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CHEMICAL WARFARE

A quarterly magazine devoted to the activities of the Chemical Warfare Service, of interest to all arms---

Edited by Staff, The Chemical Warfare School,
Edgewood Arsenal, Maryland

THE CHEMICAL WARFARE SCHOOL

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CHEMICAL WARFARE

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LINE AND STAFF OFFICERS' COURSE

The next Line and Staff Officers' Course at The Chemical Warfare School will begin on February 7th and will end on April 29th, 1932.

Allocations to the various arms and services for attendance at this course of instruction have been made by the War Department as follows:

	Field Officers	Captains
Infantry	5	8
Cavalry	2	3
Coast Artillery	2	2
Field Artillery	2	2
Corps of Engineers	1	2
Air Corps	1	2
Signal Corps	1	2
Medical Department	1	2
Ordnance Department	1	2
Quartermaster Corps	1	2
	17	27

In addition to the above quotas, it is expected that six or seven members of the National Guard and Reserve Corps will be ordered to attend this course.

SMOKE AND THE INFANTRY

By: Major John N. Robinson, Inf.

When the uncontrolled smoke of many weapons arose from the heat of battle and became a nuisance on the world's battlefields, science produced a smokeless powder which greatly abated the nuisance and left the field of vision relatively clear. But later on when this very condition caused armies to desire some means of artificial cover, the scientific problem was somewhat simplified. It was only necessary, in this case, for science to research the past centuries, which produced many examples of the use of smoke in war, and then by the application of modern chemistry, efficient smoke materials for modern warfare were produced. And so it is that we now have an artificial cover for our armies - controlled smoke - perfectly controlled as to time and generally controlled as to place.

Smoke has been given unqualified recognition by the leading powers of the world and there can be no doubt of its wide use in any future war, by all branches of the service, to secure the main objective - success in battle. Smoke offers to the commander of any unit who employs it intelligently a saving in time, munitions and human life, which materially increase his chances of success - a boon which he cannot afford to ignore.

The United States,with its wealth of strategic materials, in chemicals and smoke-producing materials in particular, has recognized the importance of this modern weapon and training directives and allowances contemplate its use in our army training. That present training allowances are inadequate may be directly charged to a failure to realize its importance by the branches of the service most directly concerned with its use. The infantry may well be charged with the greatest failure in this respect since - "Infantry is the basic arm, and upon its success depends the success of the army. All other branches of the service are organized, equipped and trained to assist the infantry in its needs, functions and methods of war".

Hence we find the infantry particularly concerned with this new weapon - smoke. It is the infantry which will reap the greatest rewards from its intelligent use and it rests with the infantry to determine the requirements in smoke supplies, smoke weapons and their application to tactics - not only for its own

use but for the support it may require from other branches of the service - much as the Ordnance Department furnishes our usual weapons, so has the Chemical Warfare Service furnished us with an excellent smoke weapon and going even further, has pointed out the known advantages, disadvantages and limitations of smoke, applied to tactical situations. From this well established foundation it remains for the infantry to build further; and by training in smoke and with smoke to test out its possibilities, discover new methods of application and to fully develop the smoke weapon, much as it would test and develop a new rifle. The Chemical Warfare Service is ready to go forward with the infantry in the improvement or alteration of present material and present means of projection of smoke. It is for the infantry by practical training experience to determine reasonable specifications for its requirements.

The governing principle in the use of smoke is to blind the enemy so that he is denied the use of aimed or observed fire, or both,without hampering our own troops. The proper application of this principle in the World War shows smoke to have been most effective, and it is only to its improper use that any failures may be charged. These errors, unfortunately, have resulted in antipathy to its use in some quarters - but since these errors resulted from lack of intelligent application, they only serve to drive home more firmly the necessity of proper training in the use of smoke.

The purpose of this article is to direct attention to the somewhat neglected subject of smoke;its possible advantages; its disadvantages and limitations; and last, but of great importance, to call attention to the unsolved problem of defense against hostile smoke. It is well to enumerate here some of the outstanding possibilities of its use.

1. Smoke may cover an approach of troops across open terrain which is subject to withering hostile fire. It should thus speed up the advance, result in fewer casualties, and cause less expenditure of ammunition.

2. Smoke may conceal the direction of attack or the place of origin of the main blow. It will conceal the movement of reserves, may lead the enemy to draw false conclusions and hold hostile reserves inactive until too late for their decisive use.

3. Smoke may be used to cover troops in withdrawal and to delay hostile pursuit.

4. Smoke may cover landing parties on hostile shores.

5. Smoke may cover river crossings.

6. Smoke may cover gaps in a line or exposed flanks, troop concentrations, routes of approach, working parties and carrying parties. It may conceal important roads, fords, bridges and important establishments; it may render hostile searchlights and air observation ineffective; it may conceal the flashes of artillery.

7. Smoke, mixed with toxic gas, may force masking and thus hamper hostile communication to an even greater extent as well as to lower enemy morale.

8. Smoke may be used to neutralize hostile weapons. Its neutralizing effect compared with artillery fire is very high. All direct fire weapons are at a tremendous disadvantage when targets become invisible; and indirect fire weapons are at a like disadvantage when the observation posts serving them cease to function.

9. Smoke may be used in making feints against hostile positions.

a. By setting up a smoke screen the enemy may be led to fire his defensive fires on unoccupied terrain, while the main effort can go forward with greater strength and correspondingly greater chances of success.

b. A screen may influence an enemy to man his defenses and thus cause him to disclose his plans.

c. Screens may be developed on several occasions without being followed by attacks - when the attack is finally launched under cover of a screen, it may result in surprise.

d. Simultaneous screens may be established on several fronts with an attack behind only one of them - this should serve to pin the enemy to his position and allow the attack the greatest possible opportunity for success.

10. Smoke used in limited quantities by smaller units, such as the squad, and platoon, offers almost unlimited possibilities in screening the advance against machine gun nests, combat groups or other hostile defenses which would ordinarily stop the advance, or without smoke, could only be taken at tremendous cost.

11. Smoke, while primarily considered as a screening or obscuring agent, may produce other effects which should not be disregarded. White phosphorus, our best smoke material, is likewise a casualty-producing and an incendiary agent. It produces painful burns which are slow to heal and poisons the human system. As an incendiary agent it will set fire to light construction work, such as modern camouflage material,and will burn dry grass or brush. The probability and effect of setting up a conflagration must be carefully studied in its use.

The above listing of the more important uses for smoke should not create the impression that it is a general panacea or that its use is freely recommended. It is only when time, place and conditions are opportune that it can be used to maximum advantage.

Chief among the conditions which control the use of smoke,is weather. Both wind direction and velocity have a direct bearing. A wind which blows smoke back upon our own troops is a boomerang which presents to our own forces all the difficulties which we are attempting to inflict upon the enemy. When the wind velocity is greater than sixteen miles per hour, a smoke cloud is rapidly dissipated and the maintenance of an effective and economical screen becomes practically impossible. A wind of from four to sixteen miles per hour will generally favor the use of smoke, while a wind of from six to nine miles per hour is considered ideal. A cross wind is more economical in material than wind from any other direction. Other weather conditions which affect the smoke screen are low barometric pressures, heat and sunshine which cause smoke to rise more rapidly, and high barometric pressure, cold, clouds,and dampness, which cause smoke to linger for longer periods of time.

From the point of view of terrain, it is well to note that in rolling or mountainous country smoke will fill valleys or other depressions and endure for longer periods of time. It will move with natural air currents in broken country and will

linger in woods and villages.

Smoke can be expected to attract the attention of the enemy and may bring down heavy hostile fire, and like the artillery preparation, it may disclose the time of attack. It may furnish the necessary cover for a beaten enemy to conduct an orderly withdrawal,or for an unbeaten enemy to mass his reserves for counter-attack. It may furnish cover for an enemy to move forces to a flank from which he can enfilade our attack. To obviate these latter possibilities will require our own observation to be so disposed that we will not be denied accurate information of hostile movements.

The greatest coordination must be secured, in using smoke, so that the fire of our supporting artillery and other units will not be blinded and rob the attack of its maximum fire power. In this connection it is well to note that smoke has its greatest value in the attack. To screen our own defensive fires will paralyze the defense by preventing carefully coordinated aimed and observed fire against an advancing enemy. Hence, in defensive situations,we may expect to find smoke used principally in the hostile rear areas where it will not interfere with the small arms or artillery fire of the defending troops.

Since the fire of supporting weapons must generally cease before attacking troops reach assault positions, the smoke screen is primarily useful in covering the approach march and deployment. The screen will generally lift when the infantry is from two hundred to three hundred yards from the hostile position. This is especially true when the screen is being maintained by mortar fire. From this distance on, the screen may be maintained by artillery fire to some extent or it may be possible for the infantry to devise means of maintaining its own screen for the last few minutes before the assault is made.

The supply of smoke material presents a considerable problem in itself. Its value, compared to high explosives, must be carefully studied for various situations and the amounts of each to be used in any situation must be carefully balanced. The trend towards the close of the World War was to increase the supply of chemicals, including smoke. It remains for future training and experimentation to determine the proper proportions and work out the details of supply.

Reference has been made above to the unsolved problem of defense against hostile smoke. While its solution concerns all branches of the Service, it is vitally important to the infantry, that it be able to stop the hostile attacks while operating within smoke screens. The problem is not solved in this article, but suggestions as to possible lines of action open to the infantry are enumerated. Attempts of the Chemical Warfare Service to disperse gas clouds have failed and it seems highly improbable that means of dispersing smoke clouds will materialize in the near future, if any such practical means are ever found.

Infantry must be thoroughly trained in smoke so as to minimize the tactical advantages accruing to the enemy who uses it. Since night conditions prevail in a screen, infantry must be highly trained in maintaining directions and communications at night. It has been suggested that a simple system of light signals be used to pierce the fog of smoke and assist in maintaining the cohesion of units. Infantry should be prepared to move forward to the far edge of the smoke where aimed fire and observation are again possible; or it may move to a flank from which it can enfilade a hostile attack; or it may withdraw to a prepared position in rear where the effect of the original screen will be lost to the enemy.

Greater delaying force should be placed in the outpost lines. This is especially true in deployed and position defense. Observation at least must be well forward of the hostile screen to warn of attack, and such observation must be provided with immediate communication with the main line of resistance in order that no time will be lost in putting into effect any prearranged plan for meeting such attacks.

Greater coordination of defensive fires must be sought in all classes of defense. Artillery and other weapons with unobstructed observation on the flanks of the hostile screen must be prepared to assist with defensive fires - an effect which calls for wider contingent zones and alternate emplacements to cover fronts of extreme width and at extreme ranges.

Small arms fire must be so coordinated that the covering of all portions of the front, even under conditions of night firing, will be assured. Automatic rifles may be so sighted on tripod mounts, in vises or by other mechanical devices so that

this effectiveness will not be entirely lost.

Aviation must be maintained alert, to take the air at an instant's notice and conduct battle reconnaissance behind the enemy's screen, to keep both artillery and infantry informed of every hostile movement.

Finally smoke offers the possibility of the attacker closing more often with the defender. It will become more difficult for the defense to repulse an attack by the means of fire alone. This should tend to increase the amount of hand to hand fighting to be expected. The bayonet and the pistol will serve a purpose here and greater stress placed on training in individual combat will further strengthen the defenders' chances of a successful repulse.

Notwithstanding the disadvantages and limitations in the use of smoke, it must be admitted that the occasions when it can be used to advantage, are almost innumerable. Authorities are agreed that the use of smoke in future battles will be limited solely by the amount of material available and the ingenuity and resourcefulness of commanders. Hence, it becomes the duty of officers of all grades and of all branches of the service to become familiar with smoke and its tactical employment.

That smoke is particularly vital to the infantry should be a well-established fact. And the infantry training in time of peace should deal with smoke as both an offensive and a defensive weapon. It should be a mission of infantry to develop smoke and arrange for its coordination and use with supporting branches. As an early step in the proper direction, it is urged that movement be instituted to provide adequate allowances of smoke so that its use in infantry training, both in garrison and in maneuvers, will become the rule rather than the exception.

GRENADES AND INFANTRY ARMAMENT

By: Major Paul E. Peabody, Inf.

Last year a new organization for the infantry regiment was adopted. This organization followed in the main its predecessor except that the fire power and sustained fighting life were materially strengthened. In accomplishing this result machine guns were increased from 24 to 48 distributed among four

companies one of which was the regimental machine gun company. The number of automatic rifles was doubled in number, each rifle squad containing two guns instead of one. A regimental cannon company of four platoons, each of two 37 mm guns and two 75 mm mortars was organized as a substitute for the former Howitzer Company which had a total strength of but three guns and three mortars. In man power the new unit was 16% stronger than the old while in weapons it was double its forerunner.

It was hoped that this organization would possess marked advantages in sustained combat life and driving power. Experiments in the field, so far as could be indulged in in peace, demonstrated that in all probability the unit would live up to expectations. On the other hand experiments and study also demonstrated that the increase in weapons, particularly of machine guns, required much greater frontages for battalions, lengthened the column on the road, was slower to move and all in all resulted in poor maneuverability and controlability.

As an example, it will be recalled that with the 1929 organization, a battalion in a main effort attack would have a zone about 600 yards in width. With the 1930 regiment a battalion under similar conditions would be given a front of about 1000 yards. In the defense this same battalion would occupy a position about 1600 yards in width while its predecessor would cover about 800 to 1000 yards.

In certain types of terrain it was found to be a difficult thing to employ all available machine guns and cannon company weapons in the attack without making intervals so great as to practically lose control by the battalion.

The increased width mentioned above was accompanied by an increase in depth - the two together making control more important and at the same time more difficult.

It is interesting to note that the divisional organization employing this regiment made no provision for increasing the strength in artillery pieces. The result was a decrease in artillery brougnt about by the increased infantry frontages.

It is apparent at once that the ammunition requirements for the new organization were much greater than formerly had been the case. Approximately 45 tons of infantry ammunition

were required to fill all combat and company trains. This is three-fourths of the entire rolling reserves carried by the service trains of the division.

Very significant in this connection is the fact that the infantry regiment - and the following applies to the 1929 organization as well as to the 1930 unit - requires approximately 34 classes of ammunition. By the expression class is included different loadings of the same calibre of ammunition, different kinds and calibres of ammunition, and the several kinds of pyrotechnics prescribed. To show why different loadings of the same calibre of ammunition are considered as different classes we find that while the rifle, the automatic rifle, and the machine gun all fire .30 calibre, this ammunition must be loaded in different containers or carriers for each weapon. The rifle requires a clip, the automatic a magazine and the machine gun a belt. Ordnance plans for the next war include packing .30 calibre ammunition at the factory in expendible carriers for each weapon.

Among the 34 classes of ammunition mentioned above are found grenades, hand and rifle. Basic allowances prescribe at present that the war equipment shall include fragmentation and smoke grenades for both the hand and rifle type. It is interesting to note that the hand grenade reaches the rifle company in two parts, the fuze and the body proper, while with the rifle grenade four parts are essential,namely the body proper the fuze a thong to be attached to the body and a special cartridge with which to fire the grenade - another type of ammunition with but one use. Members of the company must prepare the grenade before issue to the soldier. In addition the soldier must be equipped with a special gadget in which to carry the grenades.

The picture is discouragingly complicated for if these things are to be done there must be training in how to do them. The training of that personnel responsible for the resupply of ammunition is small compared to the training required of the personnel in its proper use technically and tactically. Superimposed on this is the training required of the battalion commander who directs the training of his unit and who is to fight it in the face of an enemy. It is not an impossible task, provided time exists but therein lies the joker. Time isn't going to exist. Certainly if we assure that there will be time we are gambling with a highly fluctuating commodity.

Fortunately there is a ray of hope. The organization adopted in 1930 has been discarded in 1931 and the door is open to adopt a new one. The reader may properly wonder why, since the 1930 unit has been set aside, any mention should have been made of it in this discussion on grenades. Small as they may appear grenades are an indication of just what has been happening to the infantry organization ever since the World War. And the 1930 regiment is a culminating example of the influence of static warfare. Gradually but surely infantryman and the infantry regiment - or more properly the battalion - is becoming an all purpose weapon. We are trying to acquire unto ourselves all kinds and sorts of weapons and are making of the infantryman,and artilleryman, an engineer, a chemical warfare man etc, etc. At the same time we increase our immobility and become more cumbersome until eventually our feet will no longer carry us.

We need an over-haul and a thorough reorganization to meet the demands of modern infantrymen. And this reorganization should be based on the employment of our troops in the United States and consequently prepared for warfare of movement. Simplicity, flexibility, maneuverability and fire power are primary requisits. A six man squad, a three regiment division with a greater proportion of artillery fire per yard of front appear as desirable changes. The Pederson type of individual weapon should supplant the present Springfield.

But more important than any other one thing and basic in its influence regardless of the organization adopted is the need for reducing the load carried by the individual rifleman whose sole means of movement are his two legs. It is a matter of common knowledge that the rifleman is overloaded and it is equally well known that the mobility of infantry units is based upon the foot soldier. Yet the tendency is to keep adding more and more stuff on to his back. At present he carries about 85 pounds of clothing and equipment.

In approaching a solution to the question, and its a hard one to solve, it is believed that every article should be examined and a decision reacned whether the item in question is essential or simply desirable. And we must remember that we are organizing for a war in the United States and a war of movement. If we go overseas again modifications can be made then, as they will be anyway. Furthermore we must remember that the rifleman is primarily a rifleman, not a cannon nor an air bomb however

much we might want him to be both at one time or another.

Among those items which are now prescribed for the rifleman are grenades. They are issued to him from the combat train at the same time "extra" ammunition is issued. While nothing is laid down as to who in the squad is to carry them, the Infantry School advocates distributing the hand grenades among the riflemen and the rifle grenades to one member known as the grenadier.

Whether this is the best method makes little difference. The fact remains that somebody in the squad must carry them and that somebody progresses across the battlefield by short runs, or long periods of snake like movements on the surface of the ground, under conditions demanding an alert mind and a nimble body.

Granting for the moment the false premise that weight does not retard a man's movements, we find that the grenade is best used against personnel in positions which cannot be easily reached by rifle fire. The target must be comparatively close to the firer and when employing smoke grenades wind conditions must be favorable. Under certain conditions grenades have demonstrated their usefulness but with all their use in the past war, which incidently was rather ideal for grenades, it is very doubtful if they, at any time, were decisive weapons.

Grenades became prominent in the past war, probably for two reasons. The first and foremost was the fact that much fighting was done from extensive trench systems where grenades were rather excellent weapons especially for clearing dugouts. The second reason was the apparent inability of supporting weapons, both infantry and artillery, to bring prompt accurate fire on close-in targets delaying the infantry advance. Both of these conditions may be present in the next war but the probability of extensive trench systems in the United States is not as apparent as was the case in France. Trenches will exist but it is doubtful if they will be as secure against artillery fire as they were in France.

Whether we will ever be able to solve the problem of supporting fire as nicely as it should be is a grave question. If we cannot, it is believed that the rifleman, if not overloaded, can over-come the resistance more effectively by maneuver than

by any other means.

In conclusion it is recommended that in equipping the rifleman for a war of movement that grenades, both hand and rifle be eliminated, primarily for two reasons; to reduce his load, or rather to help reduce it as other items must go likewise, and because the grenade is not a decisive weapon.

It is believed that, when our force becomes stabilized and extensive trench systems appear then and then only is the time to equip the rifleman with grenades. In the meantime they should not be carried even in the division.

THE PHYSIOLOGICAL ACTION AND THERAPEUTIC POTENTIALITIES OF MUSTARD GAS

By: Lieut. Comdr. L. D. Arbuckle, (MC) U. S. Navy

The term "Mustard Gas", under which cognomen bis (B-chlorethyl) sulfide is generally known, is an unfortunate one. By this name many people confuse this most important chemical warfare agent with the true natural mustard oil which is prepared from black mustard seed and is chemically allylisothiocyanate having the following formula $CH_2:CH:CH_2N:CS$. From a purely physical standpoint the classification - Mustard Gas - is also a misnomer, as the substance under ordinary conditions is a heavy oily liquid which solidifies at 14 degrees centigrade.

The vesicant action of mustard together with the clinical course and pathological effects produced by this agent are well known; however the factors which enter into or produce the blistering effect are still debatable. Before going into the subject let us briefly review the laboratory method in the manufacture of mustard together with the products formed by hydrolysis. In the laboratory method of preparation, which was first carefully described by Victor Meyer in 1886, the following operations are involved: Ethylene is prepared by the dehydration of ethyl alcohol; the interaction of hypochlorous acid and ethylene yields ethylene chlorhydrin; when this is treated with sodium sulphide, thiodiglycol and sodium chloride are formed and when thiodiglycol is treated with hydrochloric acid the reaction yields mustard gas and water. The reactions may be written as follows:

C_2H_5OH equals $CH_2:CH_2$ plus H_2O

$CH_2:CH_2$ plus HOCl equals $OHCH_2CH_2Cl$

$2OHCH_2CH_2Cl$ plus Na_2S equals $(OHCH_2CH_2)_2S$ plus 2NaCl

$(OHCH_2CH_2)_2S$ plus 2HCl equals $(ClCH_2CH_2)_2S$ plus $2H_2O$

On contact with water, mustard very slowly hydrolyzes. In this reaction thiodiglycol and hydrochloric acid are formed as follows:

$(ClCH_2CH_2)_2S$ plus $2H_2O$ equals $(OHCH_2CH_2)_2S$ plus 2HCl

From a casual glance at the above reactions it can readily be seen that thiodiglycol and hydrochloric acid are intimately associated with mustard not only in the process of manufacture but also in the products of hydrolysis. Knowing that hydrochloric acid is an escharotic or has a caustic action when applied to the skin, it is only natural and logical that the vesicant action of mustard would be attributed to this agent.

The theory of skin penetration by mustard, its hydrolysis and subsequent production of an intracellular acidosis was first advanced by Marshall. This theory bases its argument upon the fact that mustard while almost insoluble in water is freely soluble in organic solvents and therefore has a high lipoid solubility or partition coefficient. It would on this account be expected to penetrate cells very rapidly; having penetrated the cell it would hydrolyze thereby liberating HCl within the substance of the cell, thus causing the characteristic vesicant action. To summarize this hypothesis, the mechanism of mustard seems to be as follows: (1) Rapid penetration of the substance into the cell by virtue of its high lipoid solubility. (2) Hydrolysis by the water within the cell to form HCl and thiodiglycol. (3) The destructive effect of HCl upon the mechanism of the cell.

Now let us look into this very logical solution of the problem a little further and see if it will withstand the light of logic and scientific experimentation. It is a well known fact that HCl can be injected in relatively large quantities directly into the blood stream without producing any deleterious effect due to the substance being neutralized by the buffer action of the blood, thereby preventing the agent from coming into direct contact with body cells. The application of HCl to the skin causes almost immediately a sensation of pain and burning whereas the application of mustard is devoid of subjective sensation. Both thiodiglycol and HCl are freely soluble in water and very slightly soluble in organic solvents and, therefore, have a low lipoid solubility or partition coefficient.

From this it would be judged that they would not readily penetrate body cells. Granting that mustard rapidly penetrates and produces an intracellular acidosis by reason of the HCl formed, it must be admitted that any substance with a high lipoid solubility and a speed of hydrolysis near that of mustard should give the same effect. For if the toxicity is due solely to the HCl evolved once within the cell any substance yielding HCl by hydrolysis at a rate approaching that of mustard should be toxic in a degree comparable with it. However this is not the case. Let us consider the two products formed by the action of oxidizing agents upon mustard:- one, the sulphoxide, is absolutely inert, - the other, mustard sulphone, is a powerful vesicant, in spite of the fact that the latter has a lipoid solubility of only 1/20 that of mustard and hydrolyzes only 1/100 as fast. Further, by the simple addition of chlorine to the mustard molecule we obtain a harmless compound. From two to four chlorine atoms may be added in a similar manner and none of these compounds is toxic although HCl is one of the products of hydrolysis in each case and the speed of hydrolysis and lipoid solubility is about the same as that of mustard. Mustard undoubtedly does hydrolyze to some extent within the cell; however it certainly has not been proven that the minute quantity of HCl thus produced would have any vesicant action. The smallest droplet of a 1% solution of mustard applied to the skin of the average individual will produce a blister and the quantity of HCl that can be produced by the hydrolysis of this small amount of the agent is almost inconceivably minute. The cells of the body are normally alkaline in reaction and are bathed in alkaline fluids, therefore they can be expected to neutralize and render inert far greater quantities of acid than could be possibly liberated by the hydrolysis of small quantities of mustard gas.

Now let us consider some experimental work on animals conducted for the purpose of comparing the action of mustard, thiodiglycol and HCl upon vital tissue. In this connection it may be stated that mustard when applied to the skin or mucous membrane acts only as a local chemical irritant and has no systemic or constitutional effect, in this respect differing markedly from Lewisite. On the other hand, Warthen and Weller have clearly shown that if mustard is injected into an animal characteristic constitutional symptoms are produced, the time elapsing between injection and the onset of symptoms depending upon the dosage and method employed - whether subcutaneous, intramuscular,

or intravenous. The symptoms and signs adduced are a rapid fall in temperature, salivation, hyperexcitability and convulsions, diarrhoea, muscular weakness with a terminal coma preceding death. When mustard is injected intravenously nervous symptoms predominate; when injected subcutaneously intestinal symptoms are more pronounced.

Now let us compare the effects of mustard with its hydrolysis products in animal experimentation. First we will consider the action of mustard. (In this work the rabbit was the animal of choice although dogs were, at times, employed).

A subcutaneous injection of 0.06cc of mustard: The injection caused no apparent pain or signs of local irritation. Diarrhoea developed on the second day and continued to the seventh day. Animal died on the twelfth day. At autopsy there was edema at the site of injection but no surface lesion. A simple catarrhal enteritis was the only important pathological finding.

An intravenous injection of 0.06cc was followed in a few minutes by hyperexcitability, general convulsions, marked reduction in temperature and death within three hours. No important pathological changes found at autopsy. Now we will consider the effect or corresponding or greater amounts of thiodiglycol upon animals to determine if this hydrolysis product of mustard is important from the standpoint of specific action.

A subcutaneous injection of 0.60cc of thiodiglycol produces no evidence of local irritation, no local lesion, no diarrhoea, no symptoms of any kind. Animal eats and apparently enjoys life the moment released.

An intravenous injection of 0.30cc of thiodiglycol causes no local reaction or systemic manifestations. No pathological lesions found at autopsy.

Since it is generally assumed that the deleterious effect of mustard is due to the HCl formed, it will be interesting to see what effect this chemical agent has upon the animal.

A subcutaneous injection of 0.60cc HCl. (This is 10 times the amount of mustard used in a similar experiment). Results: Intensive local reaction; no constitutional symptoms.

Immediately after injection there was evidence of severe pain which lasted for 5 minutes, this was manifested by marked contraction of the muscles and skin in the affected area. At autopsy no pathological lesions were found with the exception of extensive eschar formation at the site of injection. Now it is logical for one to assume that if the same quantity of mustard had been used as that of the HCl employed similar results might have been attained. To forestall this argument the experiment was carried out exactly as that given above except that mustard was substituted for HCl; however the results were diametrically opposite. With the use of mustard there was no pain whatever or evidence of local irritation but animal soon developed a severe diarrhoea and died within 48 hours.

An intravenous injection of 0.06cc HCl. Results: No symptoms whatever either local or general. No pathological lesions demonstrated with the exception of a thrombophlebitis at the site of injection.

To briefly summarize: When pure mustard is injected subcutaneously or intravenously in doses varying from 0.015cc up to 0.60cc the injections are apparently painless and the animal shows no signs of discomfort, however following a latent period, the time interval depending upon the size of the dose and the method of injection, constitutional symptoms ensue which usually lead to the death of the animal and which are characteristically intestinal if the substance has been given subcutaneously or nervous if given intravenously. In contrast to the anaesthetic action of mustard HCl causes intense pain together with extensive eschar formation which is entirely different from that produced by mustard. No systemic signs or symptoms are produced by either the subcutaneous or the intravenous injection of HCl. Thiodiglycol produces no effect either locally or systemically. Concluding this specific subject it may be stated that whereas the HCl theory has not been completely overthrown its foundation has been considerably weakened.

I will mention here briefly the other theories in regard to the action of mustard. The unsaturated theory: This theory assumes that the toxicity of mustard depends upon the breaking up of the molecule and the formation of an unsaturated compound. It is a well known fact that the vinyl group has a great influence upon the toxicity of a substance. However experimentation has proven that the toxicity of mustard does not

depend upon the formation of divinylsulphide and no other tonic unsaturated radicle can likely be formed from mustard.

The theory of the reactivity of the sulphur atom: Many compounds are changed by the addition of sulphur to the molecule. However any change in mustard from a valency of two to a higher valency must mean the transition through a non-vesicant compound-mustard sulphoxide. Also it has been definitely proven that the excretion product of neither the sulphoxide which is tetravalent nor the sulphone which is hexavalent contains the bivalent sulphur atom while the excretion product of mustard does contain it. The end product of mustard metabolism has been isolated from the urine but no traces of this product has been found after sulphone or sulphoxide injection. This theory therefore seems to be untenable.

By far the most plausible theory yet advanced is that the action of mustard depends upon the integrity of the entire molecule. By this we mean that the characteristic action or toxicity of a substance is only maintained as long as it remains in the original molecular state and anything which brings about decomposition of this product destroys its action. This view of the action of mustard is now in general scientific accord throughout the World. This theory follows what we know of other complex substances. For example the specific action of strychnine on the motor cells of the cord and other alkaloids used in medicine depend upon their entire molecular structure and are rendered inert or action modified if decomposed.

Now let us discuss very briefly the therapeutic potentialities of Mustard. The great majority of gases used in the World War had been known for years prior to the beginning of hostilities and were employed in commercial enterprises. The many pacific uses of chlorine are known to all. Phosgene has long held an important place in the dye industry, especially in the manufacture of methyl violet. The properties of the organic compound bis (B-chlorethyl) sulfide were understood approximately 30 years prior to the beginning of the War. However Victor Meyer was not interested in the potential value of the compound for war purposes, instead he was seeking for a new chemical which would be of value in the perfume or dye industry. Just because an agent is destructive when employed during war is no reason why the same substance cannot be used, in some way, in peaceful pursuits. The mere mention of the term "Mustard" to

one who has had an unpleasant experience with it immediately brings forth a flow of uncomplimentary and abusive adjectives. However, it may be possible to change this attitude if it can be proven that the substance is beneficial and useful under certain conditions. Let us see if this much maligned agent called mustard has any therapeutic possibilities. Cancer has long been and still remains a scourge to the human race. Any substance which, in any way, would have a deterrant action upon the growth and development of this malignant tumor would most certainly be a boon to mankind. Of course no one at the present time would be so optomistic as to dogmatically state that mustard has any such action upon carcinomatous growth. It has been noted by clinicians, especially those practicing in the British Isles, that cancer does not,or very rarely,develop in those individuals who suffered from the vesicant action of mustard during the war. This knowledge resulted in some research work carried on at the University of Leeds in which mustard was employed in experimental problems relative to new growth development. It is a well known fact that warts will develop upon mice by the repeated application of certain forms of tar. Investigations showed that this warty growth was completely inhibited by the addition of 0.1% mustard to the tar. It is also well established that the repeated application of tar to mice will eventually produce a malignant growth (Cancer). Experimental work was conducted at the University of Leeds in which tests were carried out with carcinogenic tar alone and the same tar in which 0.1% mustard was incorporated. Three (3) groups of mice - 40 in each group - were subjected to the test. To one series of 40 mice carcinogenic tar with the addition of 0.1% was applied. To a second series of 40 mice carcinogenic tar alone was applied. To a third series of 40 mice mustard 0.1% solution in acetone was only applied. These applications were repeated weekly for a period of 50 weeks, or until the death of the animal.

In the first place the mustard gas control series failed to yield a single tumor, thus setting at rest the assumption that mustard alone, due to its chemical irritation, would be instrumental in producing neoplastic growth. In the tar alone series 23 mice developed tumors. In the tar plus mustard series only 4 developed tumors. In the tar alone series 11 mice developed malignant tumors (Cancer). In the tar plus mustard series only two of the mice developed malignant tumors.

Perhaps it is a far cry from the metabolism of a mouse

to that of a human being, however with such results obtained by competent investigators, the anti-carcinogenic action of mustard certainly demands serious consideration.

Now I will touch upon a therapeutic possibility of mustard that will probably,sooner or later, be of vital interest to a great majority of the male population - that is will this agent promote and stimulate the growth of hair. The use of mustard in a very dilute solution will undoubtedly produce a hyperemia of the scalp similar to Tr. Cantharides and other well known "hair restorers", however mustard may have a more specific action than these time honored remedies. In experiments carried out on animals a 0.01% of mustard in 50% alcohol was employed. This was applied to shaven areas with other similar untreated areas acting as controls. The results obtained when the cat was the experimental animal were very promising; the hair growing much more luxuriantly and rapidly in the treated areas than upon the control surfaces. However when other animals were used,such as the guinea pig, the rat and the rabbit, the results were very discouraging. Therefore with the information now available on this subject, those wishing an abundant growth of hair should first be informed as to the classification in which they belong.

There still remains a further possibility of the advantageous use of mustard in the treatment of certain types of skin affections especially those in which indolence and chronicity are the characteristic factors. I have been unable to find any instances in the literature where mustard has been so employed, but I believe that it is worthy of a trial. There are many forms of skin disease in which the usual drug store remedies are hopelessly inadequate. I believe that I can safely say without fear of successful contradiction that there is no branch of medicine that offers such a field for new and better remedies than that coming under the wide scope of skin affections.

The types of skin disease which might be benefited by the judicious use of mustard are those requiring stimulation and hyperemia production, such as certain forms of Psoriasis and Eczema, the various Keratoses and Granulomatous proliferations together with the parasitic infections. It is in the treatment of the parasitic skin diseases that mustard or some similar agent will find its greatest field of usefulness. Anyone who has had a good case of Epidermophytosis - commonly known as dhobie itch or socially known as "Athlete's Foot" will agree as to the

difficulties encountered in complete and permanent eradication.

No one knows what the future holds for this agent, Bis (B-Chlorethyl) sulfide. When the substance was first introduced as a war gas the British would not countenance its manufacture or use,stating that the agent was of little tactical value; however this erroneous idea was soon changed. Our knowledge of the peacetime use of mustard is meager and limited. When we gain a fuller conception of its possibilities and the methods of application who can say that our ideas may not also change and instead of the despised "Hellish Stuff" (HS) we will joyously acclaim it "Heavenly Stuff" (HS).

CARRYING OUT A UNIT PROGRAM

By: Lieut. Thos. J. Ford, C.W.S.

After the regimental program has been issued those responsible for its execution are largely concerned with methods of instruction. It is not particularly difficult to take from pedagogy the practical points essential to good teaching and apply these to our chemical warfare instruction in its three phases. The difficult part comes about through the fact that unit personnel will rarely ever have adequate training supplies and equipment. The unit instructor will not be able to follow the normal procedure; he will have to make many substitutions for desirable training supplies and he will have to tax his ingenuity to find suitable methods of presenting the subject.

It is a comparatively easy task to draw up a general plan for the training of a regiment. It is more difficult to prepare a definite plan for a specific regiment for the simple reason that in the latter case the chemical warfare training must be carefully coordinated with other training requirements and with training conditions as they actually exist in the said unit. It is likewise a simple problem to prescribe from a staff office what were good to do; but it is a different problem to the unit gas officer or other instructor who is charged with doing it. The plan may look good on paper,but there may be untold difficulties in carrying it out in its entirety. In presenting a desirable plan, The Chemical Warfare School is well aware of the fact that there are numerous obstacles in the way of equipment, lack of training time, and lack of qualified personnel. There is no denying the fact that in most of our regiments the

desirable plan cannot be completely carried out, nevertheless we must keep the ideal in mind and include as much of it in our programs as conditions will permit.

In this article I hope to outline some of the things that can be carried out in the average infantry regiment under present conditions and with present allowances of equipment and munitions. We might state the conditions as follows:

You are a captain of infantry who has recently graduated from the Line and Staff Class or the Unit Gas Officers' Class of The Chemical Warfare School. You have been appointed regimental gas officer and have been detailed as instructor of the Officers' School. You are expected to supervise the training of the regiment in chemical warfare,to advise company commanders in the preparation of schedules and to assist the regimental plans and training officer in the introduction of chemicals into field exercises. You take an inventory of your training supplies and equipment and find that the regimental allowance of 90 CN candles and 100 smoke candles are available; that each company has an allowance by conversion of obsolete smoke grenades of 45 CN hand grenades. You also find that each company has its allowance of 15 gas masks. The Corps Area Chemical Officer has informed you that he will loan you his museum material and that he will occasionally be able to assist in your instruction.

Under these conditions,how much training and what kind of training can you carry out?

The first thing that we are interested in is the Officers' School. This school has a two-fold purpose - namely, the general education of all the officers of the command and to qualify company and battalion officers to instruct their respective organizations in the company and tactical training phase. A primary requisite to the conduct of a thorough course in the school phase is texts. Chemical Warfare School texts will usually not be available for use in regimental schools and even though they should be available they are too voluminous and too technical to be very suitable for this purpose. Chapter 8,Basic Field Manual, Vol. I, "Defense Against Chemical Attack" will be devoted to chemical agents and individual protection. Section 6, Vol. VIII,"Security Against Chemical Attack" of the same manual, will cover certain phases of collective protection. These publications, together with Training Regulations 155-5,will provide

in condensed form practically all literature that will be needed in unit training. The manual has not yet been published, but it is expected that it will be available for distribution before the end of the current year. In the meantime, Training Regulations 195-5, "Protective Shelters", Training Regulations 415-15, "Tactical Uses of Smoke" and Technical Regulations 1120-5, "Candles", Technical Regulations 1120-35, "The Gas Mask" and Technical Regulations 1350-B, "Hand Grenades", are available and can be used to good advantage in unit schools. These, however, do not entirely cover the subject of chemical warfare in all its phases and until such time as the training manual is available, some means of supplementing technical and training regulations will have to be devised. The Unit Gas Officer who has graduated from The Chemical Warfare School has his set of School texts and problems. Even though no other literature should be available he can satisfactorily present his course by the free use of the blackboard and by supplementing his classroom instruction with an occasional mimeographed sheet containing essential data on some of the more important topics.

In beginning the officers' school, the instructor should bear in mind that the majority of the officers of the regiment know very little about chemical warfare, while still others have absolutely no conception of this phase of warfare. The greater part of the officers are therefore beginning a course concerning which they have no practical experience and little or no theoretical knowledge. For a class of this kind, the course should begin with a general lecture on "Chemical Warfare". Its purpose is to explain what chemical warfare is, its general scope and application to the unit concerned. This can be very well covered in a period of 30 to 45 minutes. A lecture on the "History and Development of Chemical Warfare" should be presented on the following day and soon thereafter, possibly the same day, the War Department Training Film "Defense Against Chemical Warfare" should be shown. This film can be obtained from the Corps Area Signal Officer at almost any time. Another lecture of a general nature that can be made very interesting to the class is "A Comparative Study of World War Casualties from Gas and Other Weapons". These periods should be sufficient to create interest in chemical warfare and to give the class a good general idea of the subject and its importance in modern warfare. Ample material for all of these lectures can be found in The Chemical Warfare School texts and publications, and slides can be obtained from the Corps Area Chemical Officer to illus-

trate the lecture on World War Casualties.

Continuing in the logical sequence, the next subject with which we are concerned, and the subject which forms the basis of all subsequent instruction, is chemical warfare agents. There is no reason for any officer who has graduated from the Unit Gas Officers' Class or Line and Staff Officers' Class to have any particular fear of this instruction. In preparing this instruction the instructor should bear in mind that the officers of the regiment are not chemists and that it is not his purpose to try to make chemists of them. His objective is to familiarize the officers of the command with the agents that may be used, their capacity for doing harm, their limitations and their methods of action. The first instruction period should be a general discussion of the various types of agents and their general classification with respect to physiological action, persistency and tactical use. The reasons for the various classifications should be pointed out and the general properties of the group should be emphasized from several viewpoints,even at the expense of repetition. The discussion of the various types of agents should be limited to the general properties of each group. Subsequent instruction periods should take up in sequence the detailed presentation of the general properties and methods of action of the various agents of each type. An easy division for instruction periods, following the initial period,is the physiological classification. These in their proper sequence are "Lung Irritants", "Lacrimators", "Vesicants", "Irritant Smokes" and "Screening Smokes". Each of these topics can be covered in about 30 minutes. The first requisite to good teaching is thorough knowledge of the subject and the more thorough the knowledge of the instructor the easier it will be for him to present it to his students. However, it is not necessary for the instructor to memorize a great mass of data in order to efficiently present the instruction on the above topics. The instructor will considerably simplify this problem by putting the essential data on each group of agents on the blackboard and limiting his instruction almost entirely to an explanation of it. While the instructor is discussing any particular agent, any samples that may be available should be passed around to the members of the class. A sniff set containing samples of various agents can be obtained from the Corps Area Chemical Officer. The student should be given opportunity to become thoroughly familiar with the odor of each agent at the time it is being studied in class. One classroom period of 30 to 45 minutes should be devoted to "Chemical

Cloud Travel". In presenting this subject diagrams and examples should be freely used on the blackboard. Practical study and observation can be obtained during the weapons demonstration hereinafter mentioned. Another important part of the agents instruction is "Identification". It is not very likely that the unit gas officer will be able to secure agents in detonation tubes for field identification training. If the instructor can get the Corps Area Chemical Officer to put on this instruction for him it will add greatly to his course; otherwise, the instructor will have to limit this instruction to the use of the sniff bottles. After students have had ample opportunity to become familiar with the odor of the various agents, an interesting,as well as instructive period can be conducted by blindfolding students and grading them on their ability to identify each sample of the sniff-set by its odor.

At first glance it may appear that instruction in Chemical Warfare Weapons will be difficult to present without having the various types available for demonstration. We must remember, however, that the primary object of such a course for infantry officers is to familiarize the student with the characteristics, limitations and possibilities of these weapons,except in the case of the weapons with which the unit is armed. In the latter case, of course, the weapon will be available for demonstration. The unit gas officer can obtain from the Corps Area Chemical Officer a set of drawings showing quite accurately the design of the various chemical weapons. By using these charts and by placing essential data on each weapon on the blackboard, there should be no difficulty in presenting the essential information on chemical weapons that should be known by every infantry officer. The Corps Area Chemical Officer also has sectionalized candles,grenades and chemical shell. He also has a chemical mortar, a cylinder and a Livens projector. It will be possible at many stations to secure this material and thereby add to the classroom instruction. The infantry regiment has its allowance of candles and grenades. These can be shown in class and one or two of each type can be used in the field to demonstrate the functioning of these munitions.

In our weapons course then, our unit gas officer can conduct about five periods in the classroom and one outdoor period. The classroom periods will require from 30 minutes to an hour each and should be divided as follows: "Grenades", "Candles", "Cylinders and Projectors", "Chemical Mortars" and "Chem-

icals by Artillery, Tanks and Air Corps". It will probably appear that the time allotted to "Candles" and "Grenades" is too much in proportion to that allotted other weapons, but it is to be remembered that we are speaking of training in an infantry regiment. Candles and grenades are infantry munitions and the instruction on these weapons should be quite detailed. Another reason for emphasis on candles and grenades is that they are chemical warfare training munitions and the officers of the command should be thoroughly familiar with them. For the outdoor period an hour will be necessary if the class must travel some distance to find a suitable demonstration field.

Although instruction in chemical agents forms the basis of all chemical warfare training, we come to our primary objective when we take up the subcourse in Protection. In the training of the individual, the knowledge of how to defend himself against chemical attack is just as essential as is personal hygiene or first aid and unit training in defense against chemical warfare is just as necessary to combat efficiency as are the principles of maneuver or the use of cover. The basic protective device is the gas mask; we should therefore begin our instruction with a lecture of about 30 minutes in length on this article of equipment. Another reason for beginning the subcourse with this lecture is that in our first gas mask drill it will be necessary for the instructor to mention various parts of the mask in explaining the drills. Unless the student has had opportunity to become familiar with these parts, instruction in gas mask drills in the first periods will be considerably more difficult. For this initial lecture, the issue mask can be used to show the parts described and to demonstrate the manner in which it functions. A sectionalized canister which may be obtained from the Corps Area Chemical Officer, will also be of assistance in presenting this instruction. The instructor may also be able to obtain a salvaged mask, tear it down and mount the component parts on beaver-board for use in class instruction. This initial lecture should be immediately followed by the first gas mask drill. The first drill should be about 45 minutes in length in order to enable the instructor to go through the drill in detail three or four times and to carefully correct all mistakes. For the entire course about four hours of gas mask drills are desirable. The second and all subsequent gas mask drills should not be more than 30 minutes in length. The second period should review the work of the previous day, concluding with a few minutes drill "without the numbers". The third period should cover "In-

spection Drill" in detail and subsequent periods should be devoted to a repetition of all drills for precision and dexterity. The last two drills should require the wearing of the mask while playing games or performing military duties such as marching by map and compass, preparing a situation map, assembling an automatic rifle or machine gun. Gas mask drills should culminate with "The Gas Chamber". It is not likely that any agent other than tear gas will be available or permitted in unit instruction, however, this should serve to test the fit of the mask and to give the students confidence in it. CN capsules will be available from the Corps Area Chemical Officer,or in case of necessity a CN candle can be torn apart and portions of it used to set up a concentration. In view of the powder mixture in the CN candle, care should be exercised to prevent it from coming in direct contact with fire. It will be necessary for the instructor to secure some kind of a room for a gas chamber and this somewhat removed from personnel of the post. In case nothing better is available,a tent can be used by tamping the walls with dirt and keeping the door and ventilation hood closed. In all gas mask drills and gas chamber work the instructor should not forget that efficiency in protection is largely dependent upon gas discipline. This should be impressed upon the student by the rigid compliance with all details of these drills and by letting no errors, however slight, go uncorrected.

Interspersed with gas mask drills there should be a lecture on "Individual Protection" and a lecture on "Collective Protection". The former will cover in detail the functioning and use of the gas mask as well as the various other types of masks, canisters, and items of individual equipment. Sectionalized canisters, various types of masks and protective clothing may be obtained from the Corps Area Chemical Officer for classroom demonstration. For collective protection the only material available from the Corps Area is a model dugout entrance and gas alarm devices. This period will therefore largely confine itself to a presentation of the subject matter of the text as regards demustardization, general protective measures,and the protection of food and equipment. The "Duties of the Unit Gas Officer and Noncommissioned Officer", "First Aid to Gas Casualties", "Standing Orders for Defense Against Gas" and "Chemical Warfare Intelligence" will also be limited to a presentation of the subject matter of The Chemical Warfare School text. The best way to present the subject of "Plans of Protection" is by means of tactical problems such as used at The Chemical Warfare

School. There is at present no gas mask repair kit for issue to troops; however, repair supplies can usually be obtained from the Corps Area Chemical Officer and these can be used in class to actually repair some of the defective masks of the regiment. At the close of the protection subcourse, each student should be required to disinfect his own mask. Solutions of cresol,phenol, or formaldehyde are suitable for this purpose and can usually be obtained from the Post Surgeon.

Only a very small amount of instruction on weather as it relates to chemical warfare can be given in the average infantry regiment. In fact, there appears to be no reason why an infantry officer should be given very much instruction in this subject. He is concerned with only the "Effect of Weather Conditions on the Projection of Chemicals", "Conditions Favorable for an Enemy Gas Attack", and "Wind and Safety Limits". Half an hour of classroom instruction on each of these subjects, using The Chemical Warfare School text as a basis, should be sufficient. These periods should be so arranged in the schedule as to coordinate them with instruction in "Chemical Cloud Travel" previously mentioned under Agents.

The necessity of thorough training of each officer of the regiment in the tactical use of chemicals is too obvious to require comment. This instruction should include the tactical employment of chemicals of all classes and by the various arms of the service. The unit gas officer who has not graduated from the advanced course of his special service school will probably have difficulty in presenting the tactical instruction. It will be better, at least from a psychological standpoint, for such a unit gas officer to assist a graduate of the Command and General Staff School in preparing this instruction and to let the latter officer conduct it. A graduate of the Command and General Staff School,with the assistance of Chemical Warfare School literature on the subject,and with the assistance of a unit gas officer who has graduated from The Chemical Warfare School, should have no difficulty in presenting this course. The following are suggested lecture periods,each requiring from 40 to 50 minutes for presentation:

General Principles of Chemical Warfare Tactics.
Tactical Uses of Smoke.
Technique of Smoke.
Use of Chemicals by Chemical Warfare Troops.

These lectures should be followed by a few well-chosen map problems illustrating some of the tactical principles presented in the lectures. The following are suggested:

The Tactical Use of Smoke.
Chemicals by Chemical Warfare Troops.
Chemicals by Artillery.

Problems used at The Chemical Warfare School are suitable for the above. The problems should preferably be given out on the day preceding the classroom discussion of it. If the student officer is required to stake out his problem and prepare his decision prior to the class period, be that decision right or wrong, he will get more out of it and the time required for the conference and general discussions can be considerably reduced.

The culmination of the tactical instruction of the officers of the regiment will be the introduction of training munitions into field exercises and maneuvers. This, however, will come with the tactical phase of unit training.

Throughout the course the unit gas officer should use every opportunity to train company instructors. If this is done, company officers should be fairly well qualified to conduct the training of their organizations. However, to secure uniformity throughout the regiment a few periods on methods of instruction should be included in the officers' school. The following 30 or 40 minute periods can be well used for this purpose:

Training Methods, General Instruction.
Training Methods, Chemical Warfare Agents.
Training Methods, Protection.
Training Methods, Weapons.

In each of these periods the scope and methods of presenting each of the above phases of company training should be covered.

The instruction that can be given to gas noncommissioned officers varies only slightly from that given in the officers' school and the requirements of instructional material and equipment are practically identical. Whenever practicable,

lecture periods should not be more than 30 minutes in length. The instruction in chemical agents should be confined to general properties,characteristics and physiological action of the individual agents,avoiding all technical data. Instruction in chemical weapons should be limited to "Candles", "Grenades", and one general lecture on "Other Chemical Weapons". The protection course should be identical with the officers' course, with the exception of the problem on "Plans of Protection", which should be eliminated. The tactical course should consist only of two or three short talks on methods of employment that might be expected of an enemy using gas. Instruction in weather and its relation to chemical warfare and conditions favorable to an enemy gas attack can be covered in one period of about 30 minutes. Considerable attention should be given to the methods of instruction to be used in the company training phase.

The training that can be carried out in the company training phase and the methods to be used are sufficiently different from those used in the officers' school to require some discussion. In this phase of chemical warfare training the regimental plan requires company officers to train their organizations in the drills and mechanics of protection,the care and use of protective equipment, when to use it and how to use it, and in the functioning of the chemical weapons of infantry. In company training all highly technical instruction must be avoided. Outdoor drills and exercises must take the place of lecture periods insofar as practicable and when not practicable the latter should take the form of informal talks, not more than 15 or 20 minutes in length and in language that the soldier can understand. These short talks must be made as easy and as practicable as possible by the demonstration, during the discussion of them, of all possible items of equipment and material.

There are only 15 gas masks in each company. It will therefore be necessary to pool gas masks by battalion or company in order to train a complete unit at one time. The better method is to pool them by battalion and let each battalion commander train his unit in turn. However, in single battalion posts it will probably be necessary to pool them by company unless a temporary transfer from nearby posts can be effected.

In the average company very little is known about chemical warfare. There will frequently be not a single man in the company, outside of the gas noncommissioned officers, who

have any idea of this method of warfare. The course should therefore begin with a short talk or 15 or 20 minutes on "Chemical Warfare", telling the members of the company what it is, how it causes casualties and how we can minimize these casualties by training. The instructor should emphasize the result of not being properly trained and the fact that casualties do not mean death or permanent disability. Lantern slides illustrating these points can be obtained from the Corps Area Chemical Officer. Tne use of these will emphasize the essential parts of the talk and will impress the student long after the words of the instructor have been forgotten. This initial lecture should be followed a day or two later with the film "Defense Against Chemical Warfare". In view of the necessity of returning both films and slides as soon as possible, the unit gas officer should preferably assemble the entire regiment at the post theatre and should personally conduct the initial lecture and the showing of the training film.

The material available for instruction of enlisted men of the company in chemical warfare agents will be the same as in the officers' course. The instruction periods should be divided into a general period, a period on lung irritants, lacrimators, vesicants, irritant smokes and screening smokes. As mentioned above, these talks will be short, somewhat informal and will be limited to a general description of the agent and its method of action. The sniff-set method of training in identification will be impracticable and this instruction, valuable as it is, will have to be left out until field identification supplies are available.

Instruction in chemical weapons should include one or two short talks on how gases are projected by the various types of chemical weapons and one period each on candles and grenades. The sectionalized material and drawings mentioned in the officers' course can be advantageously used in these periods. Two or three fifteen minute periods should be devoted to grenade drills, using the dummy grenades provided by A.R. 775-10. The final instruction period should be a field demonstration of chemical candles and grenades. In view of the necessity of conserving ammunition only a very few of each type munition should be expended in a purely materiel demonstration.

The principal part of the company training program is that of protection. For reasons previously stated this course

should begin with a talk on the gas mask. A more detailed description of the mask and its limitations should follow a day or two after the initial talk and then in turn such additional periods as "Other Masks and Canisters", "Protective Shelters", "Demustardization", "Protection of Supplies and Equipment", "First Aid" and "Duties of Gas Sentries", using such instructional materials as have been previously mentioned. A practical demonstration in demustardization cannot be carried out without protective clothing,a simulated mustard and disinfectants,and since these are not available, such a demonstration should not be attempted. Gas mask drills and gas chamber work will be similar to that prescribed for the officers' course. A number of periods should be scheduled requiring the soldier to wear the mask while playing games, drilling and performing various military duties. Before turning over masks to the next battalion, each soldier should be required to disinfect his mask.

Any instruction that may be necessary in the training of the individual soldier on the effects of various weather conditions on the projection of chemicals can be included under the training of gas sentries and under the heading of conditions favorable for an enemy gas attack.

It is hardly worth while to spend much time and effort in lecturing to the company on the subject of chemical warfare tactics. Anything that is attempted along the line of tactical instruction should be in the nature of practical field exercises. The greater part of this will come in battalion and regimental exercises. The company allowance of tear gas grenades is available for tactical training in the company and these can be very profitably used in small tactical exercises to represent enemy gas attacks. In these exercises we will not attempt any particular tactical lessons, but will try to instruct gas sentries and to teach the company the importance of gas discipline.

In the field training phase of unit training we are concerned with the introduction of chemical warfare features into the normal field exercises of the unit. The object of these exercises in our training scheme is to put into practice in the field the things that have been taught in the preceding school phase and company training phase. There is available for this training an allowance of 90 tear gas candles and 100 smoke candles. Smoke candles may be substituted for tear gas candles, or vice versa, on the basis of money value. It has usually been

found desirable to convert about forty of the tear gas candles into smoke, making available for training purposes about 50 tear gas candles and 160 smoke candles. If these are carefully expended several valuable exercises can be conducted. These exercises may be conducted by either battalion or regiment; however more instruction can be given in regimental exercises, using one battalion as attacker and one as defender, while the third observes or fills in as replacements. With average wind conditions these allowances are ample for two exercises in the tactical use of smoke, assuming that our peace-strength battalion will have a frontage of not more than 300 yards; and at least three exercises can be conducted under favorable wind conditions. The tear gas candles will be sufficient for two or three simulated gas attacks. The following are suggested exercises:

The Influence of Smoke on Aimed Rifle Fire.
The Use of Smoke to Cover Infantry Attack.
The Use of Smoke to Cover Infantry Withdrawal.
The Use of Smoke to Cover Minor Tactical Situations.
The Use of Smoke in River Crossings.
The Employment of Chemical Agents in Civil Disturbances.
The Use of Gas in Harassing Fire.
The Use of Gas in Interdiction Fire.
Casualty Fire with Gas.

There should be no particular difficulty in carrying out any of the above exercises. It is simply a question of writing a normal field problem to fit the organization and terrain available, putting into the problem sound tactical principles and introducing smoke or gas into it in a logical way and without forcing the situation. Such exercises will be helpful not only in teaching chemical warfare, but in teaching basic tactics as well.

Following this article is an example of this type of exercise, showing the tactical principles involved as regards chemical warfare, the details of the exercise and the technique of introducing chemicals. Telephone wire, electric squibs and an automobile battery are desirable, though not essential. Automobile batteries and telephone wire are available at any post. Electric squibs may at times be available from the Corps Area Chemical Officer, or, if not, they can be purchased from the Corps of Engineers at about four cents each or from commercial con-

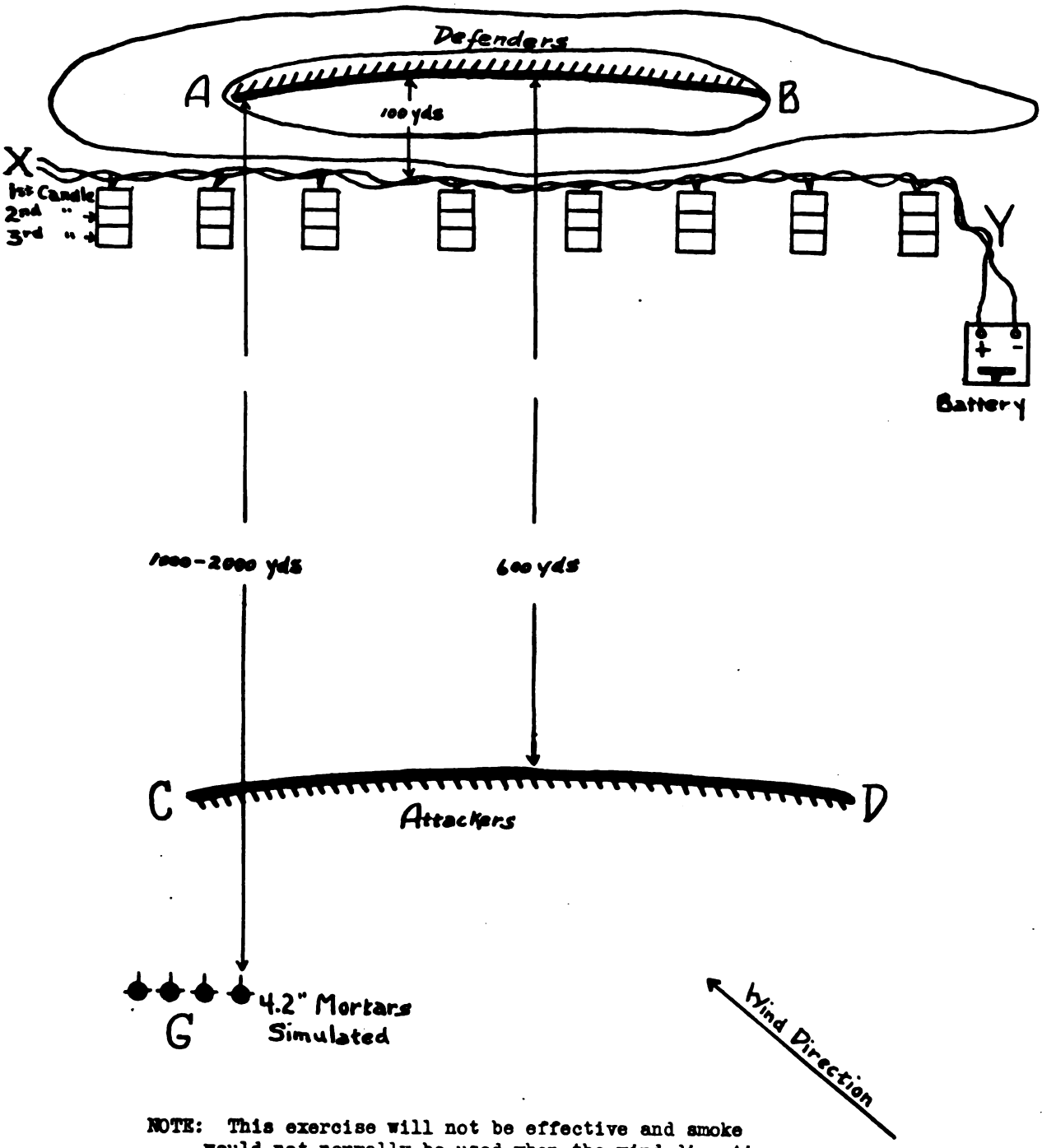
cerns at a slightly higher cost.

Considering again the program as a whole, these various methods and means of carrying out a unit program as set forth in this article are merely suggestions. No doubt many other methods will suggest themselves to the unit gas officer as he proceeds with the course. All of the things mentioned can be carried out in the average regiment under average peace-time training conditions, but they can't be carried out without a great deal of work on the part of the unit gas officer. They can't be carried out effectively if this graduate of The Chemical Warfare School - this regimental gas officer - is required to command a company or perform other military duties during the time that he is carrying out and supervising this instruction. It will take all of his time and many of his evening hours to do this task well. If he efficiently carries out this course, he will not present quite all of the instruction that we would put in a desirable program, but he will go a long way toward it.

TRAINING EXERCISE
in
USE OF SMOKE TO COVER AN INFANTRY ATTACK

Principles Involved.

The principle of smoke tactics is to deny the enemy the power of aimed fire or of observation, or both, without hampering the action of friendly troops. By placing smoke on the enemy line or immediately in front of it, the enemy is placed in the position of not being able to observe the attacking force. He is likewise unable to deliver aimed fire on the attacking force and furthermore he has no auxiliary aiming point to assist him in delivering indirect fire. It is true that our own forces will not be able to deliver aimed fire on the enemy, but the smoke cloud and intervening terrain will offer auxiliary aiming points which give our fire an advantage of 3 to 1 over the enemy, other factors being equal. Another advantage to our force will be its ability to advance rapidly under cover of smoke over open terrain to within striking distance of the enemy and without suffering the losses incident to aimed fire. The defending troops in this situation are kept in ignorance of the progress of the attacking troops and when the smoke lifts and the charge is made our forces may gain many of the advantages of surprise.



NOTE: This exercise will not be effective and smoke would not normally be used when the wind direction is such as to blow the smoke back on the attackers.

Smoke in situations of this kind may be laid down by artillery or chemical mortars. The mortar will probably be used in most situations. Firing will ordinarily begin one minute before the jump-off of attacking troops in order to give time for the building up of an effective screen. Firing will cease when troops have advanced to within 300 yards of the enemy line. The rate of the infantry advance is estimated at 100 yards in 2 to 3 minutes. (The smaller figure is used in this problem).

Details of the Exercise.

a. Tactical Details. A normal tactical situation is written requiring the first battalion to occupy a defensive position along the line A-B. (See sketch).

The second battalion is on the offensive side of the situation and has been stopped along the line C-D.

A platoon of chemical troops (4 - 4.2 chemical mortars) is attached to the second battalion and is now in the vicinity of.....

The second battalion, supported by the chemical platoon is ordered to attack the position A-B at H-hour.

The chemical platoon from positions in the vicinity of G, is directed to cover the attack with a blanketing smoke on the enemy line from H-1 minute to H plus 6 minutes.

b. Technique. The chemical platoon is simulated and the blanketing smoke required for the exercise is put down by means of smoke candles along the line X-Y. When the smoke screen is effective, the second battalion advances at the prescribed rate. As the smoke lifts the second battalion delivers its assault.

The result will be considerably more effective if the smoke candles along the line X-Y are ignited electrically. Firing details across the terrain over which the advance is to be made will tend to spoil the tactical effect from the attacker's point of view and will destroy the element of surprise for the defenders. Electrical ignition requires double telephone wire across the front, electric squibs and automobile batteries or an exploder box. The double wire is stretched across the

field along the line X-Y. Squibs are hooked-in to the telephone wire in parallel (series if exploder-box is used) at intervals of 15 or 20 yards, as wind conditions require, and the squib is taped to the candle as prescribed for electrical ignition. The time for maintaining the screen in this problem requires three candles at each point of ignition. The second and third candle are taped to the first as shown in the diagram. The end of the telephone wire line extends to cover on the flank. At H-1 minute the loose ends of the wire are touched to the poles of the battery and ignition of the candles across the front results. A well-charged battery of 6 volts is sufficient for 600 or 700 feet of wire.

In case equipment for electrical discharge is not available, a fairly good method of keeping firing details from view is to dig small pits at 30-yard intervals across the front and have one man hidden in each pit. At a pre-arranged signal each man ignites candles and tosses them to his right and left as required to maintain the screen.

Variations.

With a suitable wind to blow the gas over the defenser's position, an interesting variation in this exercise can be made by mixing a few tear gas candles in with the smoke. These may represent the firing of gas by the enemy for harassing purposes, and to further reduce the efficiency of defending troops by forcing them to wear the gas mask. In any situation where tear gas is used, all defending troops must be equipped with gas masks and the gas used sufficiently early in the action to insure its dissipation by the time the attacking troops cross the line of release.