Volume 19 October, 1933 No. 4

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

Edgewood Arsenal, Maryland

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COMMANDANT, THE CHEMICAL WARFARE SCHOOL

LIEUTENANT COLONEL J. W. LYON, C. W. S.

Lieut. Colonel J. W. Lyon, Chemical Warfare Service was designated as Commanding Officer of Edgewood Arsenal and Commandant of The Chemical Warfare School by War Department orders to succeed Major General C. E. Brigham after his appointment as Chief of the Chemical Warfare Service.

Colonel Lyon was the Executive Officer of Edgewood Arsenal under General Brigham from 1929 until the promotion of the latter in May of this year.

CHEMICAL WARFARE

VOL. 19 OCTOBER, 1933 NO. 4

TACTICAL EMPLOYMENT OF MECHANIZED CAVALRY

By: Captain Rhey T. Hollett, Cavalry

NOTE: This is the third of a series of articles on Mechanized Cavalry and Chemicals.

The tactical employment of mechanized Cavalry is still a project for development. The principles set forth herewith are based on experiment and experience with such elements in both the United States and foreign countries. The success of mechanized combat depends on the application of the following tactical principles:

Early and thorough reconnaissance.
Prompt decisions and their rapid dissemination.
Maximum surprise thru speed of maneuver.
Maximum use of mobility to turn or envelop hostile positions, hastily prepared position.
Use of simple fixed formations.
Maximum use of the tremendous shock power of the combat car to smother resistance.

AMMUNITION AND SUPPLIES. - The ammunition and supplies, carried within the regiment, are adequate for two days operations.

RATES OF MARCH. - On average roads, the rates of march per hour are as follows: Day - Troops, only 20; Troops and Trains, 16; Night - with lights, 12; without lights, 10. On hard surface roads these rates may be increased.

Over suitable terrain the maneuvering rate is about 15 mph, while from 20 to 30 mph may be expected in the attack proper. Movements across country during darkness are at 7 mph with lights and 3 mph without lights.

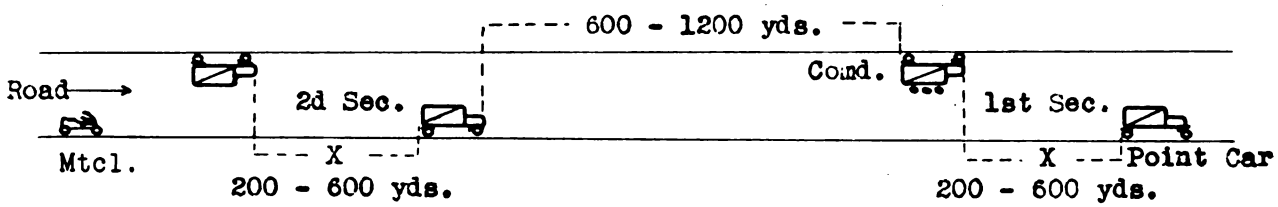
RADIO COMMUNICATION. - With vehicles in motion, voice radio is dependable up to 10 miles and the telegraph radio from 25 to 60 miles.

The Armored Car Troop normally operates under the commander of the covering squadron of which it is a part. The more important functions of this organization are distant reconnaissance, bat-

tle reconnaissance, security, and light combat. The troop rarely operates as a tactical unit, since it is mainly concerned with the assignment of missions to platoons and coordination of their operations, and is charged with the administrative, supply, and maintenance functions, for the organization as a whole.

The platoon is the basic tactical unit. Platoons in carrying out reconnaissance missions normally remain on roads where their rates of movement are the greatest. When confronted by obstacles, and when the tactical situation precludes the use of roads, cross country movements are resorted to. Although the rates of movement will be decreased, armored car units can operate effectively over fairly level and open terrain. In situations requiring stealth the car crews may reconnoiter dismounted. In all reconnaissance operations the principle of working in pairs is conformed to. The individual cars constantly remain within close supporting distance of each other. The section includes two cars and is the smallest unit to which a mission is normally assigned. In road movements the sections advance by bounds, the rear section prepared to support the leading section by either fire power, advancing along the road, or by encircling movement off the road.

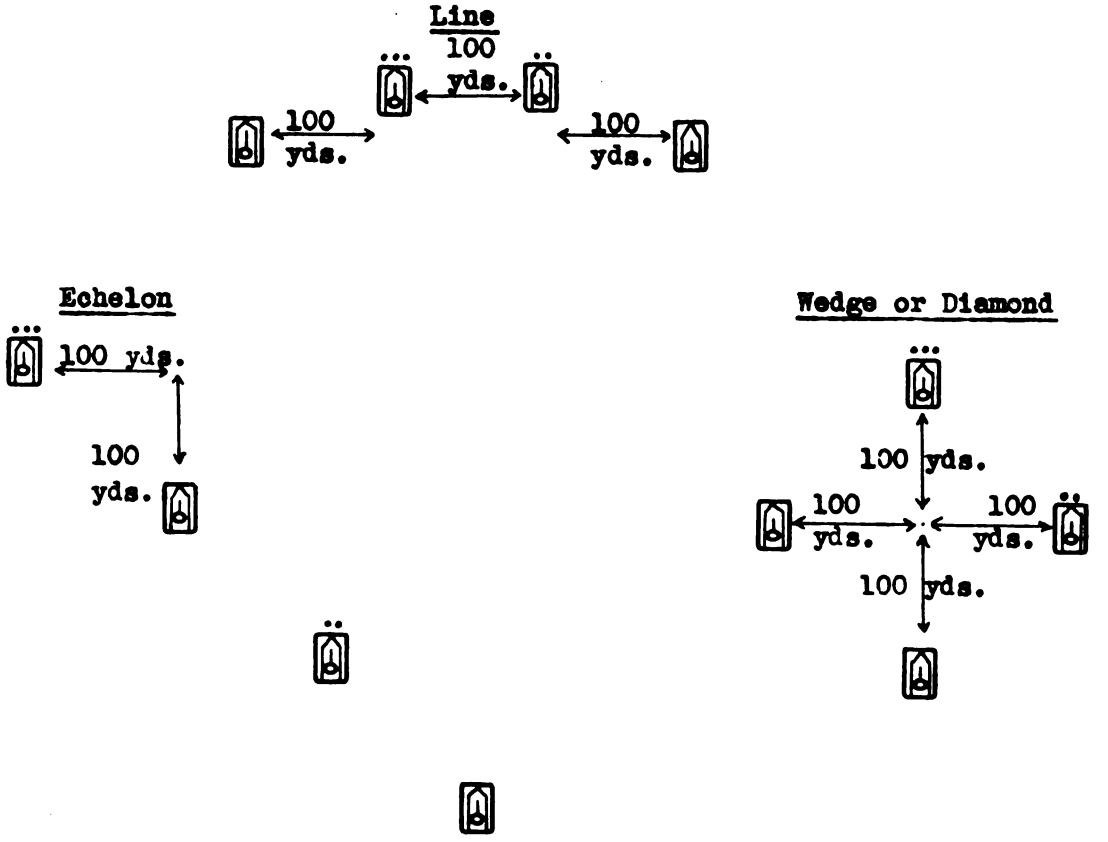
Armored Car Platoon - Road Formation



The normal fire tactics include rapid movement to a favorable firing position, halting and delivering the maximum fire, followed by a rapid change of positions. When the platoon leaves the road in combat situations it normally adopts either a line, echelon, or wedge formation. The platoon commander has no prescribed location in combat. Initially the commander either leads or directs the movement from a forward position, thus permitting indication of the target or objective by means of tracer ammunition, or by other signals. Thereafter, he may signal "Disregard" and maneuver his car as the supporting element in order to insure a successful outcome of the action. The distances and intervals between cars should not be so great as to prevent effective control and maximum fire power. On the otherhand the

elements should be sufficiently separated to permit maneuver and utilization of the existing ground cover. One hundred yards is considered normal for distance and interval and will be taken in the absence of other instructions.

Armored Car Platoon - Attack Formations

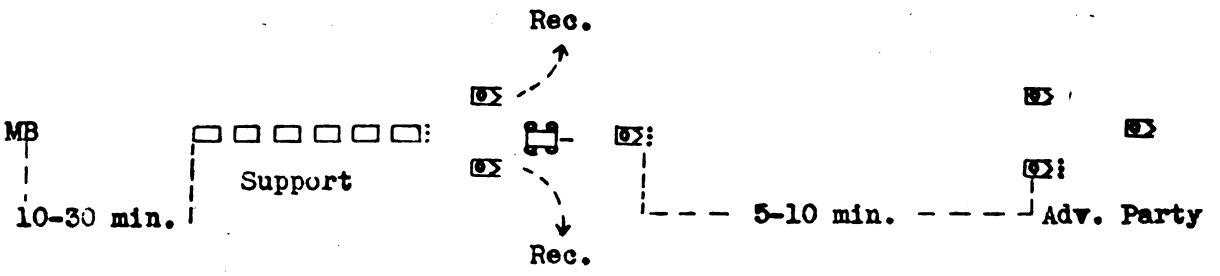


Prior to contact the bulk of the armored car troop will be employed on distant reconnaissance well forward of the advance guard. With 2 to 5 hours start over the main body, one armored car troop can reconnoiter a zone about 15 miles wide. This time permits the removal of obstacles, repair of bridges, or the planning of detours without delaying the main body. After contact the armored car units continue an aggressive reconnaissance along the hostile front and around the flanks and rear, endeavoring to develop the strength, composition, and disposition of the enemy force. During combat the armored car elements provide flank security, while maintaining close contact with the

enemy in the view to giving timely warning of a withdrawal of the arrival of hostile reinforcements. After combat armored car elements initiate pursuit or assist in covering a withdrawal, if the latter becomes necessary.

The scout troop, as a component of the covering squadron, normally operates under the commander of the latter. The functions of this organization include: security for the main body while on the march and during deployment for combat; employment in the secondary attack, and reserve, and in reconnaissance incident to combat. Preceding combat the scout troop forms the advance guard for the regiment. In this duty, it may at times be augmented by an armored car platoon. When attached, armored cars provide additional agencies for flank reconnaissance at greater distances from the axis of movement than is normally provided by elements of the combat platoon and motorcycle scouts. The advance party (consisting of one scout platoon) precedes the support (remainder of the troop) by 5 to 10 minutes. The advance guard advancing by bounds,acts boldly and aggressively. When the regimental objective is distant, the advance guard elements do not attempt to search for, or to be concerned with, hostile patrols or small bodies. Both the advance guard and the regiment boldly over-run or smother light resistance, exploiting to the full their tremendous mobility and crushing power. When strong resistance is met the combat platoon is employed to form a pivot of maneuver and cover the operations of the scout platoons, the whole covering the deployment of the regiment. The riflemen are employed for dismounted reconnaissance and security which are always essential. During combat the troop is usually employed in a secondary attack in which it employs both fire and movement, utilizing both scout and combat platoons. In operations such as penetrations or frontal attacks,the scout troop may often form the reserve.

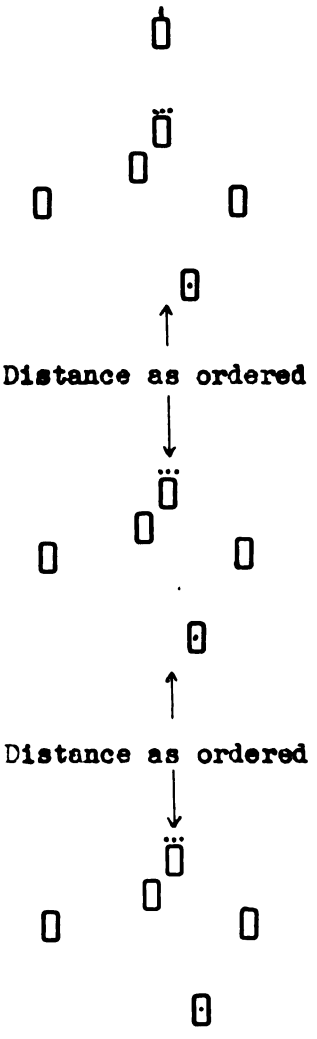
Scout Troop - Advance Guard Formation



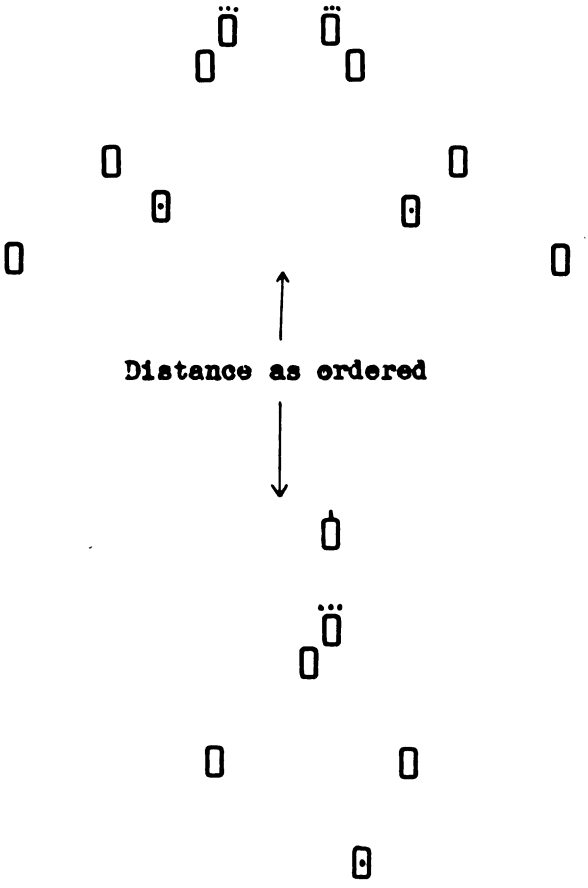
Possible Troop Formations

(Combat Car)

Column of Platoon

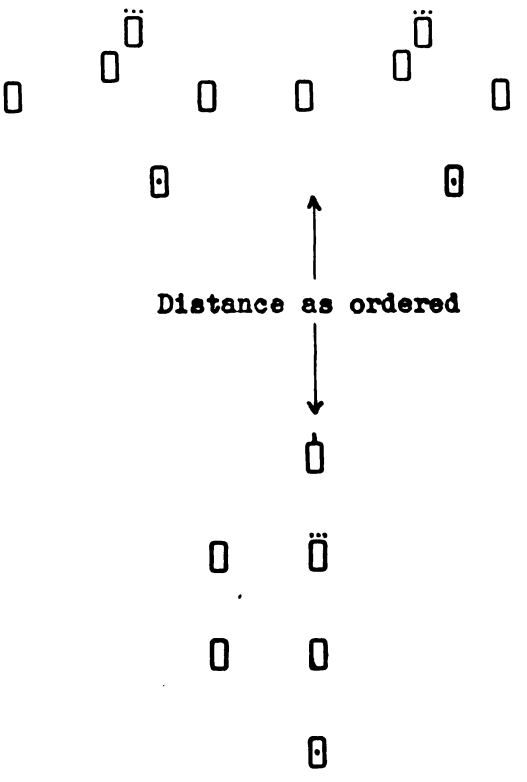


1st and 2d Platoon in Assault (echeloned to right & left) 3d Platoon in Support (wedge)

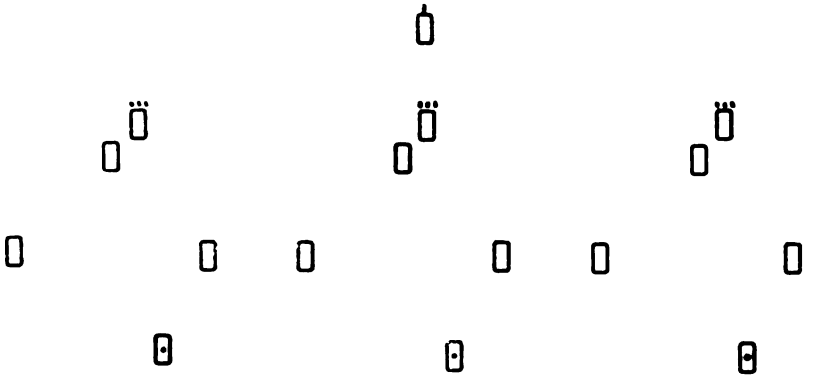


(Combat Car)

1st and 2d Platoon in Assault
3rd Platoon in Support



Line of Platoon Wedges



The combat car elements of the regiment form the striking power. These constitute the maneuvering force or forces and the reserve.

The platoon is the basic tactical unit. It operates under the troop commander, with the assignment of either an objective or a zone of action. The latter is usually from 300 to 400 yards in width. Prior to attack the leader normally has little opportunity to assemble his squad leaders and give oral orders. The platoon commander controls the movement of his unit within its zone of action by his own movements, use of tracer ammunition, and by simple signals. During the attack, after indicating the platoon objective, the leader signals "Disregard" and directs his command car to a position from where he can best observe his platoon, observe the enemy, and control (again by tracer ammunition) the fire of the self-propelled gun which becomes the platoon reserve. The self-propelled gun rarely fires except at the halt. Therefore,it moves rapidly from one position to another so that it can give close support to the fighting cars and observe the signals of the platoon commander. When platoons come under hostile fire, they open fire at the maximum ranges at which the targets can be designated. The fighting cars do not halt or reduce speed to fire, but depend on own fire and speed to reduce casualties, while closing with the enemy. The platoon in combat normally employs a line, wedge, or echelon formation.

The platoon leader after observing the effect of the attack, moves rapidly forward to regain control of his unit which rallies on him. After the platoon has over-run the objective, it promptly returns and runs through it as long as there is opposition.

The troop commander controls his platoons by radio, supplemented by visual signals when necessary. The troop is assigned a zone of action or objectives. It may attack in line or in column. A normal formation is with two platoons abreast, either in line, wedge, or echelon, forming the assault, with the third platoon in support. Troop frontages are usually from 400 to 800 yards. Prior to the attack the troop commander may assemble his platoon commanders and give oral orders or issue instructions by radio telephone. He may lead the assault elements until they have been definitely committed to the attack or he may initially move to a position from where he can observe his

assaulting elements and the enemy, and best control his support. During the attack the troop commander will normally be at the head of the support or so located as to control the action thru its employment. The support usually follows the assault platoons at such distance as will permit its early employment at a crucial stage, by passing through or around the assaulting units.

The squadron is usually employed with troops in column; therefore, it will normally attack on a front varying from 400 to 800 yards. One or more platoons are held in reserve. The squadron commander controls his troops by radio, supplemented, if necessary, by visual signal or courier. The squadron is usually assigned objectives. It may be given a zone of action when adjacent to other troops or when the regiment is operating as part of a larger command. Prior to the attack, the squadron commander when practicable will assemble his troop commanders and issue oral orders. Thereafter, and when the situation does not permit oral orders to be issued, they will be given mainly by radio. During the attack, the squadron commander normally remains in proximity to the reserve or at such a position that he can maneuver it to best insure a successful outcome of the action. In meeting engagements and in attacking hastily prepared positions, the squadron carries its attack through the entire enemy position. Limited objective attacks are unsuited for mechanized cavalry unless closely supported by other troops. In the attack, poor visibility, casualties, and unforeseen circumstances may disorganize the assaulting elements to such an extent that they become relatively inaffective. Under such conditions, the rallying and subsequent reorganization of these units will be necessary. While assaulting troops are undergoing reorganization, usually to a flank, the attack is continued even though it may necessitate the employment of the supporting or reserve elements. When the latter units are committed to the action, immediate steps are taken towards forming a new support or reserve. Such elements are normally provided by so assigning the former assault units upon completion of their reorganization.

The Platoon, which includes two sections of four machine guns each, and one rifle squad, is the basic tactical unit. The platoon normally fights dismounted. In convoy, its machine guns are mounted on the carriers so that if surprised, or in special operations such as pursuit and delaying actions, the guns may be employed directly from them. When going into dismounted action, the carriers are pushed rapidly forward, utilizing avail-

able cover, to the proximity of the position. Guns, ammunition and personnel are quickly dismounted and immediately deployed for action. The carriers are retained under cover as close to the position as possible.

The machine guns are always sited in pairs. The squads of a section are seldom separated over 50 yards, and the sections of the platoon are seldom separated over 150 yards.

The machine gun troop constitutes the main holding force in the regiment. Its primary mission is to hold ground gained by other means. Employment may be as a unit under regimental control or attached in whole or in part to the combat car elements making the main effort. The latter method appears normal in strictly offensive combat. The use of this organization may include: support of the main effort from forward positions on a flank; the following of combat car elements with the view to quickly securing the ground over-run by them, or of covering their reorganization; the covering of an exposed flank and of ground which is unsuitable for combat car maneuvers but over which hostile attack may be expected. Again, the machine gun troop may be held in reserve until the combat car units have secured an objective.

A typical employment of the regiment involves the following:

(1) BEFORE COMBAT - Early reconnaissance and the taking of measures for security to cover the rapid deployment of the main body, executed by the covering squadron.

(2) DURING COMBAT - A prompt and vigorous attack, executed by the combat car squadrons and supported by the machine gun troop. The covering squadron normally executes the secondary attack.

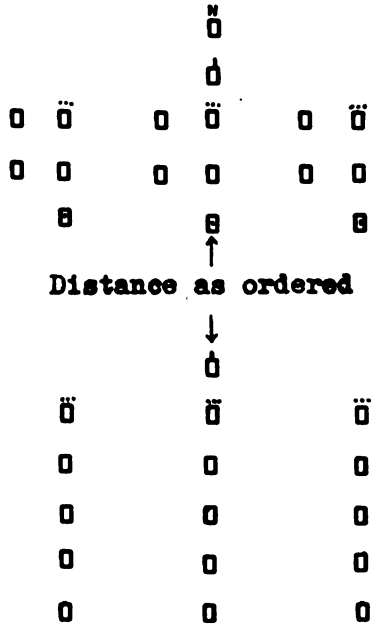
(3) AFTER COMBAT - Occupation of the captured ground by the machine gun troop (assisted in security measures by the covering squadron); pursuit by all available elements; or withdrawal, covered by the machine gun troop and the covering squadron.

The Regiment in the attack employs that form which best utilizes its characteristics of mobility for rapid maneuver

Possible Squadron Formations

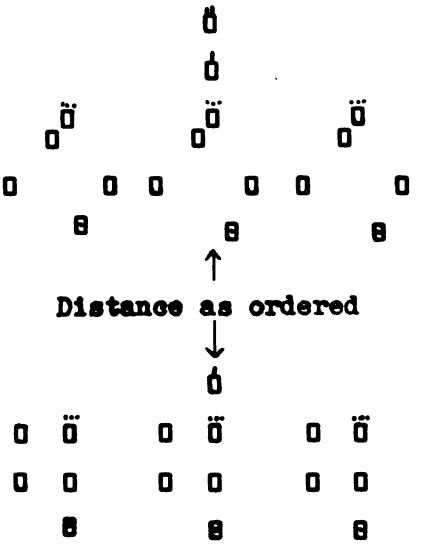
(Combat Car)

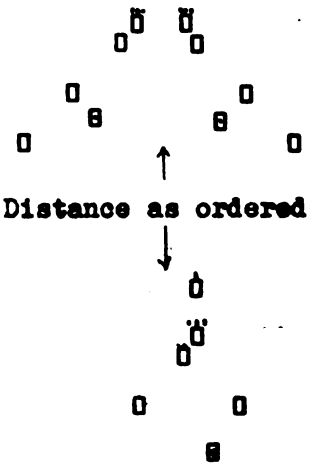
Approach Formation



Column of Troops

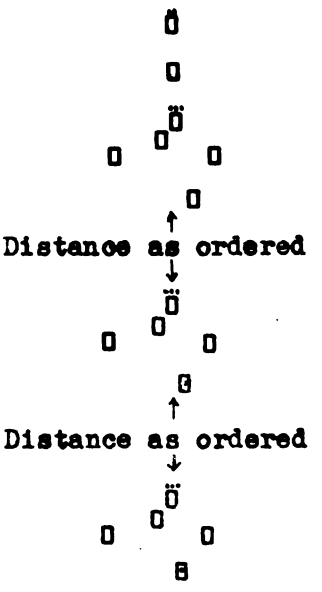
1st Troop - Line of Platoon Wedges
2d Troop - Line of Platoon Squares





Squadron in Attack

1st Troop in Assault (2 Platoon Front)
2d Troop in Reserve (Echeloned to the Right in Column of Platoons). The distance and interval determined by the situation.



in effecting surprise and for decreasing casualties, and shock action in crushing resistance. When acting alone, the forms of attack may include penetration, frontal attacks, envelopments, double envelopments, and turning movements. Normally, double envelopments and turning movements are only employed against forces greatly inferior in either mobility or strength, as a defeat in detail might otherwise result. When the regiment is functioning as a part of a larger unit, it may be assigned a zone of action or an objective. In any case, the mission should require that the attack continue through the entire hostile area. The main effort should be launched at such time and in such a direction as will find the enemy least prepared to meet it. The element of surprise is an important factor.

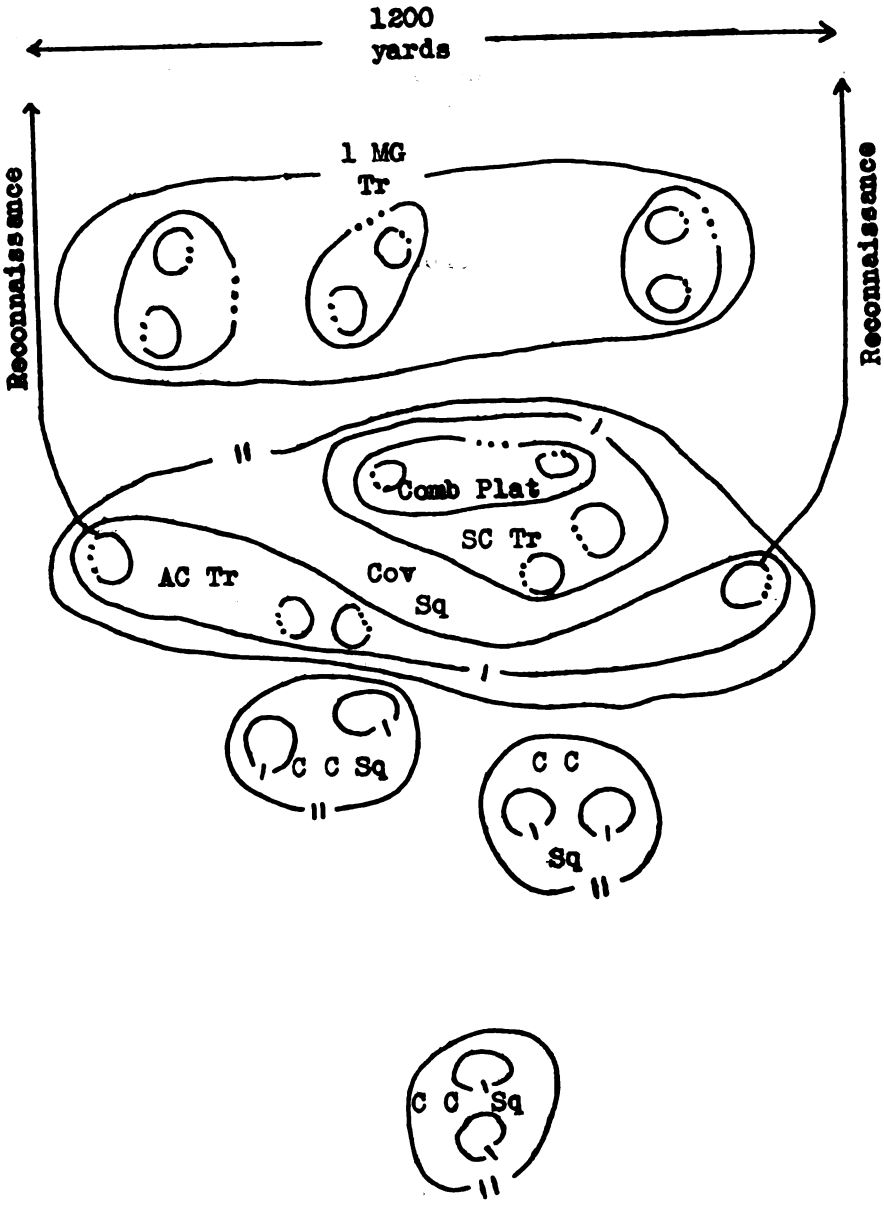
The enemy contemplating combat with mechanized units will undoubtedly be provided with weapons for meeting such elements. Exercises involving defensive action against mobile mechanized units have brought out various methods of organizing the anti-mechanized defenses. These have varied from a heavy centralized organization to a cordon of anti-tank weapons disposed all around and well out towards the line of outposts. A combination of the two extremes appears best in a position defense or when the defensive is assumed from a meeting engagement. As an example an independent force of relatively small mobility opposed to a mechanized unit might have its anti-mechanized guns disposed in three echelons as follows: first echelon - guns located well forward, in the area between the main line of resistance and the outpost line; second echelon - guns located in the area between the battalion and regimental reserve lines; third echelon - guns centrally located so as to protect the general reserve and artillery areas. Guns in all echelons must be so located as to cover the terrain most suitable for vehicular movement from both the front and the flanks. All around protection is best. However, the more adequate this provision the weaker will be the defense on any given front.

The number and dispositions of the enemy's anti-mechanized guns, as determined by reconnaissance, will influence both the direction and form of the attack. In many situations, wide turning movements or attacks against the hostile rear will be best, while in other situations a quick penetration or frontal attack will be most effective.

The organization of the brigade often permits those

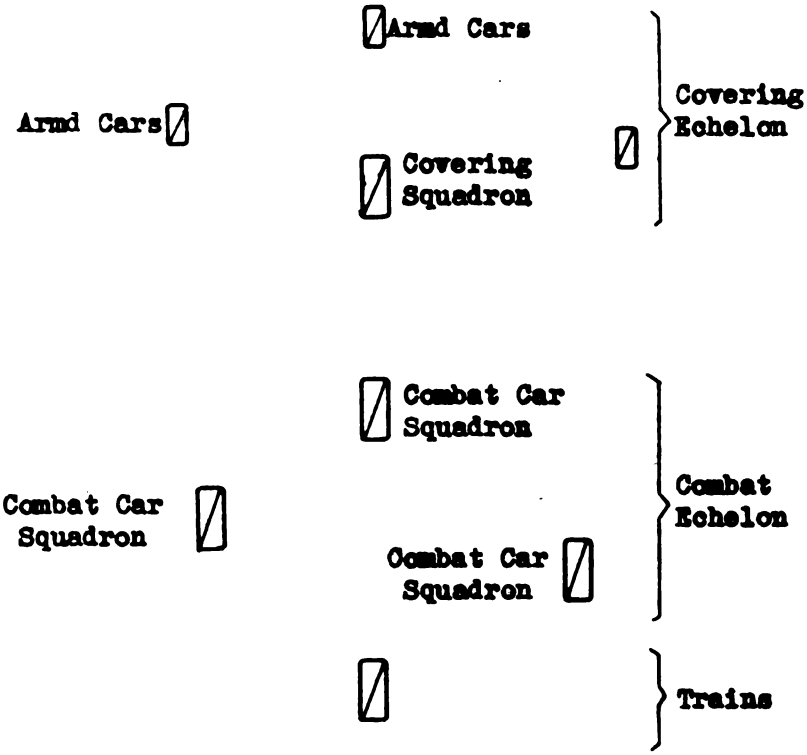
A Defensive Formation

(Mechanized Cavalry Regiment)

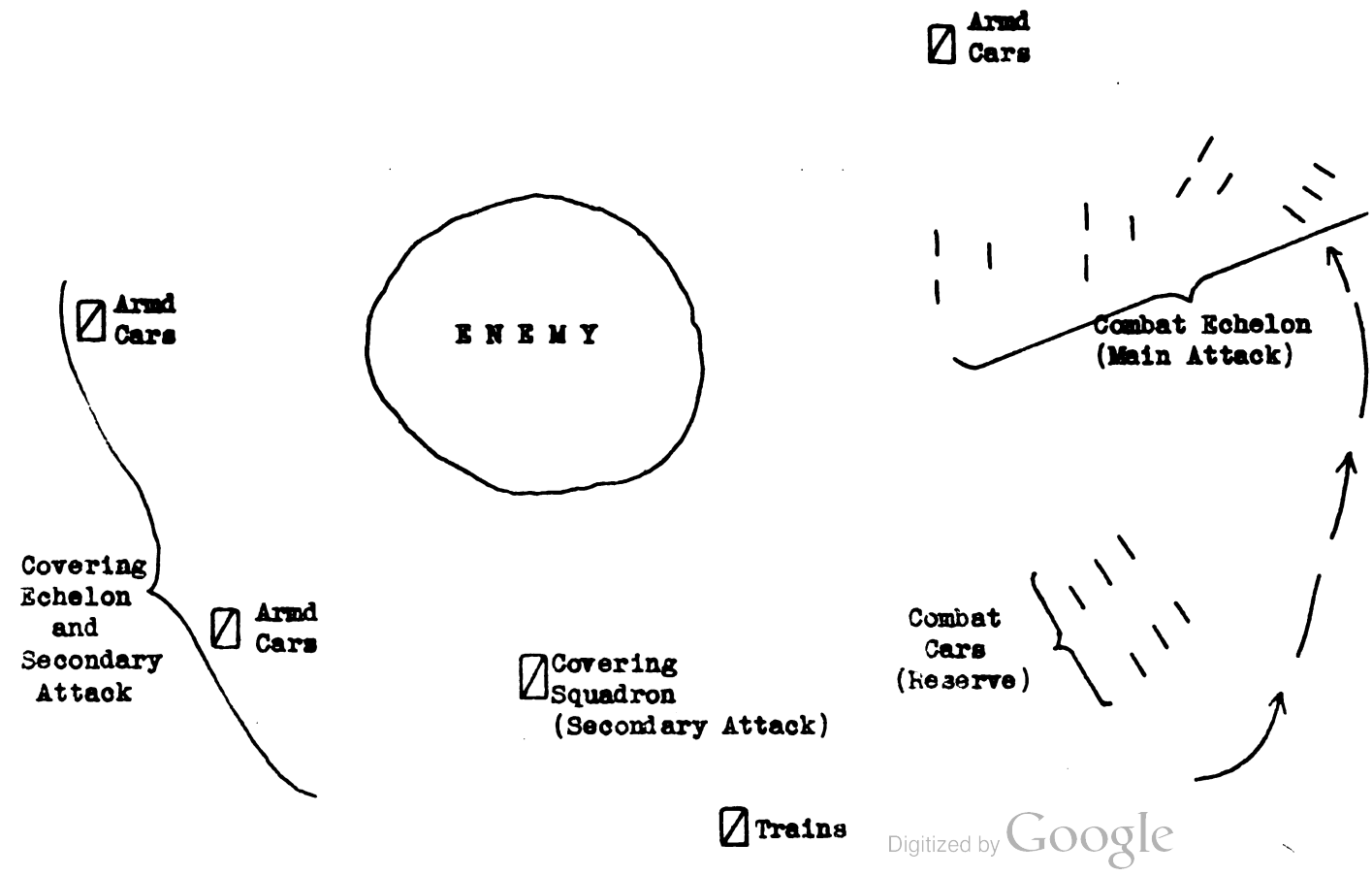


POSSIBLE REGIMENTAL FORMATIONS

One of many arrangements of march formations



One of Many Arrangements of Attack Formations



forms of attack, viz., wide envelopments, double envelopments, and turning movements, in situations under which they might prove dangerous for the regiment. Although the regiment is organized as a self-contained tactical and administrative unit, it is less capable of subdivision into two or more independent combat elements than is the brigade. In the brigade, the organization of which includes two of these self-contained tactical units, combat will often consist primarily of individual engagements by the regiments, directed and coordinated by the brigade commander. When operating against less mobile forces, the brigade will use that form of attack appearing most certain of success. These may include: straight frontal attacks and penetrations, in which the regiments are disposed either in column or abreast; envelopments, with either one or both regiments (less detachments) making the main effort; double envelopments, with one regiment making each (possibly one less detachment); turning movements, with either one or both regiments (less detachments) operating against the hostile flank or rear; or direct attacks against the hostile rear, with regiments either abreast or in column. In other than complete surprise situations a maneuvering form of attack will be given consideration. When the brigade is opposed to enemy forces of similar tactical mobility, the action will be characterized by a heavier massing of its elements. Normally, at least one regiment will be in reserve. Wide envelopments of maneuvers, which might result in concerted action by the enemy against any tactical sub-division of the brigade, will be avoided.

In the defensive, the regiment holds a front up to 1200 yards with the Machine Gun Troop occupying the main line of resistance, the Covering Squadron forming the squadron reserve, and the Combat Car Squadrons the regimental reserve.

The defensive capabilities of mechanized cavalry are inferior to its offensive powers. Against less mobile forces, the best defense is often provided by an aggressive offense. Against hostile mechanized forces, the defense may result in a delaying action, in which the elements are withdrawn by echelon, or in a counter-attack after the enemy has committed his main force to a definite line of action and is unfavorably disposed to meet the counter-attack. In either case, defensive action of such a nature as will check the enemy's advance and require him to attack in force should be contemplated. As the terrain is a big factor in any mechanized attack, it should be given careful thought in the selection of a defensive area. Villages, woods,

streams, steep slopes, etc., should be considered as obstacles, and the defensive locality should be selected with the view to their effective employment. The same principles govern in the selection of a bivouac area. In the latter, the plan of defense should be made at an early hour for the purpose of expediting an orderly occupation of the positions when an attack appears imminent.

ADDRESS DELIVERED AT THE GRADUATION EXERCISES OF THE CHEMICAL WARFARE SCHOOL, EDGEWOOD ARSENAL, EDGEWOOD, MARYLAND, AUGUST 4, 1933

By: Brigadier General Oscar Westover, Air Corps

Colonel Lyon, Members of the Field Officers' Class, Ladies and Gentlemen:

I am delighted to have this opportunity to address,even though briefly, this select group of officers of the Army, Navy and Marine Corps who have just completed the Field Officers' Course. Although I have had no direct contact with this school in recent years, I am familiar with the scope of its instruction and the general progress being made in chemical warfare research and development.

At one time I was Commandant of the Air Corps Tactical School, and, in that capacity, learned to appreciate some of the difficulties confronting the commandant and staff of a new service school in developing such a school to serve its fundamental mission. The Chemical Warfare Service, in a way, is a younger sister service to the Air Corps. Both services are new. Although aviation and the use of chemicals originated hundreds of years ago, their development into practical form for military application extended over an unusually long period of time, and it has taken until the present century for real progress to have been achieved. In the case of aviation,so far as concerns heavier-than-air craft, its practical development and marvelous progress has occurred entirely within your lifetime and mine. With regard to the use of chemicals in warfare, that development, too, has been largely confined to your lifetime and mine. Both services were promptly developed through the stress of war to a point where their offensive and destructive power was so recognized as to cause, on the one hand, international agreements to prohibit the use of asphyxiating, poisonous, or other gases in warfare, and on the other hand, present day attempts to abolish bombardment from the air through the medium of mutual agreement among nations.

This praticular school is of but a few years growth. During this course of time it has made remarkable progress in fulfilling its primary mission as a service school charged with the research and development of tactical doctrines and the technique of chemical warfare. I understand that your instruction has embraced the history of chemical warfare and the Chemical Warfare

Service; the general classification and the powers and limitations as well as specific characteristics of the various chemical agents; the organization of chemical troops and their equipment; chemical weapons and apparatus both for offensive use and defensive use; protective equipment; weather forecasting. You have studied the general principles of chemical warfare and the tactics and training methods required to apply these principles. By means of map problems,demonstrations and theoretical analysis you have studied the advantages and disadvantages of the use of chemicals in various offensive and defensive situations, and have evolved methods of employing chemical warfare troops to assist the basic ground forces in accomplishing their mission. Your studies of the use of chemicals have not been confined to the Army and ground forces,but have included in scope their application to Naval and Air Activities,and to some extent their use in civil disturbances. Moreover, the scope of your instruction has also extended to a study of the chemical warfare activities of other world powers. This progressive study and training has been augmented through the medium of the Chemical Warfare Service Journal, and the preparation of theses to develop initiative in thought and planning, as well as practice in research. It is needless for me to elaborate on any particular element relating to the broad and balanced scope of training which you have just completed. All in all, this course is excellent in scope and nature of instruction,and should be made available to a much larger group of officers. Some consolation comes from the fact that with each succeeding year, the graduates of this school are being used more directly within their respective Services on assignments which permit of the dissemination and application of the knowledge acquired here and thus materially advance general education of our commissioned personnel with regard to chemical warfare.

Since the Air Corps and the Chemical Warfare Service are very intimately connected in solving the problem of the most efficient use of chemicals in warfare, reference at this time to some things which I believe must be jointly developed by these two services may be appropriate. I assume that in the course of your studies at this school you have concluded that the development of aviation and chemical warfare service should go hand in hand,and that these two agencies by joint operations can best assure maximum efficiency in laying the necessary concentration of gases or smoke over a desired point or place in the minimum of time.

The Air Corps believes that before further and real progress can be made in the development of sound doctrine for the proper use by military aviation of chemicals in warfare, it will be necessary to have a board of officers study and analyze in detail the requirements of the various arms and services as to the chemical warfare and aviation service needed. Before any arm or service can submit adequate information to the board of officers convened for this purpose, it will be necessary to conduct actual and extended demonstrations or operations with aircraft to afford a practical basis for the requirements set up by such arm or service. The practical tests or demonstrations should extend over a considerable period of time in order to insure results broad enough in scope to properly determine the requirements, both for the offensive and for the defensive,in various conditions of weather, and whether by day or by night. For example,take the question of smoke screens laid by attack airplanes. Questions which enter into this matter are: just which arm or service needs a smoke screen, and when; just where should it be placed to accomplish the result desired; how many planes will be necessary to build up the required intensity or concentration,or to extend the duration of the screen for the time desired; should the screen be solely for the purpose of limiting visibility or should there be confined within the smoke screen some other agent of destructive or harassing effect; should the screen be continuous or broken; should it be laid in parallel lanes at close intervals, or should it be laid in lanes echeloned upwards at varying distances; will smoke bombs be more efficient under certain circumstances; will the method of laying smoke vary under different meteorological conditions. Such questions indicate the necessity for careful study and analysis by a continuing board of officers because not alone must we know the requirements of any one arm or service,but we must study the effect upon other arms and services when chemicals are used to meet such requirements.

Similar problems undoubtedly confront Naval aviation. I have read a number of articles within the past year dealing with the subject of protection of Naval personnel subjected to gas attack on shipboard as the result of enemy air attack. These articles have represented varying viewpoints. Some minimized the effect due to the limited area exposed to such attack and the combined action of wind and ship's speed to dispell the effect of any gas concentration successfully launched against the ship. Others have indicated the terrible effect that such a gas attack would have upon the controlling and operating personnel of the

vessel. The very fact that such conflicting views are evidenced in recent study indicates the need within the Navy of studies similar to those which I have just mentioned as being necessary for future development of doctrines applying to chemical warfare.

While attending a motion picture show recently I saw an international news reel showing the extent to which Japan is going in the matter of protection against gas warfare. Even the children in the schools are being instructed by Japanese Army Officers in the use of gas masks. Is it probable that a nation will turn to the mass instruction of its people for protection against gas warfare, if it is convinced of the sanctity of international agreements? Normally, such instruction would not extend beyond the training of its military or naval personnel. Training of civilians in protective measures implies the possibility of the use of the offensive in gassing, since all warfare is a measure to break the will of a nation to resist. Whatever views you or I may have as to the possibility of adherence by a nation to their solemn agreement regarding the use of gas warfare in future wars, I believe that we mutually abhor its use against any objective which is not a strictly military objective subject to immediate attack. Particularly do we abhor its use against civilians. The use of asphyxiating or poisonous gases to deny to the enemy unoccupied key possessions is without doubt a logical and proper use of chemicals for military purposes even though such operations may extend well into enemy territory.

Although we visualize the greatly extended use of chemicals in warfare, we are not now preparing adequately to meet our problems should we ever be involved with a nation which is not a signatory to the international agreements abolishing the use of asphyxiating,poisonous or other gases in warfare. We rely on the sincerity of international agreements, well knowing that history teaches their ineffectiveness as guarantees and their violation for selfish causes in time of war, and also well knowing that no nation has ever voluntarily relinquished an offensive weapon of warfare.

It is refreshing to see both Army,Navy,and Marine Corps officers studying chemical warfare at the same school. The breadth of experience which each of you has so far acquired is made available for mutual benefit,and the combined viewpoints expressed by you individually during the period of your course must have a potent influence in shaping the trend of that development

in the application of chemicals to warfare.

In closing, I heartily congratulate each and every one of you on your graduation from this fine school. Your course has not been long, but it must have given you, within the time available, a maximum of new knowledge concerning this new science of warfare. You now comprise a part of that select and limited group of trained officers upon whom this country must rely for real preparedness to wage chemical warfare if forced to engage in such warfare, and who must be our reserve of officers on whom rests the obligation of teaching preparedness for and protection against that warfare. Again, I congratulate you.

THE WORK OF THE CHEMICAL WARFARE SERVICE

By: Captain M.E. Barker, C.W.S.

The Chemical Warfare Service, as such, was established on July 1st, 1918, as a part of the National Army. Prior to that time, the work in the United States pertaining to chemical warfare had been divided among a number of civilian branches of the government and various departments of the Army and Navy. Research work on chemical agents and defense equipment was initiated about the outbreak of the World War, by the United States Bureau of Mines, under Dr. Manning. The Medical Corps of the Army and the Navy Departments each untertook the manufacture of gas masks, while the Army Ordnance Department undertook the production of chemical agents as well as the design and manufacture of special chemical weapons. The Corps of Engineers was charged with the organization and training of special gas troops. A certain duplication of effort naturally occurred when work on this subject was being undertaken by so many different branches of the government. In the A.E.F. in France, however, all work pertaining to chemical warfare was from the beginning organized as a Chemical Warfare Service and placed under the direction of a single head who happened to be Lieutenant Colonel, later Major General, Amos A. Fries.

The Chemical Warfare Service of the Regular Army was established by the National Defense Act approved June 4th, 1920, and became effective July 1st, 1920. This act authorized 101 officers and 1200 enlisted men for this branch of the Army. In 1922 a large reduction in personnel of the Regular Army took place, and at that time the strength of the Service was considerably reduced. Other reductions have followed so that at the present time there are 91 officers and 407 enlisted members of the Chemical Warfare Service. In addition, there are employed approximately 575 civilian employees of all grades. The Chemical Warfare Service Reserve Officers number about 1,800. More than 90% are college graduates, and about 50% have graduate training.

At the beginning of the World War there was a mass of typewritten material available in the Army War College describing poison gases, their methods of manufacture, the methods by which they had been used in the field, the protection needed, as well as the tactical use of these agents. All this information had been carefully collected by the Military Observers with both Allied and Central Powers and had been filed in Washington, but

had not been studied. With the entry of the United States into the World War it became necessary to start at the beginning and study the information available as well as obtain additional information by research and investigation. This research was initiated by the Bureau of Mines, which had in February, 1917, when war between the United States and Germany seemed inevitable, offered its services to the Army and Navy Departments. This offer was accepted and a Subcommittee of the National Research Council known as the Committee on Noxious Gases was formed. This committee opened its meeting on April 7, 1917, and spent its first few weeks of existence in the study of reports on gas warfare available at the Army War College.

The experimental work was conducted under the direction of the Bureau of Mines and was carried out in its Pittsburgh Laboratory and in various university laboratories throughout the country until September, 1917, at which time the buildings and grounds of the American University in Washington, D.C., became available, and the American University Experimental Station became the central research establishment for chemical warfare of the United States. Several research stations at industrial plants and universities continued through the war functioning as a part of the American University Experimental Station.

The first gas masks were designed under the direction of the Surgeon General of the Army. Production was started on May 21, 1917, on the first 25,000 masks. However, due to lack of information on the part of the designers, the masks, when completed, were not satisfactory for service. In this initial lot of masks cedar wood charcoal was used. This charcoal had large adsorptive capacity for chlorine against which it had been tested experimentally, but when it was found that chlorpicrin was the chief agent then in use, the test conducted on the finished canisters showed that they were valueless against the agent. Later, the work of the Medical Department on gas masks and similar pieces of protective equipment was transferred to the Gas Defense Service which established large factories at Long Island City and branch factories at several other industrial locations.

5,692,499 gas masks were manufactured in the United States during the World War. 4,210,586 service gas masks were shipped to France for use by the A.E.F.

The first gas troops were authorized on August 15, 1917, as a Gas and Flame Service in the Corps of Engineers and was organized as the 30th Engineers. The first two companies and Regimental Headquarters sailed for France on December 28, 1917. As fast as possible, additional companies of this service were raised, equipped and partially trained and sent to France. This regiment, the 30th Engineers, later became the First Gas Regiment and at the present time is designated as the First Chemical Regiment. It now contains about 250 men.

The Ordnance Department through its Trench Section organized Edgewood Arsenal, which was set aside as a proving ground under Proclamation of the President, October 16, 1917. Work at Edgewood rapidly progressed until manufacturing plants having a daily capacity of 200,000 pounds of chlorine, 120,000 pounds of phosgene, 61,000 pounds of chlorpicrin, and 60,000 pounds of mustard gas were actually put into operation. In addition, three shell filling plants were constructed having a total capacity of about 80,000 shells per day. Branches of Edgewood Arsenal were established at seven places scattered through the country where it was believed that their location would facilitate the manufacture of such material as activated charcoal, phosgene, chlorine and other materials. Edgewood Arsenal was transferred from the Ordnance Department to The Chemical Warfare Service on July 1, 1918. At that time Colonel W. W. Walker, head of the chemical engineering department at Massachusetts Institute of Technology, was transferred from the Ordnance Department to The Chemical Warfare Service and continued throughout the war as Commanding Officer of Edgewood Arsenal.

During the war 17,881,000 pounds of toxic gases and 4,386,000 pounds of smoke materials were produced in this country. Of this material about 9,000,000 pounds were shipped in bulk to England and France for loading into munitions. Considerable amounts of the remaining agents were loaded into shells in this country, but these shells failed to arrive in France before the Armistice, with the exception of about 300 tons of phosgene loaded in Livens projector shells which were fired by the 30th Engineers at the Germans. No other American gas in American munitions was used during the World War.

There are many extremely interesting developments which took place during the World War under the Chemical Warfare Service and its predecessors. However, none of these things are

more interesting than the development of gas masks, and the various materials required in the construction of a satisfactory gas mask.

A gas mask in order to be satisfactory must remove the last trace of various poisonous gases from the air breathed by the individual. Dr. W.K. Lewis tells an interesting story about the first work that was carried out on individual protection. A famous professor of chemistry was consulted as to the best means available by which the soldier could be protected from poisonous gases. It was explained to this professor that the soldier might get chlorine in the field in very considerable concentrations. He therefore suggested a wash bottle containing caustic of some kind. Then the problem of protecting against chlorpicrin arrived. Sodium bisulphite in solution was suggested as a possible means of absorbing this agent. Then it was necessary to remove the fumes of the bisulphite. The question of protection against phosgene was readily solved by a fourth wash bottle containing hexamethylenetetramine. So on down the list of war gases in use at that time protection was successively provided against hydrocyanic acid, mustard gas, ethyldichlorarsine, cyanogen bromide, etc. Finally, it became necessary to stop the solid particles of diphenylchlorarsine, the German sneeze gas, which would have penetrated the wash bottles. The final solution of the problem then took sixteen wash bottles backed by a thick mat of asbestos fiber. Obviously, such an apparatus ought to work with a high degree of perfection, provided the soldier was equipped with an individual truck and a mechanical blower for forcing the air through the entire system. The practical solution, of course, was far removed from such a Rube Goldberg piece of apparatus.

The various research groups went about the development of activated charcoal and the perfection of soda lime, together with the design of a simple filtering device for removing solid particles. The story of the development of activated charcoal, both during and since the war, is as interesting as any novel. Step by step, and due to the work of a large number of men, each one contributing a small bit of information or technique of operation, a charcoal has been developed which at the present time has an apparent density of about 0.45 and has a retentivity capacity of nearly 50% by weight, is extremely hard, and absorbs gases in an almost unbelievable short time. Such a charcoal is highly satisfactory for adsorbing any of the usual war gases or gases likely to be used in time of war. Again, soda lime has

undergone a large number of modifications so that at the present time soda lime has a high chemical reactivity for the acid gases. A mixture of special activated charcoal and soda lime gives satisfactory protection and is a highly valuable substitute for the 16 wash bottles proposed by the somewhat impractical professor.

The development of the filter for removing solid particles has also gone on apace so that at the present time the filter used by the Army in the gas mask canister is perhaps the most efficient type of filter known for removing aerosols.

The gas mask facepiece likewise has undergone numerous changes. In 1917 the English small box respirator was adopted as a starting point. This mask was known as the CE Mask, was later improved and became known as the RFK Mask from Richardson, Flory and Kops, the designers. These masks, with which most American soldiers were familiar during the World War, consisted of a mouthpiece through which air was drawn from the canister and a noseclip which prevented the intake of air except through the mouthpiece. The headpiece was held on the face by means of elastic straps carried over the back of the head. 3,050,000 masks of this model were made and sent to France during the war. Later, it became possible by means of careful fitting of the facepiece, to eliminate the mouthpiece and noseclip. This improved mask which was developed in August, 1918, was known as the Kops-Tissot mask and was an adaptation of the French mask developed by Tissot. This development primarily consisted of a valve for passing incoming air over the eyepieces as a means of clearing them of condensed moistures. Previous to that time it had been possible to obtain a gas-tight fit by means of the facepiece, but the condensation of the breath fogged up the eyepieces so that they were unsatisfactory from an optical standpoint. 337,000 of these masks were manufactured. All the gas masks developed for the Army during the war consisted of a canister connecting to the facepiece by means of a hose tube. All were carried in a satchel. The satchel was designed to hang naturally at the left side when not in use and was adapted to be quickly adjusted on the chest when it became necessary to wear the mask. This method of carriage allowed a short hose tube to be used, but it prevented the soldier from getting close to the ground in order to avail himself of all cover.

The first problem of the Chemical Warfare Service aft-

er the end of the war was to develop a more satisfactory mask of the Tissot type which would carry the mask in such a position as to allow the soldier to lie flat on the ground. A longer hose-tube and a means of securing the gas mask satchel under the left arm, together with a better fitting facepiece, accomplished this development. This mask is known as the Mark I mask and is the standard American Army gas mask at present. During the war the Navy Department used a snout-type canister similar to that developed and used in Germany. Two modifications of this mask were manufactured during the war. The Army and Navy now use the same model gas masks in order to simplify supply problems.

About 1925 a new type gas mask facepiece was developed which contained a thin diaphragm in a protected compartment, which enabled the wearer to give commands, talk over the telephone, and otherwise use his voice while wearing the gas mask. Such a gas mask is intended for issue to officers, noncommissioned officers, telephone men, and others who require the use of their voice. However, it is not quite as rugged in its construction as the Mark I facepiece, hence, is not considered satisfactory for the rank and file.

The gas mask at the present time has reached a very high degree of perfection in its construction and manufacture. All materials used in the construction of the gas mask are thoroughly tested and a fairly high percentage of finished gas masks are tested to destruction in order to be certain that every mask put in the hands of the American soldier or sailor shall be the very best means of protection against gas.

We frequently think that the gas mask is a modern invention. But such is hardly the case since gas masks, of a crude type it is true, have been used for thousands of years by miners and others working in dusty atmospheres. A great many patents have been issued in the United States on gas masks, the earliest one which I have been able to find is No. 6529 issued in 1848 to Haslett. This was a fairly complex device and consisted of a hemispherical canister, covered with a porous filtering material and connected by a short tube to the mouth and nostrils. Haslett further perfected this device and received a number of additional patents. Among the earlier gas mask patents particular attention appears to have been given to bags or reservoirs filled with air and carried on the person and connected with tubes to the mouth. Many of these devices were provided with lime to re-

move carbon dioxide, and other chemicals for the removal of water vapor so that the air could be rebreathed for considerable periods of time. This type of development has been carried out by the Army and Navy until at the present time a self-contained oxygen breathing apparatus is available for use in the Navy which provides protection for extended periods of time, and the Air Corps oxygen breathing apparatus gives protection to aviators at high altitudes. In the Navy a bag of a special design containing oxygen has lately been approved for submarines and is known popularly as the submarine lung. However, all of these self-contained oxygen breathing apparatus go back to the basic patent, No. 7476, issued Lane in 1850. The complete parent of the modern gas mask with hose tube and canister appears in United States Patent No. 148,868, issued Barton in 1874 in which a canister was provided, covered on the outside with cotton, wool or other fibrous materials for filtering solid particles from the air, while charcoal and quicklime mixed together was used as a filling for absorbing poisonous vapors. A great many other patents have since been issued inventors of gas masks, both of the canister type and reservoir type.

With all the improvements that have taken place in the development of the gas mask, however, it interferes most noticeably with the operation of soldiers in the battlefield. This is especially so at night or under conditions of high nervous strain. Where a soldier is forced to wear the gas mask longer than one hour under battle conditions, it hampers his ability to work rapidly; reduces his rate of marching; lowers his efficiency of rifle fire; and in general makes him most uncomfortable and rapidly tires him out. Training reduces the hesitation imposed by wearing the gas mask, yet the mere act of wearing the gas mask enormously reduces the soldier's efficiency in battle.

In order that the gas mask may be entirely acceptable, it is necessary to keep fully informed as to what substances might be used in the field in the nature of chemical agents. Chemical agents are those substances which are very toxic or very irritant and which can be used in ordinary munitions under field conditions. The gas mask is adequate protection against lung irritants, irritant smokes and lacrimators, but affords only limited protection against the vesicants.

Very little has taken place in the production of new gases since the World War and only one new agent was developed

during the War, that being Lewisite in the American Army. Lewisite, as you know, is beta-chlorvinylchlorarsine and is a very powerful vesicant, producing large watery blisters that are difficult to heal. Lewisite is of the same order of toxicity and has the same method of action as mustard gas. Mustard gas was,of course,known for nearly fifty years prior to the World War and so was chlorine, phosgene and many of the other agents used. In a recent book by a German authority on chemical warfare, sixteen materials are listed as possible chemical warfare agents,of these materials fourteen have been known twenty-five years or more. Lewisite and adamsite are the two exceptions.

We have been much interested in working out a theory of toxicity by which it would be possible to predict the mode of physiological action and the toxicity of compounds from a knowledge of their chemical constitution and their physical properties, but we have had little success along this line.

The major problem of the Chemical Warfare Service is to be prepared to meet the problems which would arise if chemicals were used in a war in which this country might be involved. However, the entire energy of the Chemical Warfare Service has not been or should not be expended on the development or attempted development of new gases or more effective protective means. It frequently happens that useful industrial applications arise from work carried out in connection with chemical warfare. For instance, some of the interesting peace-time work has been in conjunction with termite control in government buildings in the Philippines, Hawaiian Islands, and Panama. We found that one of our irritant smokes, DM, could readily be dissolved in furfural and that this solution quickly penetrated wooden structures when properly applied. The termite proofing of piles,foundation posts and other parts of wooden buildings in the tropics has been a source of considerable service to the government. The department chemical warfare officer in the tropical departments is also charged with thermit control.

The use of cyanogen chloride and hydrocyanic acid was developed in conjunction with the Public Health Service for use in fumigating warehouses, ships and other places infested with vermin of various kinds. The two gases are generated by immersing a bag of chemicals in sulfuric acid. Cyanogen chloride is a powerful tear gas and thus warns of the presence of the more deadly hydrocyanic acid gas.

Several years ago we received special grants of money for three years from Congress for investigating boll weevil poisons. As a result of this investigation, a new method of manufacturing calcium arsenate was developed wherein the outer portion of the chalk only was converted to the arsenate, thus cheapening the product without lessening its toxicity to the boll weevil. Another advantage of this coat of calcium arsenate is the fact that much less arsenic is introduced in the soil to act as a possible contamination of water supplies in the vicinity where large quantities of poison are used in dusting cotton fields.

Large installations for purification of air in hospitals, dugouts and other places have been developed for use in the battlefield. These developments have an immediate commercial use in that they can be applied to air purification at any location. One interesting outgrowth of the publication of this work several years ago has been the construction of small air purification units for rooms occupied by hay fever sufferers. A considerable amount of experimental work on this line has been conducted by the University of Illinois hospital.

A considerable number of other developments by the Chemical Warfare Service have been adopted into industry. For instance, the use of tear gas for the protection of bank vaults and the use of tear gas by police in subduing criminals are everyday occurrences. Tear gas candles and bombs are made by several commercial companies on patents issued government employees covering the design of these munitions. One scarcely picks up a paper these days without finding some reference to tear gas used by officers of the law in capturing criminals or restoring order in penal institutions. This one development alone has saved the lives of hundreds of persons in this country during the past ten years.

In addition to the actual work carried out on the development of chemical warfare material,either for training use or for use in war,close contact is maintained with chemical manufacturers throughout the country by the Procurement Planning Section of the Service. Manufacturers are fully advised of the needs of the Service in time of war and may thus be prepared to make the particular items which their plants are especially designed to produce,and thus secure to the government immediate production in time of need with little or no change in existing equipment. The Procurement Planning activities of the Service are under the dir-

ect supervision of the Assistant Secretary of War who is charged by law with the entire supply function for the army in time of war. This procurement planning problem is one of the major economic questions, both to the service and the country as a whole.

The Chemical Warfare Service is charged by law with training its own personnel and the entire army on problems pertaining to chemical warfare. The Chemical Warfare Service also functions for the Navy and other government departments on matters pertaining to chemical warfare materials or defense. The central training agency is The Chemical Warfare School at Edgewood Arsenal, where instructors for the Regular Army, National Guard, Reserve Corps,the Navy and Marine Corps are trained. 1398 officers have been graduated from this School.

Finally, every one wants to know if gases will be used in the next war. We in the Chemical Warfare Service sincerely hope there will be no next war, because we realize that to be hit by shell fragments, a machine gun bullet or by a drop of mustard gas are all very painful and are to be avoided if possible. However, the Chemical Warfare Service is charged by law with keeping the Army fully prepared for a war in which chemicals might be used. With the help of the American chemical profession, we hope to comply with the law.

GAS AS A DEFENSIVE WEAPON

Extracts from an Article Entitled, 'New Armies for Old'
By B. H. Liddell-Hart
In the March, 1933, issue of 'Current History'
Reprinted by Permission of the Editor, 'Current History'

What of gas? To consider it we must, perforce, assume that prohibitions against its use will go the way of most paper rules for war in the past. But if gas is used will it open the way for the advance of armies any better than artillery? Chemists seem to agree that the discovery of entirely new gases is unlikely and that future progress is likely to be along the line of producing variants of the main types of chemical compound already known. Of these the acute lung irritants, such as chlorine and phosgene - the essentially lethal gases - proved less effective than, and were gradually superseded by, the sensory irritant smokes, such as diphenylchlorarsine, and vesicants, such as dichlorethyl sulphide commonly known as mustard gas. The significance of this is that it not only had a more extensive and persistent effect, but instead of killing put men out of action for a time - a time long enough for the issue of battle, or even a war, to be decided before they were fit again. The possibility of contaminating large areas with this blistering substance, and the fact that its effect does not develop until some hours after contact, make it as potent morally as physically, for no man, having passed through a contaminated area, knows whether he has not accidentally got a smear on his hands or clothing which will presently give rise to the dreaded blisters. Uneasiness is all the greater because one affected man may "infect" dozens of others before it is even known that he is affected.

But the supreme military significance of mustard gas is that it tends to strengthen defense far more than attack. It promises an extra powerful brake on armies whose powers of movement are at present very limited. To be secure against it an infantry man must wear not merely a respirator but a complete diver's suit in which he could not move unless in a vehicle. If a man cannot move he can only fight in a post or trench - defensively. It is ominous that mustard gas and machine gun bear the same initials, for either "M.G." is a check to infantry, and the meaning of the two together would be best represented by a full stop. There is a certain irony in the fact that the proposals at Geneva to strengthen the defense at the expense of attack should include the prohibition of mustard gas.

NON-COMMISSIONED OFFICERS' COURSE, 1933

Instruction in this ten weeks course began at The Chemical Warfare School on October 2, 1933, and will end December 8, 1933. The class includes the following students:

Technical Sergeant Ernest W. Graf, C.W.S., Hq., 7th C.A.
Technical Sergeant Ralph Johnson, C.W.S., Hq., 1st C.A.
First Sergeant Robert H. Kennedy, 1st Cml. Regt.
Staff Sergeant Sam Abramson, 1st Cml. Regt.
Staff Sergeant Ernest E. Anderson, 1st Cml. Regt.
Sergeant Bert M. Dumas, A.C., Edgewood Arsenal, Maryland.
Sergeant Charles Grey, 1st Cml. Regt.
Sergeant Charles W. Jarvis, 2d Cml. Regt.
Sergeant Charles Johnston, 1st Cml. Regt.
Sergeant Richard I. LaBolle, C.W.S., Hq., 4th C.A.
Sergeant Joseph J. Mayor, 1st Cml. Regt.
Sergeant Clifford J. Walsh, 1st Cml. Regt.
Sergeant George Wilson, C.W.S., Hq., 1st Division
Corporal Frank Brown, C.W.S., Hq., 6th C.A.
Corporal Clayton G. Cook, C.W.S., Hq., 1st Division
Corporal Forest A. Embry, C.W.S., Hq., 4th C.A.
Corporal Alfred A. Fisher, C.W.S., Hq., 5th C.A.
Corporal William P. Frederick, 1st Cml. Regt.
Corporal Albert J. Guerin, 1st Cml. Regt.
Corporal Richard C. Haberstroh, C.W.S., Edgewood Arsenal, Md.
Corporal Henry R. Maye, C.W.S., Hq., 2d C.A.

The purpose of this course is to qualify non-commissioned officers of the Chemical Warfare Service (1) to instruct Regular Army and National Guard units in defense against chemical attack; (2) to assist in the instruction of Chemical Warfare Service Reserve Officers assigned to chemical regiments; (3) to command a chemical platoon; and (4) for duty in the office of the Corps Area, department, or division chemical officer.

In addition to thorough instruction in chemical warfare weapons, agents, and protection against chemical warfare, extensive instruction is given in Map Reading and Administration. The purpose of this latter subcourse is to qualify the students to perform administrative duties in the chemical warfare offices at corps area, department, and division headquarters. Special emphasis is also placed upon the technique of chemical weapons, and chemical warfare tactics. The course ends with a subcourse in training designed to leave the student with a thorough knowledge of methods to be used in applying his knowledge when he leaves The Chemical Warfare School.

CHEMICAL WARFARE

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