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DEFENSE AGAINST GAS

I. GENERAL CONSIDERATIONS.

1. The following notes have been prepared for the guidance of officers when giving instruction on Gas Defense. Such information on the offensive use of gas as can be published is issued by the Chemical Warfare Service in another pamphlet, in bulletins and by the General Staff in books on Artillery Firing, etc.

2. Gas is one of the most important weapons of modern warfare. This is due to the insidious and poisonous effects of even extremely small quantities, and the fact that large areas can be made dangerous by its use. These characteristics of gas make necessary a system of defense against it at once wide in its scope and continuous in its action.

3. There is on the other hand no type of enemy warfare which can be as successfully resisted as gas. Against well-disciplined troops, some of the most violent gas bombardments have failed to secure a single casualty, though any laxity is sure to result in more or less serious losses.

4. It is the duty of commanding officers to familiarize themselves with the nature of gas, and the means of defense against it. Our protective appliances are constantly being improved as gas warfare develops, and when rightly used, they give very complete protection against all forms of gas.

5. In warfare, any substance which is used for its poisonous or irritating effect may be called a gas, regardless of whether it is a "true gas," a mist of fine drops, a cloud of poisonous dust, an ordinary liquid, or a solid.

6. There are two groups of warfare gasses. The first group, of which chlorine is an example, consists of substances that are true gases under ordinary conditions and form gas clouds immediately upon opening the container in which they are stored. Those of the second group, typified by mustard gas, form vapors only very slowly unless scattered by shell explosion or warmed by the heat of the sun. *Even an extremely small amount of certain gases if breathed sufficiently long, will cause a casualty.*

7. A man some distance from a shell hole containing poisonous liquid may become a casualty through inhaling the vapor or by its condensation on his body, even if no shell have fallen for several hours. It is important that this be explained so that the men may appreciate the danger of gas, and at the same time realize that there is nothing mysterious or supernatural about it.

8. In order to cut down gas casualties to the absolute minimum, the following measures must be taken:

(a) Thorough training and drill of troops in the use of protective appliances so that they can adjust them accurately under all conditions and perform all duties while wearing them.

(b) Frequent and rigid inspection of all protective equipment.

(c) Absolute obedience to regulations in regard to carrying the respirator in danger and alert zones.

(d) Training all troops to recognize gas attacks.

(e) Installation of adequate gas alarms and instruction of sentries in their use.

(f) Teaching all officers and gas N.C.O.'s the properties of enemy gases, proper methods of defense against them, and action to be taken in situations likely to arise.

(g) Practice in wearing respirators for long periods.

(h) Wearing respirators as long as gas is present.

Danger from gas can be greatly reduced by these means, and officers should impress this fact on their men. *Excessive casualties from gas attacks indicate laxity or ignorance on the part of officers.*

II. GAS ATTACKS.

GENERAL.

9. The enemy employs gas for two purposes:

(a) To inflict casualties. For this purpose he relies upon surprise, and upon taking advantage of ignorance, bad discipline, faulty training and defective respirators.

(b) To reduce the fighting efficiency of our forces by compelling them to wear masks or to employ other protective appliances.

10. In making a gas attack the enemy seeks to generate a cloud of gas either directly within our own lines or in such a position that it will be carried by the wind into our lines. To accomplish this end he employs three distinct methods:

(a) Cylinder Cloud Attacks—Such attacks are employed more frequently in trench warfare than in open warfare, as there is more time to place the cylinders in the trenches and the stability of movement allows the cloud to drift over the opponent's trenches.

(b) Projector Attacks—Such attacks are limited to a stabilized front in which time and other circumstances permit the projectors to be brought up and placed in position for firing. Improvements to avoid digging trenches to emplace the

projectors and more rapid means of transportation will broaden the use of this form of attack.

(c) Bombardments With Artillery Or Trench Mortar Gas Shell—Such attacks are applicable in all modes of warfare.

In the case of cylinder attacks, a highly poisonous liquefied gas of low boiling point is liberated from cylinders placed in or near the front line. In case of projector or trench mortar attacks, and of attacks by artillery shell, the gas is inclosed in a suitable projectile and is thrown into the adversary's territory. There, by means of a percussion or a time fuse and a bursting charge, the shell is broken open and the poisonous material is liberated. The bursting charge is varied, depending upon whether the "gas" is a liquid, or a solid. The bursting charge is usually very small in the case of a liquefied gas, but often sufficient to give practically a high explosive effect, in the case of solids. A liquefied gas vaporizes when the pressure is released by the breaking of the shell, while solids are either atomized or vaporized by the explosion of the bursting charge.

Cylinder Cloud Attacks.

11. Gas clouds are produced by the sudden liberation of a liquefied gas from cylinders in which it is stored under pressure. The gas used is generally chlorine, phosgene, or mixtures of chlorine with phosgene or chlorpicrin. Formerly cylinders were as a rule dug in at the bottom of the trench and connected with outlet pipes that led from the bottom of the cylinder out over the trench parapet. Now they are often piled on trucks or flat cars and fired simultaneously by electricity. When the outlet valves are fully opened, whether by hand or electrically, the liquid is driven out as a gas in two or three minutes, which, mixing with the air forms a cloud. This cloud may vary in appearance, due to weather conditions or to smoke mixed with it. It may be almost

transparent and slightly green in color, or it may look like a thick mist.

12. The cloud is carried by the wind over the opposing line and at times the gas has been noticeable in the rear areas as much as 10 miles from the front line. Gas clouds are usually slightly denser than the surrounding air and therefore tend to fill up trenches and hollows and penetrate unprotected dugouts where the gas remains long after the main cloud has passed. Such clouds tend to follow the course of valleys. Lakes or streams do not affect the gas.

13. The chief dangers from such an attack are due to the high concentration of gas at the moment of its release and to the extent of the area which may be covered by the gas under favorable conditions. However, cloud gas attacks are very dependent on wind conditions and should not be made in heavy rains. They are best made only when upward-moving currents of air are not present, that is, when the sun is not shining. They offer a little less chance for surprise than other forms of attack, and hitherto have often been detected by:

- (a) Noise of hammering on metal in the trenches.
- (b) Active wind observations by the enemy.
- (c) Escape of gas from cylinders hit by shell.
- (d) Raids.
- (e) Prisoners' statements.

During the discharge the warning was often given by:

- (a) The hissing sound of the escaping gas.
- (b) The appearance of the cloud.
- (c) The odor of the gas before the main cloud reached the trenches.

Gas cloud attacks are still to be feared as a dangerous form of attack and when they are made, every form of gas defense equipment is given a most severe

will cause irritation of any tissue with which it comes in contact. This irritation is usually not noticed for from 3 to 12 hours after the exposure and may affect any part of the body. The worst mustard gas cases are due to irritation of the respiratory tract, which is often serious enough to cause death. A secondary effect is often pneumonia or in lighter cases bronchitis and an acute sore throat lasting for several weeks. Exposure of the eyes to the vapor will cause temporary blindness, which is very painful, and will last from a few days to several weeks, depending on the length of the exposure. The third effect, from which mustard gas derives its name of vesicant or blistering agent, is the production of painful burns on those portions of the skin with which it comes in contact, particularly the tender and moist parts under the arms and around the scrotum.

Tactical Uses.

22. Mustard gas is used rather as a neutralizing than as a surprise gas, because its slow evaporation prevents the rapid formation of high concentrations. Its persistency is greater than that of any other gas, and hence by its use any position may be made untenable for days after it is shelled. It is particularly valuable for use against valleys and woods, because such terrain will remain infected longer than open country. It is used in general against artillery emplacements, support and reserve positions, command posts, billets, woods, communicating trenches and roads. The following translation of a captured German document is instructive:

23. *"Bombardment with yellow cross shell will be executed preferably between one and four A.M. At first the bombardment will compel the enemy to wear his mask. A few hours later, when the presence of the gas is no longer revealed by the odor, the enemy will probably take off his mask, but will be overcome later, when the sun rises, by the action of the evaporation. Every attempt*

of the enemy to nullify the effects of our night gas bombardment in the morning should be neutralized by volleys of rifle, machine gun, minenwerfer and artillery fire."

24. Mustard gas is rarely used during the three or four days preceding a large scale "push," except against those points over which it is not intended to advance. Particular care must be taken in occupying terrain captured from the enemy because of the danger from gas traps left during his retreat. Gas shell and bombs may be left in dugouts or farmhouses and fused to explode when the locality is filled with our troops. Mustard gas may be sprinkled on roads and at all points over which troops must pass. All shelters will in general have been liberally soaked with mustard gas.

Individual Protection.

25. (a) The respirators in use by the American forces give absolute protection against all but the blistering action of mustard gas. Certain special precautions in their use must be observed. Because of the slight odor and delayed action of mustard gas, troops must be trained to put on the respirator immediately when any odor is noticed which *might* be that of gas. They must not remove the respirator until all traces of the gas have disappeared. They must be trained to wear it for long periods of time and to be able to work efficiently while wearing it. Men who have been exposed to mustard gas and have been *testing for it for several hours*, gradually lose their ability to detect it. On wearing the mask a short time one recovers his keenness of smell for the gas.

(b) The issue of protective clothing, such as suits and gloves, to special troops only, is authorized by the General Staff.

(c) Sag paste. This is a protective ointment which, if applied before exposure to the gas, will greatly di-

minish its effects upon the skin. The paste should be rubbed liberally in an even layer on the genital organs and region, the buttocks, the armpits, and other parts of the body which perspire freely. The length of time that such an application is effective depends entirely upon the strength of the gas. Since there is no way of judging this easily in the field, care must be taken to use a sufficient quantity of the paste and to renew the application about once every 12 hours when continually exposed to the gas. It should be carefully noted that Sag paste must be applied before troops enter an area that is likely to be shelled. This will have to be done on the judgment of the unit gas officer.

(d) Any portion of the skin which has been splashed by the liquid from mustard gas shells or even moist parts that have been exposed to the vapor should be washed as quickly as possible with soap and water. Any kind of soap will answer and cold water is satisfactory. It is only necessary to work up a good lather and massage the place well with this lather. Very little water used in this way often suffices to prevent burns.

(e) If chloride of lime is available, as it should be, some of the dry powder sprinkled on the skin that is splashed with mustard gas liquid will prevent a bad burn. The powder is to be left on the skin about fifteen minutes and then washed off with water and soap if obtainable.

Collective Protection.

26. In general, the best protection against mustard gas is evacuation of all ground infected by it, **IF THE TACTICAL SITUATION PERMITS**, and *alternative positions should be prepared or selected in advance*. If a zone has been evacuated after a mustard gas bombardment, sentries should be posted on all roads and paths entering this zone to warn troops away from it and to

prevent their entering. Sentries should also be posted in front of contaminated dugouts in a zone otherwise free from mustard gas. If not possible to evacuate, frequent reliefs, or protection of troops as far as possible in gasproof dugouts will alone prevent numerous casualties, as mustard gas will outlast the staying power of troops wearing the respirator. In connection with the use of gasproof dugouts, it should be noted that men entering such dugouts have gassed the occupants by the gas which they have brought in on their clothes and, therefore, all outer clothing should be removed in the entrance to the dugout and soles of shoes treated with chloride of lime. A scraper, water, and box of chloride of lime should be kept near the entrance to each dugout. The shoes are first dipped into the water, then thoroughly rubbed in the lime, and finally washed off in the water. This precaution, if followed by thorough washing of the body, will be very effective in preventing burns. It should be noted that the enemy will probably not knowingly attack across an area recently shelled with mustard gas.

Disinfection of Positions and Clothing.

27. After a mustard gas bombardment, the covering of shell holes with chloride of lime will render such shell holes harmless. The chloride of lime should be spaded in well, then covered with another thinner layer of lime which is in turn covered with fresh earth. This should be done by a special disinfecting squad provided with the proper protective clothing. It is manifestly impossible in the case of an extensive bombardment to disinfect all shell holes in this way, but those near which troops pass or near dugouts should always be disinfected. Men after walking over an area infected with mustard gas will find it necessary to destroy the poison on their shoes before entering a dugout, as this liquid readily evaporates afterwards in the dugout,

rendering the atmosphere extremely dangerous. Chloride of lime is placed on the ground outside of dugouts, in order that the men may use the lime to destroy the liquid that may be carried upon their shoes. There is an element of danger in the use of chloride of lime to destroy gas due to the fact that the odor of the former completely masks that of the latter. When chloride of lime is thrown on liquid mustard gas, some chlorine is given off. This will cause little annoyance. However, the heat of the reaction may vaporize some of the mustard gas which has not yet been destroyed. When large puddles of the liquid are encountered, they will first be sprinkled with sand, dry earth or ashes, to absorb the greater part of the poison before being treated with chloride of lime. Clothes which have been gassed can be disinfected by washing in running water for several days, by washing in nearly boiling water for 1 to 2 hours, by steaming for an hour, or by hanging them out in the rain. The extent of cleaning necessary and method employed will depend on the amount of contamination and the conditions in the field.

PHOSGENE.

Physical and Chemical Properties.

28. Phosgene or carbonyl chloride is a liquid boiling at 47 degrees F. with a marked odor, described as being like that of mouldy hay. Because of its low boiling point, it will not remain on any terrain on which it is thrown for more than a few minutes. It will form clouds of varying concentration, depending on the manner in which it is thrown over, and a very heavy cloud may render positions dangerous 10km. from the original point of attack.

Use by the Enemy.

29. Phosgene is sent over by the enemy in cylinders, projector bombs and trench mortar shells. In

cylinders it is usually mixed with chlorine in order to form a mixed gas of high vapor pressure. It is generally used pure in the 75, 170 and 250mm. trench mortar shells and in the 180mm. smooth-bore projector bombs. In these it is rarely mixed with chlorpicrin. Recently the enemy has used phosgene in long range rifled projector shells mixed with pumice, absorption in which retards its evaporation, making it persist for several hours. Finally, it occurs generally in small proportion as a decomposition product of diphosgene in artillery shell for 77 and 100mm. guns and in the 105, 150 and 210mm. howitzers.

Physiological Action.

30. Phosgene is a lung irritant and is probably the most deadly gas used in warfare. Exposure to high concentrations for even a short time will cause severe casualties, or death, and much lower concentrations will also have serious effects. Its full effect is usually delayed for several hours and exercise after exposure to this gas will render slight casualties much more serious or even fatal. Because of this effect, men who have been gassed even slightly and who have experienced no symptoms of gas poisoning must be prevented from taking any exercise whatever, if serious casualties are to be prevented.

Tactical Uses.

31. Phosgene is used entirely as a surprise gas, as high concentrations can be developed with it very rapidly. Its persistency is low, and it is, therefore, possible to follow up a phosgene attack with an infantry advance after a very short time.

Defense Against Phosgene.

32. The respirator gives absolute protection against this gas. Troops must be trained to put on the respirator quickly and well, under any circumstances, and

sentries must be thoroughly instructed so as to be able to recognize phosgene attacks and to give the alarm immediately. Trenches and dugouts can be quickly rid of phosgene by means of fanning and fires.

DIPHOSGENE.

33. Diphosgene, superpalite or trichlormethyl chlorformate, is a liquid boiling at 261 degrees F. Its other properties and action resemble those of phosgene very closely. It cannot be used in cloud or projector attacks because of its high boiling point. It is used mixed with chlorpicrin in green cross 1 shell of different calibers and with diphenylchlorarsine in green cross 2. Phosgene usually accompanies diphosgene in the latter, due doubtless to the decomposition of the diphosgene.

CHLORPICRIN.

34. Chlorpicrin is a colorless liquid boiling at 234 degrees F. and hence is fairly persistent. It approaches phosgene in its poisonous effect. Even in very low concentrations it will cause lachrymation and in higher concentrations vomiting, which may necessitate the removal of the mask. The clothes of men who have been exposed to chlorpicrin are dangerous because of the gas which is carried on them and the same precautions against gassing men in dugouts must be taken as in the case of mustard gas. Chlorpicrin is used mixed with diphosgene in green cross 1 shell. The respirator gives full protection.

ARSINES.

35. Diphenylchlorarsine is a solid of extremely low volatility and is practically odorless. It is used in green cross 2 and in the blue cross shell which contains in addition a large amount of high explosive. On the explosion a cloud of vapor is formed. The cloud will cause headache and intense pain in the throat and

chest, accompanied by sneezing and coughing. Vomiting and even temporary paralysis of the nervous system may finally result. It is used mainly to unnerve a man and prevent him from adjusting his mask quickly or to prevent his keeping it on after it is adjusted. It is used also for direct neutralization through the production of the above painful symptoms. The effects of this gas when used alone disappear quickly. The respirator gives absolute protection, but must be put on immediately. Diphenylcyanarsine is similar in its action and rather more effective. It is used in blue cross shell.

36. Ethyldichlorarsine is a moderately volatile liquid, present in shells whose marking has recently been changed from yellow cross 1 to green cross 3. It is analogous to dipenylchlorarsine in physiological action, exerting a more destructive effect upon the respirator tract along with the nerve poisoning. It is rapidly destroyed by moisture.

TEAR-PRODUCING GASES.

37. Various gases, such as brom-ketones, are used as tear-producing agents. They are heavy liquids with high boiling points and are used usually mixed with deadly gases, in all the various forms of projectiles. They are capable of producing blinding tears in very low concentrations and are particularly effective in forcing men to put on their masks. For this reason they are valuable as harassing gases. They have also a noticeable poisonous effect. They are fairly persistent. The respirator gives absolute protection against them. Chlorpicrin, in addition to its toxic properties, is of value as a tear producer.

SMOKE.

38. The enemy may make use of smoke, either in the form of a cloud or emitted from shell and

bombs. Smoke may be used with gas or between gas clouds; it may also be used alone to distract attention from a real discharge of gas, and in general for preventing observation, as for instance as a screening barrage, or for blotting out machine gun nests.

IV. PROTECTION AGAINST GAS

INDIVIDUAL.

39. Every man whose duty carries him to the zone of the advance will be provided with an American Tissot Respirator. No other respirator or mask may be carried or worn by any member of the American E. F. except as noted in Part 7. For description, care, fitting, inspection, drill, etc., for the American Tissot Respirator see paragraphs 65-90 inclusive.

COLLECTIVE.

40. The following precautions are included under this head:

- (a) Wind observations to ascertain when conditions are favorable for a hostile gas attack.
- (b) Adequate systems of sentries and alarms.
- (c) Gas proofing of dugouts and cellars.
- (d) Cleaning of gas from dugouts and trenches.
- (e) Disinfecting of ground and clothing.
- (f) Precautions regarding food and water.
- (g) Protection of weapons and equipment.

WIND OBSERVATIONS.

41. Such measures as the Division Commander on recommendation of Division Gas Officer may decide to be necessary will be taken within the Division for having wind observations made by the Gas N. C. O's. The

tack without wearing respirators or helmets. Signal dugouts must, therefore, be particularly well protected against gas, so as to allow this to be done. Telephone operators must be especially practiced in using their instruments when wearing respirators. The headpiece of the receiver will be worn over the mask. Linesmen must receive plenty of practice in carrying on their work, both at night and in the daytime, while wearing respirators.

Signal and Telephone Equipment.

54. The only effective method of preventing corrosion of electrical apparatus during a gas attack is to prevent the gas reaching it, and the best way to do this is to have signal offices thoroughly protected against gas. As the corrosive effect on damp instruments is very much greater than on dry instruments, the shelters should be kept as dry as possible.

55. During a gas attack, telephones must be kept in their leather cases, and unless the buzzer key is being used the leather flap must be kept down, leaving only the cords with the receiver and hand-set out of the case. The backs of switchboards and buzzer exchanges must be kept closed. All apparatus, such as magneto telephones, test boards, spare instruments, etc., which are not essential to have uncovered should be well covered up with cloths, blankets or coats, etc.

56. After a cloud attack with chlorine or phosgene, telephone apparatus that has been exposed to gas should be treated as follows:

57. The ends of the wire should be removed from terminals and cleaned by being scraped with a knife. Terminals, exchange plugs and all exposed metal work should be cleaned first with a damp and then with a dry cloth. This process should be repeated after twelve hours have elapsed. Instruments which have been splashed with mustard gas should be brushed with dry

chloride of lime and later washed with soap and water. The internal portion of the instrument should not be interfered with. If an instrument has been kept closed or covered up, it is very unlikely that internal portions will have suffered; but if these portions show signs of corrosion, the instruments should be sent back to corps or division headquarters to be dealt with by an instrument repairer.

Protection of Carrier Pigeons.

58. When the gas alarm is sounded, pigeons should be placed in the special gas-proof boxes and bags provided for that purpose, or in gas-proof shelters. If for any reason the birds cannot be protected from the gas, they should be liberated at once. Where circumstances permit, gas-proof boxes or bags should always be kept near baskets containing birds, and should be regularly inspected. Pigeons can be utilized during a gas attack. Experience has proven that they will fly up through any gas cloud, as such clouds seldom rise above thirty feet from the ground, but it is imperative that the bird should be exposed to the gas for as short a time as possible. The message and carrier should therefore be prepared and, if possible, fastened to the pigeon's leg before the bird is exposed to the gas. Twenty seconds should suffice to fix a carrier and liberate a bird.

OUR OWN GAS.

59. When the extensive use of gas in any form is contemplated, Corps and Division Gas Officers should always be consulted according to provisions of G.O. 107, paragraph 1, G.H.Q., A.E.F., 1918. The expert advice which these officers are able to furnish will not only be of value in helping to assure the success of an offensive, but may prevent injury to our own troops through ill-timed use of gas or the use of a kind of gas unsuited to the conditions. The tactical uses of the different

gases vary, greatly and knowledge of their properties is essential to a realization of their full tactical values.

60. For cloud attacks it is advisable that before gas is discharged all troops except those whose presence is considered absolutely necessary, should *be withdrawn from the line occupied by the cylinders*. Any officer or man who has special orders to remain should put on his respirator. All troops will be cleared from any posts or saps in front of this line.

61. All troops in any part of the line within one-half mile of the nearest point where the gas is being discharged should put on their respirators.

62. In all attacks measures will be taken for the protection of the troops after consultation with the officer in charge of the operation.

63. If troops advance after one of our gas attacks, it must be remembered that the gas may hang about for some time in long grass, shell holes and hollows, and for several hours in the enemy's shelters. Dug-outs should not be occupied until they have been thoroughly ventilated and the absence of gas established. This is equally necessary with regard to shelters which have been penetrated by gas from shell or bombs. For other precautions in connection with the seizure of enemy territory, see paragraph 24.

Gas Shell and Gas Bombs.

64. These may, if necessary, be stored with other ammunition. In the event of leakage, all but mustard gas shell should be expended if possible, or buried in the ground five feet deep. Mustard gas shell should be buried. They should not be thrown into water, and care must be taken that they are not buried near the sources of water supply. All rescue work and disposal of leaky shells should be carried out by men wearing respirators.

RESPIRATORS.

THE AMERICAN TISSOT RESPIRATOR—DRILLS.

65. The following drills are designed to teach officers and men to adjust their respirators accurately and quickly. The drill must be so thoroughly mastered that all will protect themselves instantly and almost automatically upon hearing the gas alarm.

66. *Drill "A." To bring the Respirator to the "Alert" position.*

1. Slung Position.

Respirator with sling over right shoulder. Satchel hanging on left side with press buttons closed and next to the body.

2. Gas Alert Position.

Being at "slung" position, (1) *Gas Alert*. Place the rifle between the knees. Slip the left arm back through the sling and bring the satchel around to the front of the body. Open the flap of the satchel. Take out the whipcord with the right hand and pass it through the metal loop on the right hand side of the satchel. Raise the satchel to the chest with the left hand so that the slack of the sling falls over the back, pulling it down with the right hand and holding it there. Then take the sling in the left hand and with the right, pass the cord through the sling, then through the metal loop on the left side of the satchel and fasten it tightly with both hands after adjusting respirator to proper height on the chest. Fold flap over top to protect respirator from wet, but do not fasten.

Alternative Position, Especially When Pack is Slung.

Being at "slung" position. (1) *Gas Alert*. Place the rifle between the knees. Slip the left arm back through

the sling and bring the satchel to the front of the body. With the right hand, grasp the metal hook at the left of the satchel and with the left hand reach behind the neck for the metal eyelet on the sling, pull down and fasten the two together. Open the flap and take out whipcord with right hand. Pass it through the metal loop on the right of the satchel, then around the back and secure it to the metal loop on the left of the satchel.

67. *Drill "B."* Drill "by numbers" to obtain complete and accurate adjustment of the respirator from the "Alert" position.

This drill will be alternated with one without the numbers to insure as quick an adjustment as possible, in which practice in holding the breath will be included. The drill must be practiced until complete and accurate adjustment is obtained by all ranks in six seconds.

The respirator in the "Alert" position. The helmet is worn with the strap adjusted at the back of the head. One end of a lanyard is attached to the left loop of the helmet and the other is passed around the left shoulder.

Being at "Alert" position with helmet adjusted: (1) *By the numbers.* (2) *Gas.* Stop breathing. Place the rifle, if unslung, between the knees. Insert the thumbs under flap and open satchel. Seize the facepiece with the right hand. *Two.* Bring the facepiece smartly out of the satchel to the height of the chin, holding it firmly in both hands with the fingers extended outside, the thumb inside at the binding midway between the two lower straps of the head harness. Stick out the chin. *Three.* Bring the facepiece forward, digging the chin into it. With the same motion, guide the straps of the harness over the head with the thumbs, knocking the helmet off backwards. *Four.* Grasp the outlet valve tightly between the fingers, to prevent the passage of air through it, and blow vigorously into the mask, completely emptying the lungs. *Five.* Feel around the edge to make sure the facepiece is well seated. Correct ad-

justment and head harness. *Six.* Replace helmet. Resume the attention.

68. *Drill "C." To Adjust Respirator from Slung Position.*

Being at slung position. (1) *Gas.* Stop breathing. Place the rifle, if unslung, between the knees. Pull the satchel around until it hangs in front of the body. Unfasten the flap and adjust the respirator as in practice "B," allowing the satchel to hang by the rubber tube. Replace helmet, and at once proceed to adjust the satchel in the "Alert" position, as in practice "A."

69. *Drill "D." Drill to teach method of testing for presence of gas.*

Respirator being adjusted. (1) *Test for Gas.* Take a deep breath. With the right hand pull the facepiece slightly away from the right cheek, hold the breath, and sniff gently. If gas is smelled, readjust the facepiece, grip the outlet valve between the fingers and thumb, and breathe out hard.

70. *Drill "E." To remove the facepiece.*

Having tested and found no gas. (1) *Remove.* (2) *Facepiece.* Insert the first two fingers of the right hand under the facepiece of the chin, placing the thumb on the metal guard of the exit valve, bend the head forward, at the same time removing the facepiece with an upward motion of the right hand.

Notes:

(a) Care must be taken to remove the respirator without undue stretching of the elastic.

(b) *Folding facepieces.* The facepiece should be folded flat (no part tucked inward) and the elastic bands should be folded against the outside of the facepiece on one side.

(c) After all drills the eyepieces should be rubbed with anti-dim, leaving a thin, transparent film of the composition on the glass, the facepiece

should be wiped dry, folded correctly and put away in such a way that the rubber outlet valve is not bent.

71. Drill "F." Inspection.

The respirator being at slung position. (1) *Prepare for Inspection of Respirators.* Place the rifle between the knees. Slip the left arm back through the sling and bring the satchel around to the front of the body. Open the flap of the satchel. (2) *Inspection.* (3) *Respirators.* Examine the satchel and sling, make sure that metal hook and clasp and metal loops at each side are securely fastened. Remove canister and hold under left arm, the tube and facepiece hanging over the arm. Examine the interior of satchel to see that wire platform and anti-dim are present, and that whipcord is in good condition and free from knots. *Two.* Examine inlet valve at bottom of canister. Examine the canister for rust spots and weak places by pressing lightly with the fingers beginning at bottom and working to the top. Watch carefully for holes in soldering at top of canister. See that flexible tube is properly fastened to the canister, and to the metal elbow tube and is free from obvious defects. *Three.* See that the metal elbow tube is securely connected to facepiece and that outlet valve guard is not loose. Make sure that the outlet valve is in good condition, has no dirt or sand in it, has no tears, and is connected properly to elbow tube. *Four.* Examine the facepiece inside and out. See that chin rest is secure, that there are no pinholes or tears in fabric, that air passage to eyepieces is in proper condition and not torn away from fabric, that eyepieces are securely fastened in the facepiece. Examine the head harness and make sure that it is firmly attached to binding. *Five.* Adjust mask to face to test valves. Hold canister in left hand. Grasp outlet valve between fingers to prevent passage of air through it, and breathe gently in and out a few times. The inlet valve, if work-

ing properly should vibrate back and forth. Test outlet valve by putting a kink in breathing tube to prevent the passage through it of air and attempt to draw air into the facepiece. If the outlet valve is in proper condition, it will not be possible to draw in any air. Remove respirators. *Six.* All men with defective respirators step forward one pace. Others replace canister in satchel, taking care not to twist facepiece into wrong position, and return respirators to slung position. (Note.) After inspection men should be given drill (B) once, so that it can be seen whether all canisters have been correctly replaced in satchel.

72. Respirators will be inspected daily in the alert zone, and at least twice weekly in the danger zone. See pars. 108 and 109. They must always be inspected before proceeding into the alert zone.

73. It is the duty of every officer and non-commissioned officer, and is especially the duty of the Gas Officers and their assistants, to make sure that these inspections are being carefully carried out. Only by constant supervision can officers be certain that respirators and other gas defense appliances are being properly and regularly inspected. The importance of this cannot be too greatly emphasized. A respirator must always give complete and absolute protection. Its condition can only be determined by constant and careful inspection.

General Points on Training with Respirator.

74. When training men in the use of respirators the following points are of importance:

(a) Ordinary infantry drill should be combined with physical drill, including arm and leg exercises, leap-frog, and double-time. The time of practice need not exceed 15 minutes at first while wearing the respirator, but should be gradually extended. This drill will be in heavy marching order.

(b) Practice in bombing, rapid loading and aiming, judging distance and rifle firing, should be carried out while men are wearing respirators.

(c) Officers and N.C.O.'s will receive the same training as the men and, in addition, will be practiced in giving orders while wearing their respirators.

(d) It must be realized that troops in the line always carry the respirator, and that practice in the rear should take this into account. Every effort must be made to approximate actual warfare conditions. Every opportunity will be taken to accustom men to carrying on their usual duties with the respirator adjusted. It is often necessary during and after a gas attack for men to wear their respirator for six or eight hours, or even longer when a highly persistent gas, such as mustard gas, is used.

(e) Practice and drill in the use of gas defense appliances should be carried out as continuously as tactical conditions will permit. This applies especially to troops which return to the line after having been in rest areas and where the incorporation of drafts incompletely trained in gas defense measures make such training very essential.

Description of the American Tissot Respirator.

75. The respirator consists of a metal canister filled with a mixture of chemical granules and connected by a rubber tube to an impervious facepiece. Air is drawn in through the inlet valve which consists of a circular rubber disc fitted on a stud in the center of a perforated metal plate. Any poisonous gas is absorbed by the granules in the canister. The purified dry air passes into the facepiece, playing over the eyepieces, and keeping them clear. Air is expired through the

outlet valve, the inlet valve closing in order to prevent air passing through the canister. If the inlet valve does not close properly, expired air passes into the canister causing deterioration of the chemicals and discomfort to the wearer.

76. The facepiece is held in position by a head harness of self centering construction which keeps it firmly against the face without discomfort. The complete respirator is carried in a satchel which is divided into two compartments, one of which holds the canister and the other the mask. The canister rests on a wire platform which raises it from the bottom of the compartment and allows the free access of air.

Fitting.

77. Respirators are made in five sizes. The various sizes will be needed in the following proportion:

No. 1 Very small.

No. 2 Small.

No. 3 Medium.

No. 4 Large.

No. 5 Very large.

When respirators are issued they should be most carefully fitted. In some cases it will be necessary to change the length of the elastic by means of the buckles. When the fit of the mask appears satisfactory, it must be tested in tear gas and the test repeated at least every month. If possible, the test should be made in the gas chamber every time a battalion comes out of the line.

78. Men should remain in the tear gas for five minutes, moving about and talking to make sure that the fit of the mask is good.

79. When the fit has been tested, each man should write his name, but not his organization, on the lower part of the front of the satchel as worn in the "alert" position to insure that he does not exchange his respirator for another that may not fit him. *Any man found*

without a respirator, or in possession of one not his own will be strictly disciplined.

Care of Respirator.

80. The most serious causes of damage to the respirators are:

(a) Water entering the canister and spoiling the chemicals.

(b) Injury to the facepiece.

(c) Injury to the outlet valve.

81. Respirators must be protected from wet as far as possible, and rough usage must be avoided. Nothing must be carried in the satchel, except the respirator and anti-dimming outfit; small articles of kit readily cause damage to the mask.

82. The inside of the facepiece should be wiped before it is put away, otherwise damage is caused by the rusting of metal parts, and by the rotting of the stitching.

83. To prevent freezing of the outlet valve during very severe frost, two or three drops of glycerine should be inserted through the slits at the bottom of the valve by means of a match or stick of wood. Supplies of glycerine are kept by Division Gas Officers for this purpose. Half a pint should be sufficient for 1,000 respirators. Inlet valves at bottom of canisters are not affected if kept dry. If moisture has entered and frozen, the valve must be removed, thawed, wiped dry and replaced. The inlet valve must not be treated with glycerine.

Life of Canister.

84. When canisters are issued, they will be painted with the number of the month of issue. They will then be replaced after the lapse of a certain number of months. They will usually become ineffective through mechanical damage before they become useless chemi-

cally. The chemicals in the canister will slowly lose their efficiency, even when nothing but pure air is breathed through them. This is due to the fact that the moisture in the air gradually cakes the granules, increases their resistance, and lowers their absorptive power.

Replacement of Canister.

85. When the canister of the respirator is defective owing to wet, rust, or other damage, or has been breathed through for 40 hours in gas, and the respirator is otherwise in good order, the canister should be replaced by a new one by the Gas N.C.O. Tools for detaching canisters are provided and should be kept in charge of the Gas N.C.O.

Removal of Old Canisters.

86. In all operations great care must be taken to avoid damaging the rubber tube. Remove the tape on the wire. Turn up the twisted end of the wire at right angles to the tube. Press on point of the "tool for detaching canister" under a single strand of wire near the twisted end. On pressing over the tool the wire will be cut by the sharp edge inside the V. Remove the wire. Insert both points of the V under the rubber, then, with the handle of the tool at right angles to the tube, move the tool around the neck to loosen the rubber from the metal. On continuing with an upward movement the tube will be detached.

Fixing of New Canister.

87. Remove the plug of cotton waste from the neck of the new box, lick the neck and slip the rubber tubing over it so that the neck is completely covered, taking care that the facepiece is in the correct position relative to the canister.

88. To bind the tubing with string, proceed as follows (see Fig. 1): Rub the string with beeswax or cobbler's wax, if available. Make a loop at one end "A" of the string. Lay it along the tube and parallel to it. Wind the remainder of the string tightly round the tube

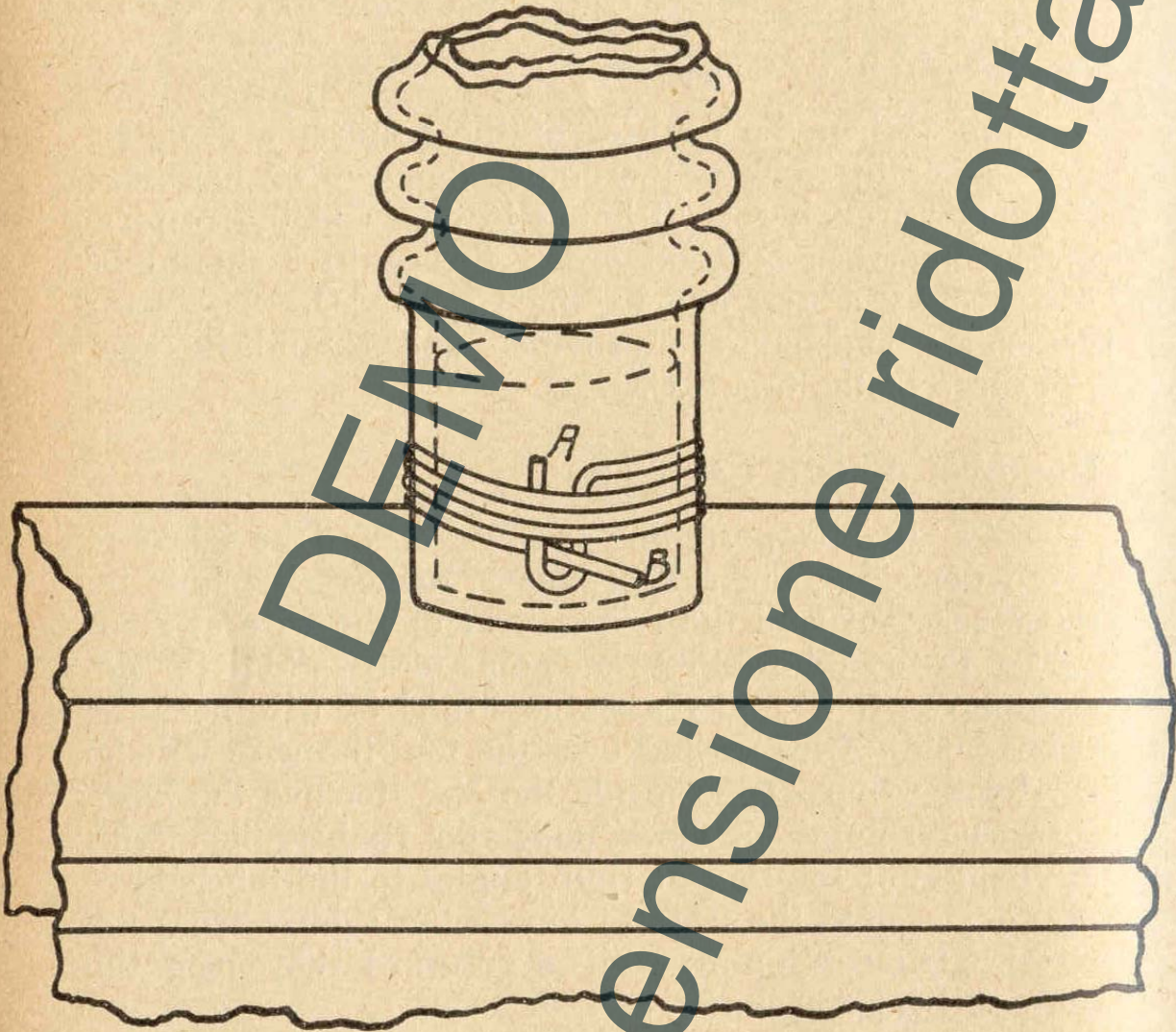


FIG. 1.

at least four times. This holds the loop in position. Pass the end "B" through the loop, and then fix it by pulling the loop tight from "A". Tie "A" and "B" together with an ordinary knot. The string binding must be below the ridge in the neck of the canister. Test the junction to see that it is secure and gas tight.

Anti-Dimming Outfit.

89. This is carried in the satchel, and contains a stick of composition and a piece of soft rag. Occasionally at inspection and always after each wearing of the respirator, the inner surfaces of the eyepieces should be cleaned and dried, a little of the composition rubbed on with the finger, and the surface rubbed with a soft rag until the film of composition is smooth and thin and nearly clear.

Minor Repairs.

90. Small perforations in the facepiece can be repaired by applying pieces of adhesive plaster both inside and outside the mask. Respirators so repaired should be exchanged as soon as possible.

HORSE RESPIRATOR.

General.

91. In choosing locations for stables and horse-lines if within shell range, high, sloping, treeless ground is preferable as less likely to hold gas. Horses should not be allowed to stand on or be ridden over areas that have been heavily shelled by mustard gas as the skin of the horse is more sensitive than that of man to the effects of this gas. They should not be allowed to eat grass that has been contaminated with mustard gas, or drink from infected shell holes. Horses exposed to mustard gas should be washed all over as soon as possible with soap and warm water, especially around the mouth, anus, and sexual organs. Horses must be practised in wearing the respirator, as they will otherwise resist protection, and cause delay and annoyance in emergencies.

Description.

92. The respirator consists of a flannelette bag with a canvas mouthpiece which goes into the horse's mouth

and saves the flannelette from being bitten through. The bag is provided with an elastic band which passes round the opening so as to draw the respirator close to the face when in use. The upper side of the mouth of the flannelette bag is furnished with a small unbleached calico patch by which the respirator is attached to the nose-band of the bridle or halter when in the "Alert" position, and while in use. Inside the bag and attached to the canvas mouthpiece there is a canvas frame which is stitched on to the bag in such a way as to prevent the material drawing into the nostrils when the respirator is in use. The whole is folded and carried in a canvas case provided with a flap, secured by three press buttons, and having two straps at the back by means of which the case is attached to the bridle or halter.

Method of Use.

93. Horses can stand a higher concentration of gas than human beings without serious injury, and it is not, therefore, necessary to protect them against cloud gas attacks when they are a considerable distance back from the trenches. Nor is it usually necessary to protect their eyes. The respirator is primarily intended for use on transport animals when they are sent to the vicinity of the trenches with supplies and ammunition. In the case of gas shell attacks, horses should be protected wherever the shelling is heavy.

Carrying When Not Immediately Required.

94. When not required for immediate use the respirator can be conveniently carried on the supporting strap of the breast harness as shown in Fig. 2, or if a zinc wither pad is worn, still more conveniently inside this pad. If a collar is used in place of the breast-strap, it can be carried in the channel of the collar where drivers often carry a sponge. However carried, the case is

steadied by being strapped on either side to the metal ring on the supporting strap, and its flap should be



FIG. 2.

passed under this strap, between it and the wither pad, and buttoned as in the "Alert position."



FIG. 3.

Alert Position.

95. When horses are being sent up to the trenches, the transport or other officer responsible should have

the respirators adjusted in the "Alert position" before moving off, as follows:

(a) The flap of the respirator case is unbuttoned and slipped under the nose-band of the bridle or halter from below upwards.

(b) The two straps at the back are also passed under the nose-band and secured to the check pieces of the bridle, above the metal D on each side.

(c) The small unbleached calico patch on the upper side of the mouth of the respirator is buttoned on to the nose-band of the head collar so that the respirator is ready to be slipped on immediately in the event of a gas attack.

(d) The cover of the case is then closed over the nose-band, and the respirator is thus protected from rain, and held in position on the nose-band. Fig. 3 shows a respirator in its case carried in the "Alert position."

Wearing In Gas.

96. The respirator being carried in the "Alert position" is adjusted for use as follows:

(a) The flap of the case is unbuttoned and the respirator removed, leaving the case attached to the cheek pieces of the bridle and lying flat on the face.

(b) The mouth of the bag is drawn down over the upper lip and upper teeth with one hand on each side of the mouthpiece, slipped into the mouth, and drawn well up to the angle of the lips.

(c) The elastic band is seized on either side close to the mouthpiece, and pulled outwards so as to draw the mouth of the bag tight around the upper jaw, above the nostrils, and is then slipped over the poll.

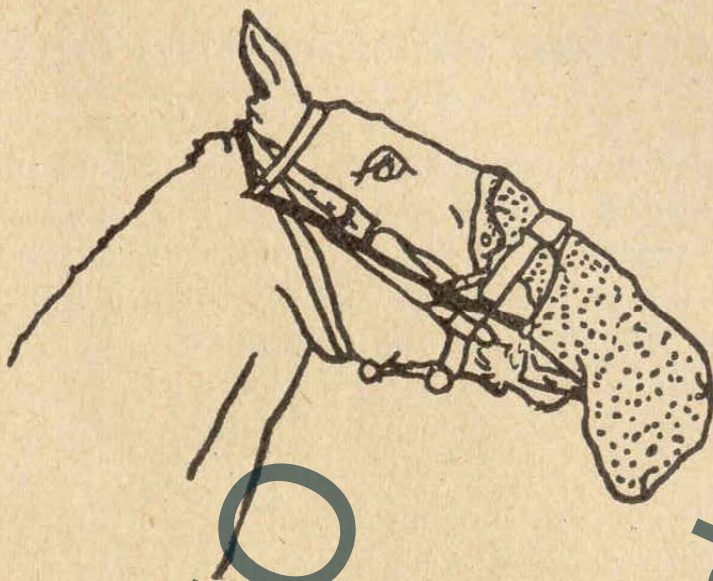


FIG. 4.

97. The respirator is then in position and the animal may be worked in it without difficulty or undue distress. The bit and reins are not interfered with in any way. This is shown in Fig. 4.

Replacement in Case.

98. In folding the respirator and replacing it in the case ready for use the following points should be observed:

(a) The canvas mouthpiece should be wiped as clean as possible.

(b) The flannelette bag should be held with the canvas mouthpiece underneath and the elastic band placed over the top of the bag in such a way that when the canvas patch is buttoned on to the nose-band the elastic band has simply to be passed straight up over the face and over the poll. The bottom end of the respirator should then be tucked in and rolled up over the elastic band to make a neat roll for insertion in the canvas case.

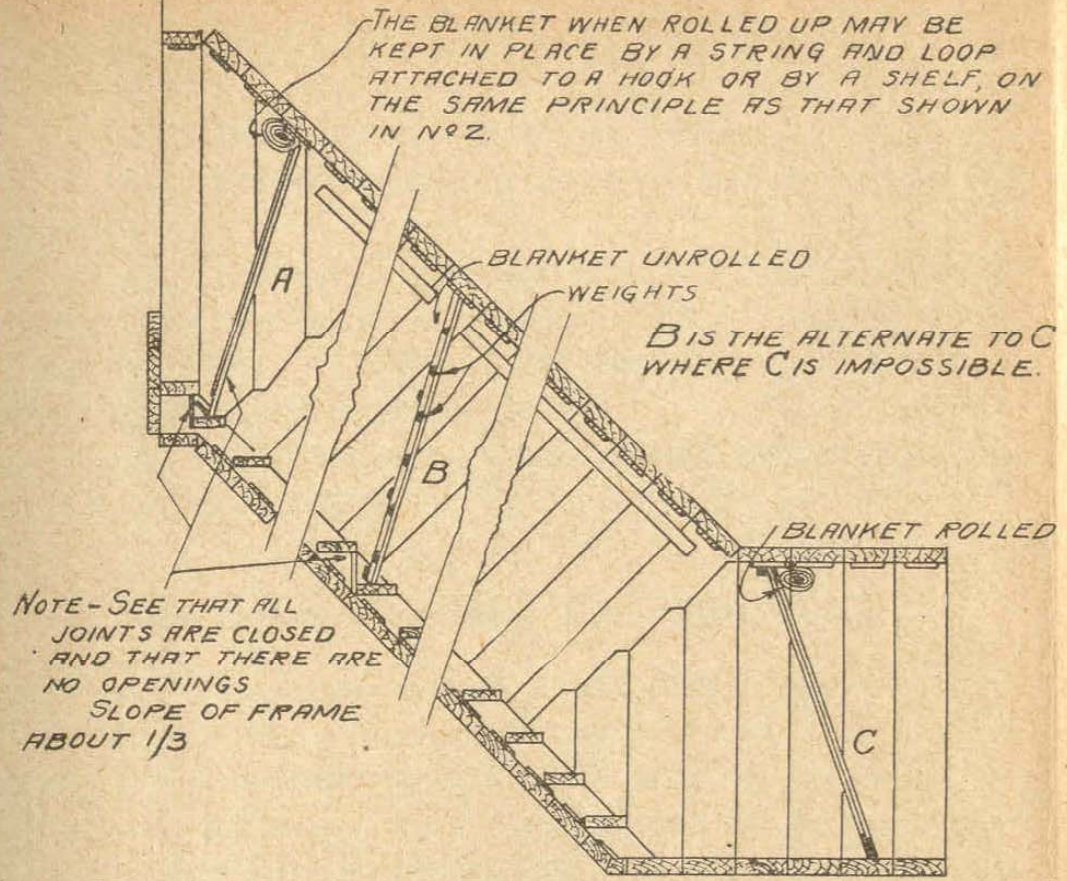
99. A double feed bag filled with straw, moss or leaves saturated with sodium bicarbonate solution will make a fair emergency mask.

SUMMARY OF MARKINGS FOR CHEMICAL SHELL AND PROPERTIES OF COMMONEST GASES

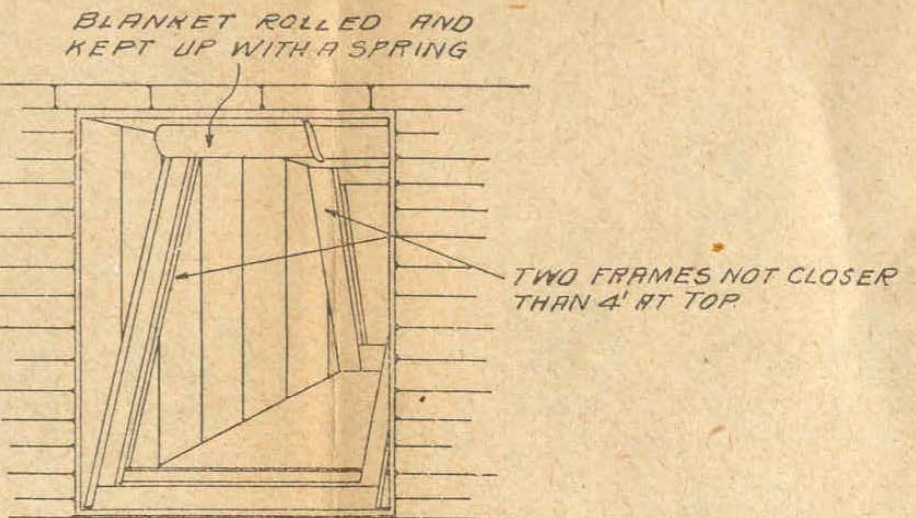
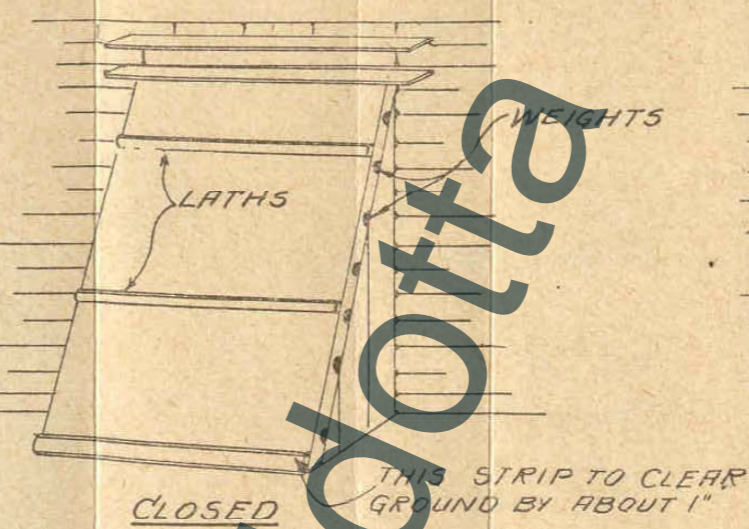
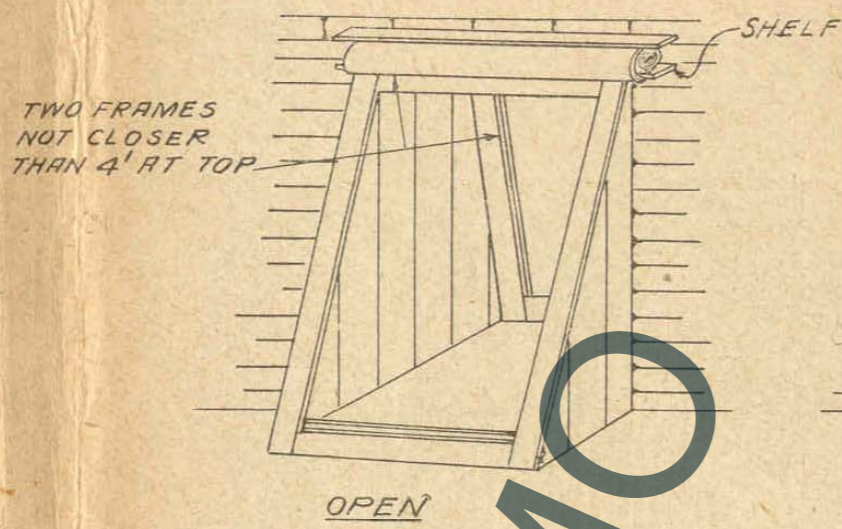
French Number	Shell Filling	American and British Code Symbols	French Designation	German Designation and Shell Marking	Odor	Persistency		Physiological Effect	Remarks	
						In Open	In Woods			
						<i>Non-Persistent Class.</i>				
4	Chlorine (Used only in cloud gas)	Red Star	Bertholite		Chloride of Lime	10 min.	3 hrs.	Lung Irritant, Deadly. Action Immediate.	These gases are very volatile; they are vaporized entirely at the moment of explosion, forming a cloud capable of giving deadly effects, but which loses more or less rapidly its effectiveness by dilution and dispersion into the atmosphere.	
	Arsenic Trichloride 30% Stannic Chloride 15% Hydrogen Cyanide 50% Chloroform 5%	Not used by A.E.F. or B.E.F.	Vincennite			10 min.	3 hrs.	Lachrymator and Respiratory Irritant. Considered quite toxic, but in high concentrations only.		
	Cyanogen Chloride 70% Arsenic Trichloride 30%		Vitrite			10 min.	3 hrs.	A Lachrymator, Respiratory Irritant and Lethal Agent		
	Diphenyl Chlorarsine	D. A.	Sternite	Blue Cross	Slight	10 min.	3 hrs.	Sneezing Gas. Nerve Depressant. Respiratory Irritant.		
5	Diphenyl Cyanarsine	D. C.	Sternite	Blue Cross	Is interchangeable with D.A.			Effects somewhat greater.	These gases form non-persistent clouds of solid particles.	
	Phosgene	C. G.	Collongite	Three White bands. White D.	Musty Hay, Green Corn	10 min.	3 hrs.	Respiratory Irritant. Very deadly. Action usually slightly delayed.		
						<i>Semi-Persistent Class.</i>				
6	Diphosgene	Not used S. F.	Superpalite	Green Cross	Disagreeable, suffocating. Musty Hay.	3 hrs.	12 hrs.	Same as phosgene.	These gases, having moderately high boiling points, are only partially vaporized at the moment of explosion. The cloud formed upon explosion is generally not deadly, but it immediately gives penetrative lachrymatory or irritant effects. The majority of the "gas" contents of the shell is pulverized and projected in the form of a spray or fog which slowly settles on the ground and continues to give off vapors which prolong the action of the initial cloud.	
	Phenyl Carbylamine Chloride			Green Cross		3 hrs.	12 hrs.	Eye, Nose and Throat Irritant. Not very poisonous.		
	Phosgene, Diphosgene and Diphenyl Chlorarsine			Green Cross 2	Resembles Diphosgene a little pungent	3 hrs.	12 hrs.	Respiratory Irritant. Slightly delayed action. Very deadly. Causes vomiting and a little lachrymation.		
	Chlorpicrin Phosgene	15% 25%	P. G.			Pungent, Suffocating.	3 hrs.	12 hrs.		Causes vomiting, Respiratory Irritant, a little lachrymation.
	Diphosgene and Chlorpicrin				Green Cross 1	Pungent, Suffocating.	3 hrs.	12 hrs.		Slightly delayed action, very deadly, respiratory irritant, causes vomiting and a little lachrymation.
7	Chlorpicrin	P. S.	Aquinite		Pungent	3 hrs.	12 hrs.	Causes vomiting, respiratory irritant, tear producer.	Phosgene in these mixtures has same effect as used above, if concentration is sufficiently high.	
	Chlorpicrin 80% Stannic Chloride 20%	N. C.			Pungent	3 hrs.	12 hrs.	Respiratory irritant, causes vomiting, tear producer.		
	Ethyl Dichlorarsine and Dichlormethylether			Yellow Cross 1 or Green Cross 3	Ethereal, Pleasant.	3 hrs.	12 hrs.	Nerve poison similar to diphenylchlorarsine, easily destroyed by water.		
						<i>Persistent Class.</i>				
9	Bromacetone	B. A.	Martonite			2 days	7 days	Lachrymator, Tear Producer.	These gases having very high boiling points are but little vaporized at the moment of explosion. A small portion of the contents of the shell is atomized and gives immediate effect, but by far the greater part is projected on the ground in the form of droplets which slowly vaporize and continue the action of the initial cloud.	
	Brom Ketones			Green Cross	Pungent	3 days	7 days	Tear Producers, Slight Respiratory Irritants. Action immediate.		
21	Brombenzylcyanide	C. A.	Camite		No Odor	3 days	7 days	Not toxic but most powerful lachrymator known.		
20	Mustard Gas (Dichloroethyl Sulphide)	H. S.	Yperite	Yellow Cross	Slight Mustard or Garlic	3 days	7 days	Respiratory Irritant. Eye and Skin Irritant. Blistering Agent. Action delayed several hours.		

NOTE: The above figures on time of persistency are approximate only and for calm weather. Persistency is dependent to a large extent on temperature, wind velocity, and the amount of gas liberated, especially in woods or other more or less closed places. High temperatures and wind velocities decrease persistency, and low temperatures and wind velocities increase it.

GAS BLANKET ARRANGEMENTS



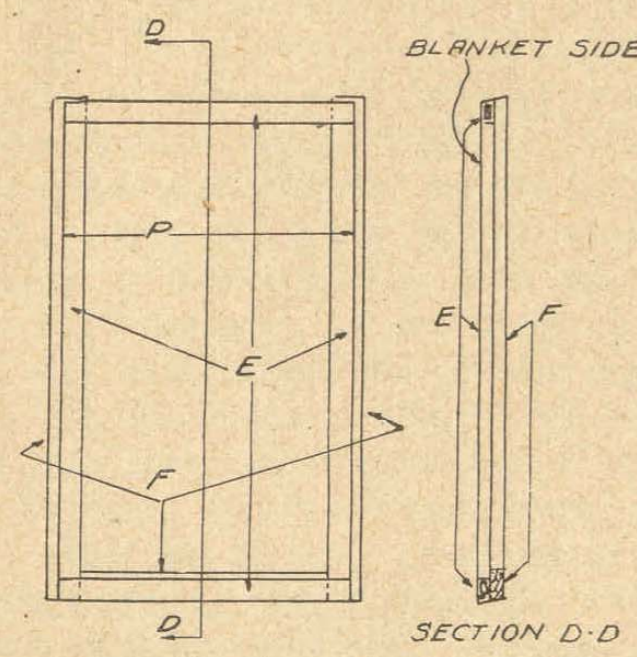
No. 1
ARRANGEMENT OF GAS BLANKETS



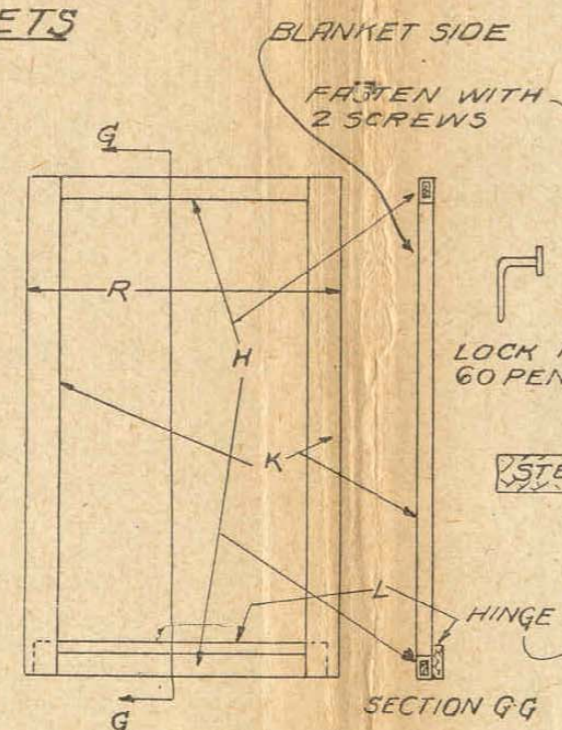
No. 3
HORIZONTAL GALLERY

No. 2
PROJECTING ENTRANCE
USED SOMETIMES IN DRESSING STATIONS TO AVOID NARROWING PASSAGE

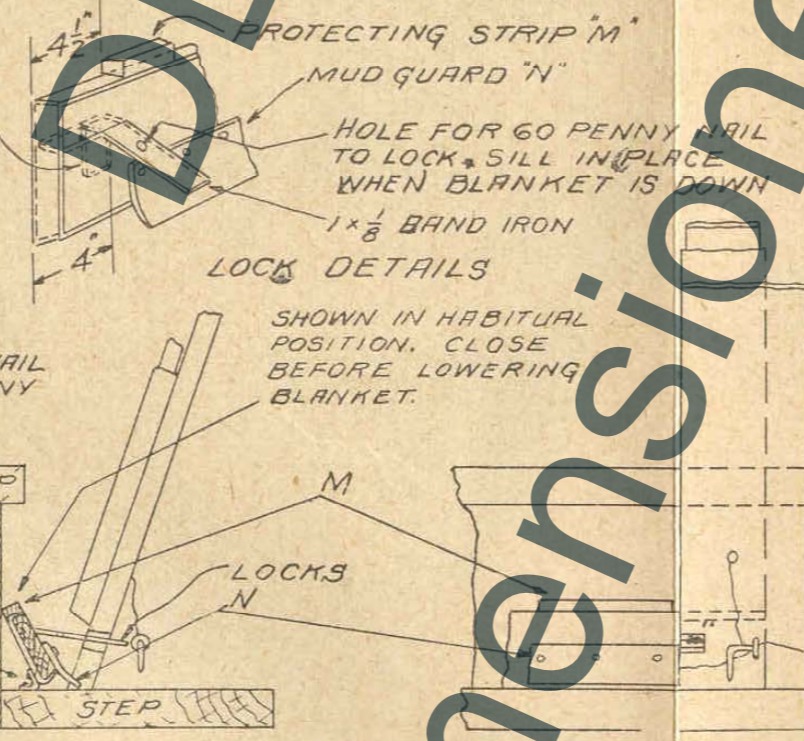
NOTE: ANY WIRES SHOULD ENTER NEAR TOP OF FRAME
BLANKET COVERED DOORS MAY ALSO BE USED TO SUPPLEMENT THE BLANKET CURTAINS.



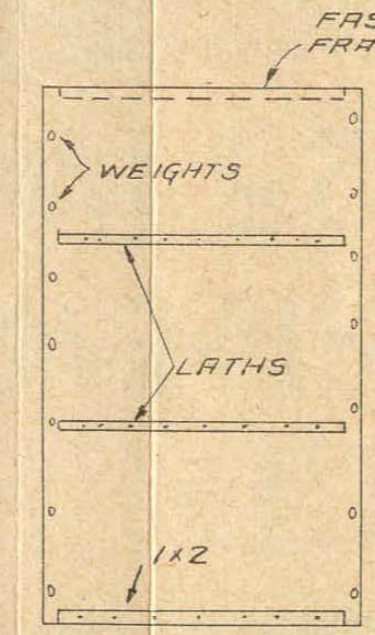
No. 4
INTERIOR BLANKET FRAME
USED AS IN "C" OF NO. 1 AND IN NO. 3
E = 1x4 BLANKET COVERED.
F = 1x6 PLAIN.
P = 2'-8" TO 3'-8"



No. 5
EXTERIOR BLANKET FRAME
USED AS IN NO. 2
H = 1x4 BLANKET COVERED.
K = 1x6 BLANKET COVERED
L = 1x6 PLAIN
R = 4' FOR DRESSING STATIONS



No. 6 (OPTIONAL)
DETAIL OF INTERIOR FRAME BOTTOM
WHEN FRAME IS USED AS IN "A+B" OF NO. 1
M = 1x1/2 PLAIN, PROTECTING STRIP
N = LEATHER OR RUBBER MUD GUARD.



No. 7
BLANKET
WHEN USED ON INTERIOR FRAME BLANKET MUST BE 3" WIDER THAN DIMENSION "P" OF NO. 4. WHEN WITH EXTERIOR FRAME 4" WIDER THAN DIMENSION "R" OF NO. 5.

LATHS ON INSIDE OF BLANKET TO BE 2" LESS IN LENGTH THAN WIDTH OF OPENING IN FRAME.

APPROVED: -
AMOS A. FRIES
COL. ENGRS, N.A., C. OF G.S.
BY
(SIGNED) E. D. ARDERY
LIEUT. COL., CORPS OF ENGRS