax then burn in a compact mass.

The over-all length of the bomb is 42.5 inches, and it has a diameter of 9.5 inches. It weighs 53 pounds when empty and 132 pounds when filled. It is painted a gray color with a thin red line from the nose to the tail. The tail struts are also painted red.

(5) *Miscellaneous incendiary bombs.*—Incendiary bombs weighing 15 kg (52 lbs), and filled with thermite or white phosphorus have been reported. The bursting charge of these bombs is said to be black powder.

The British Navy reports that the Japanese have dropped by parachute incendiary bombs, with a delayed action up to 12 hours. The bombs were 42 inches long and 6 inches in diameter and were painted black with a small red band 6 inches from the nose.

Over Corregidor the Japanese are said to have used a new type of bomb, which burst with a huge flame. Two of these bombs, dropped on 3 April 1942, exploded

about 500 feet above the ground. A few bombs of this type were also observed at Chungking in 1941.

4. FLAME-THROWERS

a. General

A Japanese pamphlet, entitled *Use and Effectiveness of Flame-Throwers,* confirms the existence of two types of portable flame-throwers previously reported and mentions a fixed flame-thrower operated from behind earthworks 50 feet high. The pamphlet likewise mentions a small flame-thrower, model 95, and a flame-thrower, model SS, but gives no details of these weapons. Included in the pamphlet is a table showing the proportions of gasoline, crude oil, and kerosene to be used as fuel. These proportions vary according to the weather and the objective.

b. Portable

(1) *No. 1.*—This portable flame-thrower, carried on the back of one man, has a capacity of 14 liters (3.7 gallons) of fuel and weighs 31 kg (68 lbs). It will throw a flame a maximum distance of 30 yards and has a duration period of 10 seconds.

Figure 42 shows the details of a Japanese portable flame-thrower captured by American forces in Bataan. The weapon, which appears to be model No. 1, is of excellent design and construction, although considerably heavier than the corresponding U. S. type. The valve of the gun is awkward to operate. The mechanism for positive ignition is a distinct advantage. A desirable feature is that the flame-thrower operator

can operate the valve of the pressure cylinder, but the Japanese method of doing this by means of a flexible shaft is considered undesirable, as the shaft is heavy and easily kinks.

(a) *Pressure tank.*—The pressure tank (capacity, 350 cubic inches) is 6 inches in diameter and has an over-all length (with valve) of 16 inches. It has

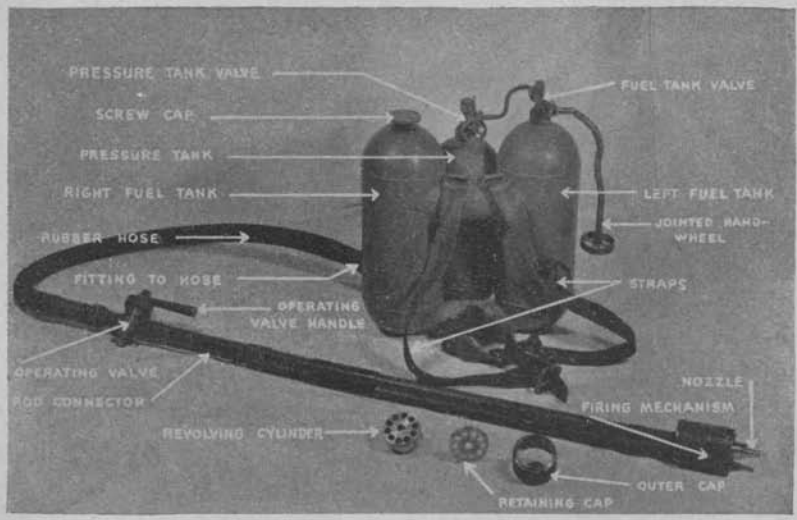


Figure 42.—Japanese portable flame-thrower.

welded joints and is of light construction. To work properly, it should have an initial pressure of 300 to 400 pounds per square inch. It is fitted with small couplings to secure it to the two fuel tanks. In the aperture at the top is fitted a handwheel-operated needle valve. Copper tubing connects the pressure tank to the left-hand fuel tank. The pressure tank is filled with compressed nitrogen.

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(b) *Fuel tanks.*—The two fuel tanks are of the same diameter as the pressure tank, but, being taller, have 25 percent greater capacity. The tanks are connected by two welded tubes, one near the top and the other near the bottom. These act as pressure and fuel channels and as joints. As mentioned above, the left-hand tank is joined to the pressure tank by copper tubing. This tubing is connected to a needle valve, of which the operating handwheel is on a flexible shaft 1 foot long that comes over the shoulder of the operator. The right-hand tank is fitted on top with a 1-inch filling cap. About two-thirds of the way down its right side is the hose connection. An interior tube insures emptying the tanks. The lower connecting tube, or channel, allows the fuel in the left tank to empty out. The upper channel insures an equal pressure on both tanks regardless of the position of the tanks or the amount of fuel remaining in each.

(c) *Connecting rubber hose.*—The hose which connects the nozzle to the fuel tanks is made of 1½-inch reinforced fabricated-rubber tubing. It is 45 inches long and has brass fittings on both ends.

(d) *Fuel-nozzle and ignition mechanism.*—The fuel-nozzle and ignition mechanism has an over-all length of 47 inches. At the hose end, the tube is 1 inch in diameter and tapers down at the nozzle end (where it passes through the ignition mechanism) to a quarter of an inch. The ignition mechanism depends on the firing of a 43-caliber blank cartridge into the stream of fuel. The nozzle, fitted in a 2½ by 5-inch cylinder, contains the firing mechanism. Within the perimeter of the cylinder are ten .43-inch caliber holes

to hold the blank cartridges. The cylinder revolves on a cam operated on each stroke of the firing handle. The firing handle is on the handle end of the nozzle, and is connected to the firing mechanism by a metal shaft. When the firing handle is turned, it performs a two-fold function: it fires the blank cartridge under the firing pin, and at the same time closes off the fuel by shutting off the valve in the handle. This action prevents the flame from reaching the tanks in case of a flareback.

(e) *Operation.*—The leather straps which enable the apparatus to be strapped on the operator are fixed to the two connecting tubes of the fuel tanks. The tanks are filled with coal tar, thinned down with hydrocarbons, and then a filled pressure tank is attached. The operator opens the pressure-tank valve, thus putting pressure on the fuel-tank valve. The apparatus is strapped on with the fuel-tank valve handwheel and shaft carried over the left shoulder, and the hose and nozzle under the right arm. The operator releases the fuel by turning the handwheel of the fuel valve. The stream of fuel is played on the target, and then the firing handle is turned, firing one cartridge, which ignites the fuel. It is estimated that the flame-thrower has a range of about 30 yards. It is capable of firing a continuous jet of fuel for 10 to 12 seconds.

(2) *No. 2.*—This weapon has a fuel capacity of 40 liters (10.5 gallons) and weighs 82 kg (178 lbs). A maximum range of 50 yards and an emission period of 12 seconds are claimed.

c. Flame-Thrower Tanks

It is reported that the Japanese moved flame-thrower tanks to Saigon during the first month of the Malayan campaign. The only tank reported to be equipped with a flame-thrower is the Ishi 108. This is said to weigh 38 tons and to be armed with a flame-thrower, two machine guns, and two 37-mm guns.

Section IV. DEFENSIVE EQUIPMENT

1. GAS MASKS

Various types of Japanese gas masks have been captured and examined by U. S. forces as well as by the British and Chinese. While some of these masks differ in detail, their general characteristics are the same.

a. 1938 and 1939 Models

Two gas masks captured in New Guinea were manufactured in 1938 and 1939, respectively, according to the characters stamped on the canisters. (For the 1939 model, see fig. 43). Their flat moulded facepieces of

Figure 43.—Japanese military gas mask, 1939 model.

rubber-covered stockinette are gray-green in color and weigh 13.5 ounces. The eyepieces, circular in shape, are made of laminated glass and are spread 3 inches apart (center to center) with an opening 2⅛ inches in diameter. These eyepieces are held in rubber rings which fit into stamped-tin eye rings. The eye rings in turn screw into roll-threaded metal rings, which are wired to the facepiece, and may be removed by hand.

The inlet and outlet valves are carried in the same cast-metal housing with a connecting piece. The inlet valve consists of a thin metal disk encased in a thin rubber sheet, which is sealed in the inlet housing. The outlet valve consists of a small rubber diaphragm fitted on a metal seating and protected by a perforated metal cover, hinged at one side and secured with a spring catch.

The head harness is constructed of six gray-green head straps. Half of each strap is of webbing and half is of three-ribbed rubber band covered with fabric. The head pad is of the same material as the facepiece.

The hose, 12½ inches long and weighing 4½ ounces, is made of corrugated rubber stockinette and is gray-green in color. It has an opening 1⅜ inches in diameter and is fastened to the canister with a ring clamp fitted with a wing-nut-type thumbscrew.

The oval-shaped canister is 6 inches high, 5 inches wide, and 2¾ inches deep. It weighs 1 pound 9½ ounces and is filled with a mixture of activated charcoal and soda-lime (or hopcalite). A ¾-inch inlet hole in the bottom of the canister is covered with a perforated metal screen. A rubber stopper to close the air

inlet was provided for the 1939 model, but none was found with the 1938 model.[5]

A concertina-type filter with seven wings furnishes particulate protection. Construction details of the filter are lacking, but usually it is made of cotton impregnated with asbestos and, contrary to usual practice, is located above the charcoal and soda-lime mixture.

b. Model 93, No. 2 (Navy Type)

A gas mask of this type was carried by a member of a naval landing party in New Guinea.

A khaki-colored haversack, with shoulder sling and metal buckle, is provided for the facepiece only, the canister being carried on the back. An inside pocket in the haversack carries a small folded square of cheesecloth and an antidim stick in a small tin cylinder. A metal plug to prevent absorption of moisture is provided for the air inlet opening of the canister. An auxiliary canister may be attached to the base of the main canister to give protection against carbon monoxide (up to 3 percent concentration) for 40 to 50 minutes.

c. Model 93, No. 3 (Navy Type)

The facepiece of this gas mask differs from earlier models in that the eyepieces are larger and non-

[5] The filling of a canister captured in the Philippines appeared to contain no soda-lime in the charcoal. This, coupled with the directions to close the air inlet with a rubber stopper when not in use, indicates that the principle of the canister is not wholly that of absorption, but rather of a small amount of absorption and a large amount of chemical reaction with charcoal highly impregnated with chemicals.

circular, and in that the outlet valve is placed in front instead of beneath the base connection. The head harness consists of five elastic bands adjusted by buckle and tab. The hose, 18 inches long, is wired to the valve assembly and is screwed onto the canister.

The canister, while similar in external appearance to earlier types, has a concertina-type filter of wood pulp, instead of cotton asbestos, and is placed below instead of above the absorbent. The latter weighs 10⅓ ounces and consists of a mixture of extruded charcoal (64 percent), granular charcoal (20 percent), and soda-lime granules (16 percent). About halfway through the filling there is a rubber-edged baffle ring, projecting inwards, which presumably will reduce channeling at the edges. A rubber plug is provided for the air-inlet opening of the canister.

This model is also provided with an auxiliary carbon-monoxide canister, which is interchangeable with those provided for the No. 2 model. Both the No. 2 model and the No. 3 model are originally packed in fiber satchels painted dark gray, and are 12 inches wide, 9 inches deep, and 4½ inches high. These satchels are neither gas nor waterproof, and appear to be for storage or shipboard protection only.

d. Accessories

The haversacks for some models are provided with a packet of celluloid lenses, a can of antifreeze liquid, and a piece of cotton waste. In addition, a cloth bag attached to the carrying straps contains a can of antiblister gas powder and a strip of cotton wool.

The spare lenses, five in number, are carried in a container of thin black plastic material and are wrapped separately in paper tissue. They are 2⅛ inches in diameter and 0.014 inch thick. Instructions on the container state that the lenses are to be used when the temperature is below the freezing point.

Instructions on the can of antifreeze liquid state that it is to be applied to the inlet valve of the gas mask when the temperature is below the freezing point. It is also stated that application of the liquid to the inner surfaces of the eyepieces will stop fogging to a certain extent.

2. GAS DETECTORS

a. Blister-Gas Detection Satchel

This is a square satchel, 6 inches by 6 inches, closed by a flap and press stud, with a strap for carrying over the shoulder. The contents consist of detector papers, a small box containing calcium hypochlorite, a box containing 16 ampoules of detector "grains," and a supply of small flags for marking contaminated areas.

The calcium hypochlorite is said to react violently with mustard gas, producing sparks. The nature of the white grains is not known, but is probably similar to the German detector powders, in which a dyestuff is mixed with an inert substance such as silica or chalk. The white grains are said to turn red on contact with mustard gas. The detector paper turns yellow under similar conditions.

The satchel appears to be unit equipment and is probably issued to the unit gas officer.

b. Chemical Testing Outfit

This equipment is used to test for the presence of gases in water and on solid materials. The case is 8 inches by 6 inches by 2½ inches in size and is provided with a leather carrying strap. The contents are reported to be as follows:

(1) Test-tube box with three test tubes.

(2) Solvent agent container (with contents).

(3) Paper box containing 100 pieces of No. 1 detector paper.

(4) Testing solution box containing A, B, and C testing solutions and heater.

(5) Box containing 30 filters.

(6) Box with five lots of compressed cotton.

When testing water, the presence of mustard gas is shown by the detector paper turning brown. A white precipitate is formed by solution B if Lewisite is present.

To test for the presence of gas in solids, the suspected materials are treated with a solvent, and the solution after filtration is tested by adding the liquid reagents. For mustard gas, solution A is added, and for Lewisite, solution C is used. In both cases a red purple color is produced if contamination is present.

c. Carbon-Monoxide Testing Device

This detector is almost certainly of the "Hoolamite" type, detection depending upon the liberation of iodine by the action of carbon monoxide on iodine pentoxide and its combination with sulfur trioxide to give an unstable green-blue color.

Two test-tube cases contain a total of 36 test tubes. The air to be tested is forced through a layer of activated charcoal by means of a rubber bulb. In this way any gas which might interfere with the detection of carbon monoxide is removed. The air then enters the test tube, alongside which is a comparison tube giving the colorations produced by 1, 0.5, 0.3, 0.2, 0.1, and 0.05 percent of carbon monoxide.

The chief disadvantage of this type of detector is that a concentration of carbon monoxide below 1:2,000, while still lethal, cannot be detected.

3. GAS ALARMS

According to the Chinese, the Japanese have an efficient hand-operated gas alarm. It consists of a centrifugal siren, operated by turning the crank handle with the right hand and gripping the lower handle with the left hand, while pressing the thumb against the sound aperture. By varying the pressure with the thumb, the sound is made to rise and fall in pitch.

The handles fold up and the alarm can then be carried by a leather strap on the back. When opened up for use, the alarm stands only 10 inches in height.

4. PROTECTIVE CLOTHING

a. General

A sample outfit of Japanese protective clothing was examined by the British in 1939. It consisted of a jacket (with hood attached), trousers, boots, and gloves. The jacket and trousers were made of light, double-rubberized fabric, and the boots are of heavy,

single-proofed rubberized fabric, with thick rubber soles and heels. The gloves were of rubber without basic fabric.

The suit was found to have relatively low efficiency against mustard gas and Lewisite, while the gloves and boots had a high efficiency because of their very heavy proofing.

b. Antigas Bag, Model 96

The Chinese report a rubberized-silk antigas bag, containing trousers and a pair of gloves, with a total weight of 2 pounds 2.6 ounces. The trousers are made of rubberized silk, reinforced at the crotch and behind the knees, and provided with binding straps at the knees and ankles. They weigh 1 pound 8.7 ounces. The gloves are of silk, rubberized on the inside.

5. COLLECTIVE PROTECTION

No detailed information has been received concerning the methods of collective protection practiced by the Japanese Army, either in regard to design of gas-proof shelters in the field or to the provision of ventilating or air-conditioning apparatus. Indications are that the methods are generally similar to those practiced by the European Powers.

6. DECONTAMINATION

a. Personal Decontamination

(1) *Personal decontamination kit.*—This kit (fig. 44) is intended for use by the individual soldier in destroying liquid vesicants that may have come in con-

tact with his skin. The package consists of a carrying bag, or pouch, a can of decontaminating agent, and a roll of absorbent cotton.

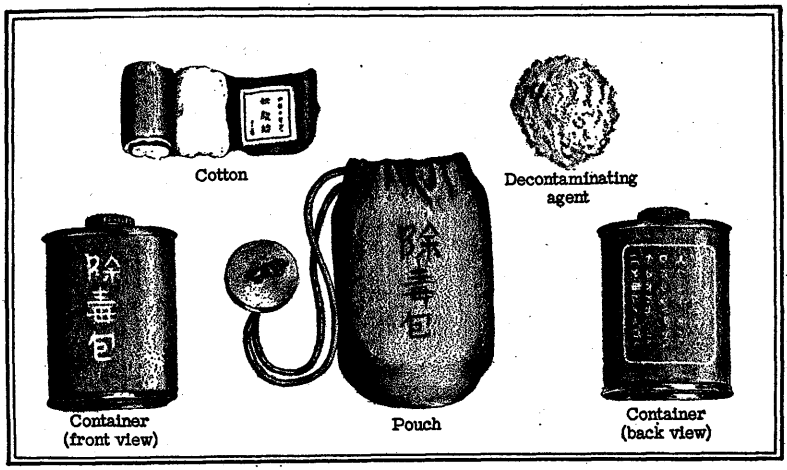

Figure 44.—Japanese personal decontamination kit.

The decontaminating agent has been identified as 17.8 percent sodium beta naphthalene sulfonchloramide and 82.2 percent clay. The active chlorine is 2.66 percent on a bone-dry basis. The active agent is apparently rather stable, as no corrosion was evident on the particular metal can examined.

Decontamination is accomplished by mixing the agent with water and applying it wet to the skin with absorbent cotton. Approximately 45 grams (1.6 oz) of the decontaminating agent and 2.5 grams (.09 oz) of the absorbent cotton are supplied.

The can is of metal with a screw top and measures 3.1 by 2.3 by 1.2 inches. The carrying bag is of cloth, with cloth tie-strings and a fiber fob. The en-

tire package weighs 95 grams (3.3 oz). The translation of the inscription on the front of the bag and can is "Decontamination Kit," while the label on the reverse side of the can gives instructions for use.

(2) *Bleaching-powder pouch (or wallet).*—The bleaching-powder pouch, weighing about 1.9 ounces, is made of a rubberized fabric and utilizes a fabric-covered, rubber tie-string and a rubberized-fabric carrying strap. It measures 11.75 by 7.1 inches and has a pocket 5 inches deep on one side to hold four pieces of cotton gauze.

The pouch holds approximately 5 ounces of bleaching powder, presumably for use in the decontamination of articles of individual equipment, and is carried in the gas-mask carrier.

The pouch is believed to be filled from the bleaching-powder carton, containing approximately 11 pounds of bleaching powder, which is unit equipment. This carton is constructed of cardboard shell, coated with tar inside and a rubber solution outside, and is provided with a carrying loop. The powder carried in the carton was found on analysis to contain 22.6 percent available chlorine.

(3) *Gas treatment haversack.*—This appears to be a new article of equipment. No specimens have come to light, and the only information available is found in a Japanese document. The contents are rather vaguely described as being rubber gloves, bleaching powder, zinc ointment, sodium bicarbonate tablets, gauze for treating the eyes, an antidote to sternutators, and a "lotion."

(4) *Antisneeze liquid.*—In addition to the personal decontamination kit previously described, the Chinese report that each Japanese officer and enlisted man carries a box containing 10 tubes of an antisneezing liquid wrapped in cotton wool. These tubes, containing 0.5 cc of liquid, are bulged at each end and thinned in the middle (dumbbell-shaped) so that they may be broken easily. The contents are stated to have the following composition:

Alcohol	40 percent.
Chloroform	20 percent.
Ether	20 percent.
Ammonia	50 drops.

It has not been possible to confirm the existence of this equipment.

b. Ground Decontamination

Ground decontamination is reported to be effected by means of chloride of lime spread by hand and by motorized equipment. The vehicle employed is said to carry approximately 1,100 pounds of the decontaminant, which the apparatus will spread over a path about 5 yards wide. It is possible that the vehicle is similar to the Italian six-wheeled cross-country truck (*autodovunque*) (cf. p. 60, part II, sec. III, par. **2e** (4), above), which is fitted with a hopper of 1,100 pounds capacity that spreads its contents over an area approximately 5 yards wide and 55 yards long.

It is also stated that the Japanese recommend the use of fresh earth, straw, twigs, or boards, or the use of straw mats soaked with linseed or soya oil with an

admixture of glycerine, for covering contaminated areas that must be traversed.

c. Decontamination of Clothing and Personnel

The Japanese have cleansing and decontamination units with motor vehicles carrying water tanks, a steam decontamination plant, boilers, and equipment. In 1938 a German military observer reported that these units had reached a high state of efficiency.

Section V. CIVILIAN PROTECTION

The Antiaircraft Defense Association (*Bokukyokai*) is a local and voluntary organization having branches in every area. Working under government control, it is responsible for the education and instruction of the public, including the warden personnel, in methods of defense against air attack.

An article published in a Tokyo newspaper during August 1941 quoted a high-ranking army officer as stating that the solidarity of the nation under air attack is founded on the "Neighbor-Group Air Defense," made up of groups of 11 families, which were to provide their own fire-fighting equipment. This officer stated that at that time nothing was to be feared from the use of gas during the bombardment of cities from the air, but recommended that every person equip himself with a gas mask.

A British official report from Tokyo in September 1941 expressed the opinion that Japanese air defense arrangements were then quite inadequate, although efforts for improvement were being made. As regards shelters and gas-defense training, the standard was said to be low. As late as 26 March 1942, the Ministry of the Interior decree that all new buildings in Japan's 543 larger towns must have air raid shelters.

The position of the Citizen's Gas-Mask Association in the civilian defense organization is not clear, but a civilian gas mask is marked as being for use by this

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association. This mask, carried in a thin canvas haversack, is of the snout type with a facepiece similar to the Japanese service mask, but smaller in size and with a five-strap head-harness. According to a German broadcast on 23 March 1942, the Japanese government commenced distributing gas masks throughout the nation. It was intended that every household should receive one in order that they might become familiar with its use, the cost being assessed against those individuals able to pay, while part of the cost to the poor was absorbed by the State.

Appendix. AREA SMOKE SCREENING

1. GERMANY

Numerous reports indicate that the Germans have found the use of smoke screens at night of considerable protective value against enemy bombing attack. This has been particularly true of the coastal areas, where unscreened coast lines offer a ready means of calculating distances accurately. In inland areas, where targets are not so easily located, smoke screens are generally limited to the protection of precision targets of prime importance. However, there are indications that several of the larger inland cities are thus protected. Also, decoy smoke screens have been effectively employed upon a number of occasions to protect nearby targets.

Relatively few instances of daylight screening have been reported to date,[1] and on the whole the practice has not proved particularly effective. However, with the increasing frequency of daylight raids over the Continent, it is to be expected that the Germans will take steps to protect vital target areas with efficient smoke screens both day and night.

Aerial observers have reported extensive use of smoke by the Germans for screening—

[1] Emden was screened on 14 May 1943 during a daylight attack by U. S. bombers.

(1) Battleships, docks, and naval installations.
(2) Oil refineries and storage.
(3) Important blast furnaces, factories, and buildings.
(4) Canals and harbors.

The most exact knowledge of large-scale smoke operations comes from Brest, where several large German battleships and cruisers were successfully protected from enemy bombing over a very considerable period of time. A screen was put up immediately upon the sounding of an air-raid warning, and within 20 minutes the docks and town were completely enveloped in smoke. It is reported that the screen was so dense that visibility on the ground extended for only a few yards.

The generators appear to have been of the type of smoke generator 41, consisting of a 40- to 55-gallon steel drum fitted externally with a stopcock and a steel projection tube. The drum contains 20 gallons of a chlorsulfonic acid and sulfur trioxide smoke mixture, which is expelled by means of a cylinder of compressed air contained within the generator drum. Alongside of the generator a similar drum of smoke acid was provided for recharging. By this means a smoke screen could be maintained at full strength for 2 hours. The smoke is described as issuing from the generator in the form of a liquid which immediately vaporizes. It has the color of tobacco smoke and is said to be almost odorless and harmless, except in the irritation caused to the throat.

The generators were scattered around Brest and its suburbs and along the docks and breakwaters, either in groups or at intervals of roughly 75 yards. Addi-

tional smoke was provided by about 20 small fishing craft (of 10 to 12 tons), each provided with a smoke generator. These boats were moored during the day at the end of a jetty and at dusk were anchored in crescent formation in the harbor 1 or 2 miles from shore.

While practically all reports describe the smoke acid as composed of a mixture of chlorsulfonic acid and sulfur trioxide, one report mentions the use of a "weak mixture of titanium tetrachloride and ammonia." It it believed that the Germans have overcome the clogging difficulties formerly experienced with titanium tetrachloride when used in spray generators, and it is known that ammonia increases the density of the smoke.

Industrial and dock areas in Bremen are reported to be protected by smoke generators consisting of two drums, each containing 50 to 80 gallons of smoke acid, and a gas bottle believed to contain compressed air connected by pipes to the drums. The smoke acid is stated to be a mixture of equal parts of chlorsulfonic acid and sulfur trioxide, producing a white to light-gray smoke. The generators are said to be installed at intervals of 50 to 100 yards, together with large containers, presumably for refilling.

It seems quite likely that smoke-screen operations in German-controlled coastal areas are aided by minesweepers (**R**-boats), which are reported to be fitted with smoke generators using chlorsulfonic acid and/or oleum. Also, German **E**-boats doubtless contribute to these operations. In addition to carrying two of the smaller smoke apparatuses (smoke generator 41) aft, one on each side, they are equipped with French smoke

floats. The latter apparatus, weighing 40 kg (88 lbs) contains 32 kg (70.4 lbs) of Berger-type smoke mixture,[2] which burns for periods variously estimated at from 8 to 14 minutes.

The Germans are also reported to be using the Finnish "Torsa" model smoke generator in some areas where dry climates reduce the effectiveness of their standard generators. With this apparatus a mixture of chlorsulfonic acid (40 percent) and sulfur trioxide (60 percent) is discharged by pressure from a pump through a specially designed nozzle, while a spray of water is ejected from another nozzle set at 180 degrees to the chlorsulfonic-acid nozzle so that the two jets meet from opposite directions. The consumption is stated to be 33 pounds of smoke acid and 1.85 gallons of water per minute.

Aerial photographs showing smoke screens in Norwegian fiords are evidence of the increasing effectiveness of this method of protecting primary targets. There is reason to believe, however, that development has not reached the point where desired results can be obtained irrespective of wind direction. While German warships shown in these photographs were not completely obscured by smoke, the protection afforded appears to have been considerable and would hamper raiding aircraft to a marked degree.

Reports concerning the materials and equipment employed in screening Norwegian coastal areas are less specific. According to an unverified report, smoke-producing liquid is stored in 40- to 55-gallon

[2] See p. 19, note 5, above.

drums in the holds of fishing vessels. This liquid, when poured into the water, takes the paint off the sides of the boats and causes the putty around their portholes to flake and drop off. A heavy grayish smoke develops, which clings to the water and spreads gradually upward as the concentration increases. On one occasion, a half hour elapsed before complete protection was afforded. This source reports, however, that smoke became effective over a limited dock area in a specific German port in only 5 minutes.

Another unverified report states that the main part of a smoke screen employed in a certain area in Norway was produced by 20 small fishing boats, each manned by 3 or 4 men, whose operations were supplemented by 3 land-based crews. The smoke here was more irritating to the nose and throat than the harmless, odorless smoke produced at Brest. It is said to have incapacitated men working in the vicinity, although cattle in adjoining fields apparently were not seriously affected. According to a Norwegian source, the Germans appeared reluctant to start smoke screens except when a major attack was imminent. The reason for this was not known, although it is suggested that the cost of the operations may be a factor.

Certain German cities are reported to be protected by extensive smoke-screen systems. RAF pilots have reported dark gray smoke screens over Berlin 20 to 30 miles long and 2 miles wide. The very dense smoke appeared to have come from generators 20 yards apart.[3]

[3] Seventy-five-yard intervals appear to be the more normal spacing.

It is reported from Kiel that a screen of gray-brown smoke covering the entire city is produced from the exhausts of automobiles dashing through the streets whenever there is danger of an air raid.

Before the war, the question of pipe-line installations with jets at suitable intervals was discussed in German technical literature. There have been indications of the use of this system to screen certain factories in Germany, such as the Krupp works near Essen. Reports from Greece indicate that a pipe line for smoke screens runs the entire length (4 miles) of the Corinth canal.

A number of smoke floats captured at Benghazi early in 1942 weigh 42 pounds when empty and 83 pounds when filled. The are 32 inches high and 12¾ inches in diameter.

The float consists of a chemical storage vessel arranged inside a drum-shaped buoyancy chamber. A pipe, open at the bottom and closed by a valve at the top, admits water to the chemical container. The valve is operated by a spindle extending to the top of the float.

When smoke is required, the valve spindle is withdrawn and the float lowered into the water. Water entering through the inlet pipe reacts with the chemical filling, thought to be sulfur trioxide, and smoke is emitted through an outlet pipe at the top of the float.

The floats were tried out and gave a good smoke cloud, but it is believed that difficulties due to corrosion may be encountered.

2. ITALY

Reports indicate the use by the Italians of chlorsulfonic acid smoke apparatus operated by air pressure for screening Genoa against air attack. The generators are said to consist of pairs of 220-liter (58-gallon) drums lying on their sides, end to end. One of each pair is fitted with a stopcock on the top side, and the other drum constitutes a reserve supply. The generators are dispersed around the harbor at intervals of about 150 yards.

There is also evidence that the Italians have developed a large smoke generator employing a sulfur-pitch mixture for screening Genoa. Upon ignition, this mixture is reported to give off a dense smoke that is irritating to the eyes and necessitates breathing through a handkerchief by persons in the vicinity.

Prior to the capture of Tripoli, on a number of occasions the RAF reported the existence of very effective smoke screens. The smoke-producing apparatus has now been examined and found to consist of a standard 60-gallon drum, filled with chlorsulfonic acid, a cylinder of compressed air, valves, gauges, and two jets. The drum was painted black and usually marked *nebbia* (smoke—literally "mist").

In this case the Italians have developed a simple, but effective, pressure system which can be attached to any of the drums. Only a few completely fitted drums were discovered, but around the whole harbor and suitably spaced to cover all wind directions were found approximately 600 drums, probably all full. From Italian documents it is learned that each post consisted

of 6 barrels and 2 spraying systems, and that the responsibility for operating the system rested with a chemical company.

3. JAPAN

A smoke-screening device for protecting the Hozan Naval Radio Station in South Formosa has been reported, but no details are available. In 1931, there was an unsubstantiated report in a Japanese newspaper that the Yawata Ironworks had succeeded in producing from "anthracine residues" a smoke-forming mixture capable of forming a screen which could effectively mask big factories from the air.

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WAR GAS COMPARISON CHART

Common name	Chemical name	Formula	Physiological classification	Odor	Tactical class	Symbols, names, and shell markings of—				
						German	French [1]	Italian	Japanese	United States [2]
Adamsite	Diphenylaminechlorarsine	$NH(C_6H_4)_2AsCl$	Sternutator	Faint aromatic	Harassing	Adamsit 1 white band	1 white band	Yellow body, red nose.	Adamusaito 1 red band	DM 1 red band.
Arsine	Arsine	AsH_3	Systemic poison	Faint phosphorus	Casualty	1 green band		Yellow body, red nose.	Arushin 1 blue band	SA
Bromacetone	Bromacetone	CH_3COCH_2Br	Lacrimator	Old leaves—bitter	Harassing	B-Stoff	Martonite *or No. 9*			BA 2 green bands.
Brombenzylcyanide	Brombenzylcyanide	$C_6H_5CHBrCN$	Lacrimator	Sour or bitter sweet	Harassing	T-Stoff 1 white band	Camite *or No. 21*		Buromushian-benjiru. 1 green band	BBC
Benzyl bromide	Benzyl bromide	$C_6H_5CH_2Br$	Lacrimator	Aromatic—watercress	Harassing	T-Stoff	Cyclite *or No. 14*		Buromubenjiru.	
Cyanogen bromide	Cyanogen bromide	CNBr	Lacrimator	Piquant—bitter	Casualty	Ce-Stoff			Buromushian	
Chloracetophenone	Alpha-chloracetophenone	$C_6H_5COCH_2Cl$	Lacrimator	Apple blossoms	Harassing	T-Stoff 1 white band		Clorocetafenone. Yellow body, 1 white band.	Kuroruasetofuenon. 1 green band	CN
Chlorine	Chlorine	Cl_2	Lung irritant	Bleaching powder	Casualty	Chlor 1 green band	Bertholite		Enso	Cl 1 green band.
Chlorpicrin	Trichloronitromethane	CCl_3NO_2	Lung irritant	Fly paper	Casualty	Klop 1 green band	Aquinite	Cloropicrina	Kurorupikurin 1 yellow band (?)	PS 1 red band.
Diphenylchlorarsine	Diphenylchlorarsine	$(C_6H_5)_2AsCl$	Sternutator	Shoe polish	Harassing	Clark I 1 blue band	Rationite *or No. 16* 1 white band.	Difenilclorarsina. Yellow body, red nose.	Jifuenirukuroruarushin. 1 red band	DA 1 red band.
Diphenylcyanarsine	Diphenylcyanarsine	$(C_6H_5)_2AsCN$	Sternutator	Bitter almonds	Harassing	Clark II *or* Cyan Clark. 2 blue bands	1 white band	Red nose	Jifuenirushianarushin. 1 red band	DC 1 red band.
Diphosgene	Trichlormethylchloroformate	$ClCOOCCl_3$	Lung irritant	Musty hay	Casualty	Perstoff *or* K-Stoff. 2 green bands	Surpalite	Difosgene	Jihosugen 1 yellow band (?)	DP 2 green bands.
Ethyliodoacetate	Ethyliodoacetate	$CH_2ICOOC_2H_5$	Lacrimator	Pear juice	Harassing	Jodessigester				
Ethyldichlorarsine	Dichlorethylarsine	$C_2H_5AsCl_2$	Vesicant and lung irritant	Biting—fruity	Casualty	Dick 3 green bands		1 green band		ED 2 green bands.
Hydrocyanic acid	Hydrocyanic acid	HCN	Systemic poison (paralyzant)	Bitter almonds	Casualty	Blausäure 1 green band	Vincennite *or* Manganite.	1 red band	Seisan 1 brown band	AC
Lewisite	Chlorvinyldichlorarsine	$ClCH{:}CHAsCl_2$	Vesicant	Geraniums	Casualty			Lewisite	Ruisaito 1 white and 2 yellow bands.	L 2 green bands.
Lewisite and mustard			Vesicant		Casualty	Winterlost			1 white and 2 yellow bands.	HL 2 green bands.
Methyldichlorarsine	Dichloromethylarsine	CH_3AsCl_2	Vesicant and lung irritant		Casualty	Mothyl Dick 1 yellow band				MD
Mustard	Dichlorethyl sulphide	$(ClCH_2CH_2)_2S$	Vesicant	Garlic—onion	Casualty	Lost *or* Senf 2 yellow bands	Yperite *or No. 20*	Iprite Yellow body, 1 green band.	Masutado *or* Iperitto. 1 white and 2 yellow bands.	H 2 green bands.
Nitrogen mustards			Vesicant	Faint fish—soft soap	Casualty	Stickstoffiost 1 yellow band				HN
Phenyldichlorarsine	Phenyldichlorarsine	$C_6H_5AsCl_2$	Vesicant and lung irritant	Bitter almonds	Casualty	Pfiffikus 1 white band	Sternite *or No. 22*	Fenildiclorarsina.		PD
Phosgene	Carbonyl chloride	$COCl_2$	Lung irritant	Musty hay	Casualty	D-Stoff 1 green band	Collongite *or No. 5*	Fosgene Yellow body, 1 white band.	Hosugen 1 yellow band	CG 1 green band.
Xylyl bromide	Xylyl bromide	$CH_3C_6H_4CH_2Br$	Lacrimator	Pungent—lilacs	Harassing	T-Stoff 1 green band				

[1] French war gases are listed here, because the Axis armies may use quantities of these gases which have been captured.
[2] U. S. gases are listed for purposes of comparison.

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