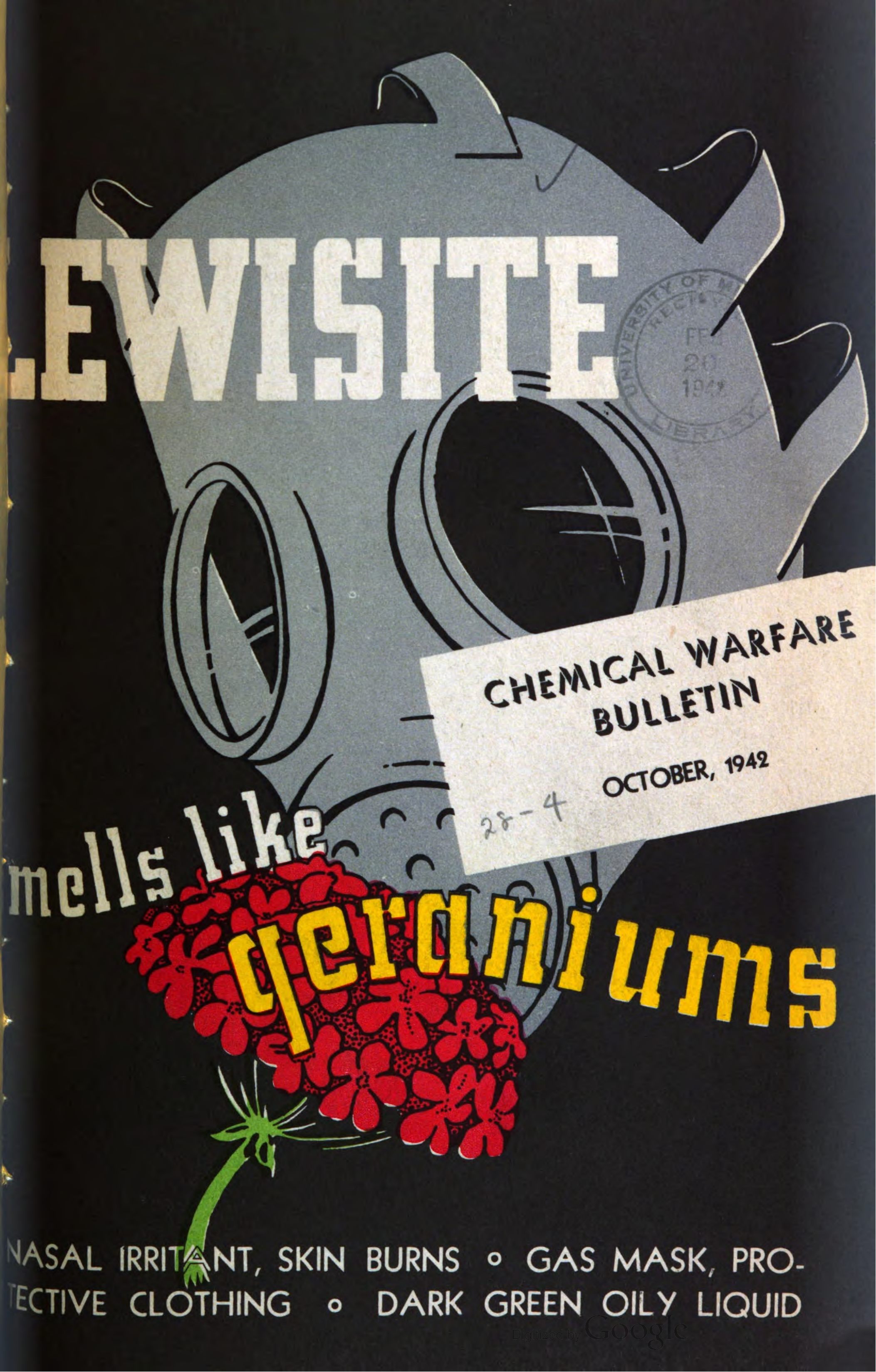
- - WASHINGTON POST

There's No Shortage of This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CHEMICAL WARFARE
BULLETIN
OCTOBER, 1942
28-4
NASAL IRRITANT, SKIN BURNS ◦ GAS MASK, PRO-
TECTIVE CLOTHING ◦ DARK GREEN OILY LIQUID

The Cover Pictures

Both cover pictures are reproductions of large posters which were made and used as training aids by Lt. Col. R. R. Knox, Chem. Officer, Camp Roberts, California, and along with two other posters on pages 157 and 159, furnish illustrations for the article TEACH WHEN YOU TEACH, which appears at the beginning of this issue.

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VOL. 28 OCTOBER, 1942 NO. 4

CHEMICAL WARFARE BULLETIN

A review of developments in the application
of chemicals to military effort

Special Notice

Many changes of address are inevitable during wartime. To insure prompt delivery of your copy of the Chemical Warfare Bulletin, please inform the Editor, C. W. Bulletin, O - C, C. W. S., War Dept., Washington, D. C., of all changes of address.

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REPRODUCTION PLANT
CHEMICAL WARFARE SCHOOL
EDGEWOOD ARSENAL, MARYLAND

"Required reading" for the many officers whose responsibilities include the training of men:

TEACH WHEN YOU TEACH!

The Lives of Many Men Depend Upon the Efficiency with which Officers Train Them for Combat

by

Capt. Edwin L. Roe, C.W.S.,
Chemical Warfare School

The rapid expansion of the Army of the United States which has taken place in the last two years has brought into the foreground many complicated problems of procurement and supply but none of these can compare with the problem of providing a rapid and orderly expansion of officer personnel. Many young officers have come into the service directly from school or from civil life with little or no military background and with no experience whatever in directing or instructing others. Most of these young men have sensed the glamour which attaches to wearing the gold bars of office but usually have little realization of the long hours of work and attention to detail which their new positions will demand of them.

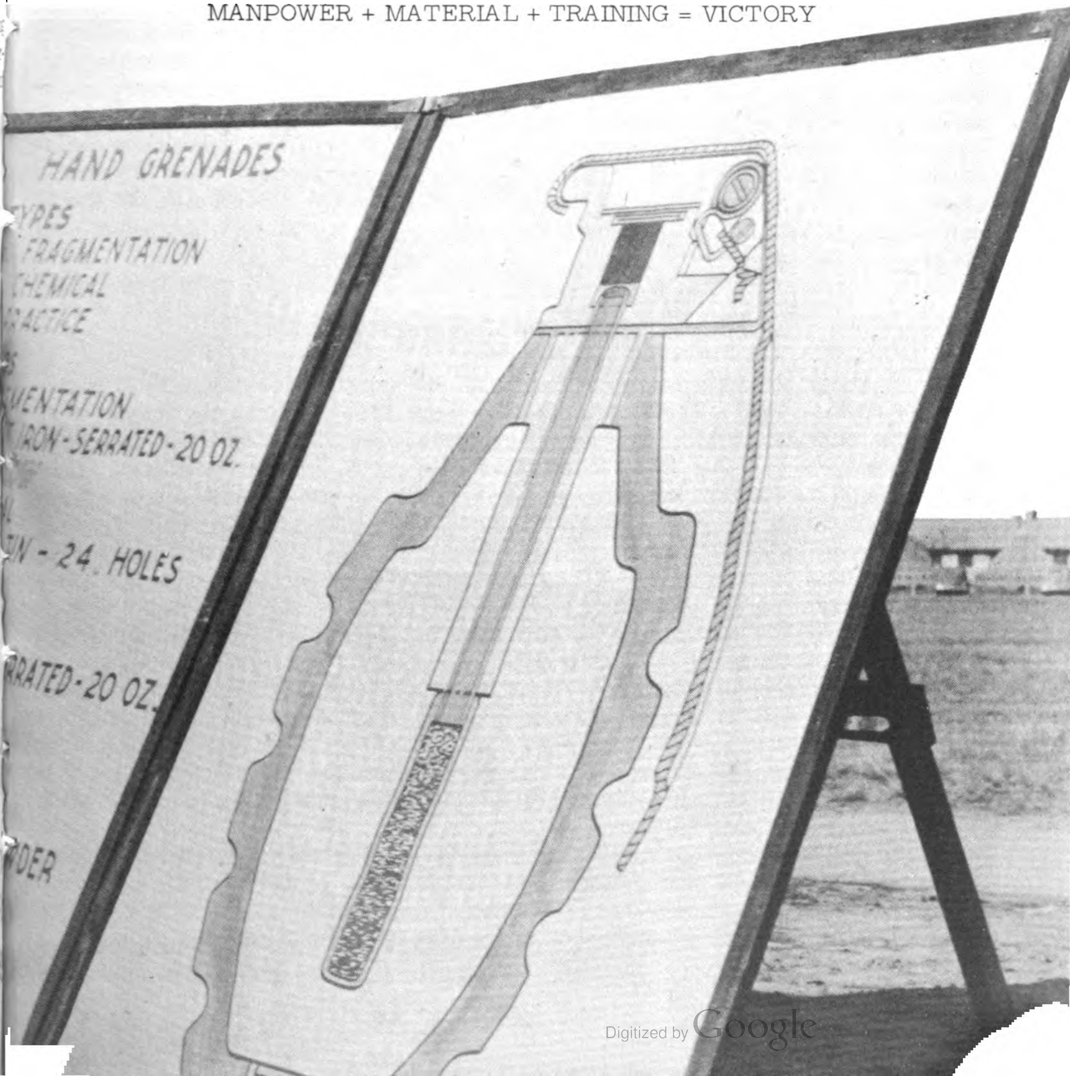
This is especially true in the technical branches and services like the Chemical Warfare Service. A knowledge of Chemistry is thought by many to be the "open sesame" to our organization. The newly appointed officer usually visualizes himself as working in a spotless laboratory on the development of a new gas, the perfecting of which will bring about the downfall of Hitler, Hirohito and Mussolini and win for our hero the thanks of a grateful people. Unfortunately this rosy vision is far from the truth as the young officer will soon discover. There can be no question but that a commission in the Army is a great honor to the recipient but the acceptance of it entails duties and responsibilities far greater than those imposed by any position in civil life.

We, of the C.W.S., are accustomed to thinking in terms of chemical symbols and formulae. We read of our great manpower and of the vast amount of war material coming from the factories of America and it seems that the national equation for victory is quite simple. Stated in chemical terms the accepted equation seems to be

MANPOWER + MATERIAL = VICTORY

However a brief consideration of this equation in the light of our knowledge of military history and of War Department plans and directions shows us that one very important ingredient has been left out. Consequently we must rewrite our equation to include this new ingredient and it becomes

MANPOWER + MATERIAL + TRAINING = VICTORY



All will agree that this statement provides the only true equation for victory and so the fundamental job of the officer force of the Army is that of providing and administering a thorough course of military and technical training for the men of the Army. The sooner each officer in the Army recognizes his place in the great general plan the sooner victory will come.

The responsibility for training is, in the first analysis, a function of command and is directly the responsibility of the organization commander. Consequently there is a tendency on the part of some officers to "pass the buck" with regard to training along to someone else or try to leave it to the person specifically charged by regulations with the responsibility for it. This is one of the worst bits of self deception that an officer can practice and one that lessens to a marked degree the potentialities for training which lie in the officer force of the U. S. Army.

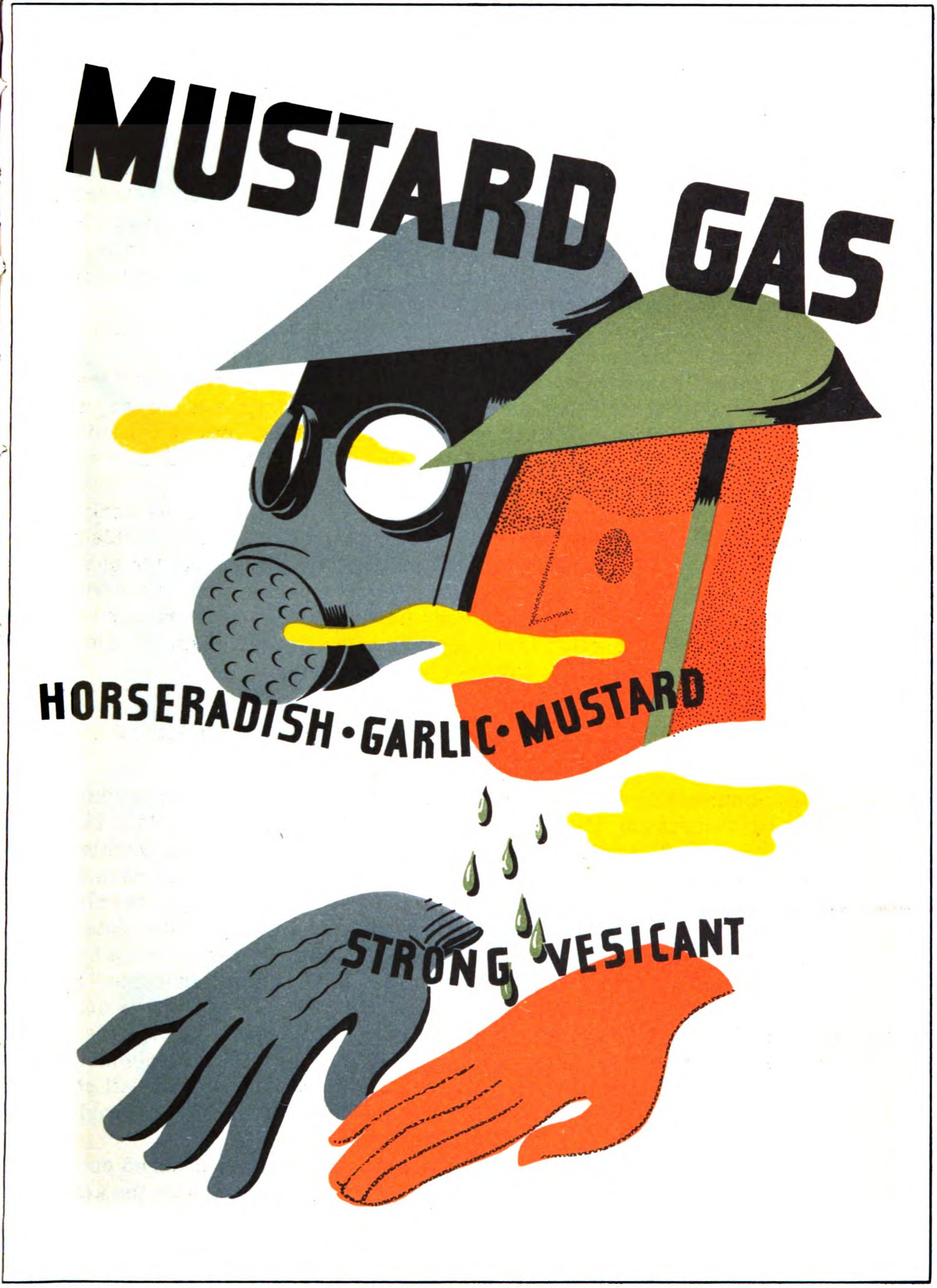
GOOD OFFICERS, GOOD ARMY

Time and again the fact has been brought to our attention that there has never been a good Army without good officers and never has this been as true as at the present time. The great technical advances in the art of war necessitate the development of specialists of every kind. The job of training soldiers is the job of every officer and one that he cannot shirk or avoid if he is to do his duty to his country and to his men. No one officer is qualified to instruct in all subjects but every officer should work hard to make himself the master of the subject, or subjects, in which he does instruct. It is certainly the duty of all officers to use every opportunity to instruct enlisted men in such things as military courtesy, respect for government property and consideration of the rights of civilians on trains and elsewhere. Any violation of law or good taste by Army personnel should be promptly corrected by an officer. Many times minor infractions by enlisted men are the result of thoughtlessness or ignorance, and correction by an officer will prevent a recurrence of the happening.

LET'S NOT MAKE THE SAME MISTAKE TWICE

A study of battle losses of American divisions in World War No. 1 serves to show us that well trained organizations were able to carry out extensive and dangerous operations with few casualties while other divisions thrust into battle with insufficient training lost far more men in much simpler operations. (Lack of training on the part of both officers and men took an unnecessary toll of American lives in 1918; we must prevent the duplication of that in this war.) If we are to escape this happening every officer of every grade of every arm and service must recognize the fact that he has been commissioned by the American people to teach American youths the art of war and that the lives of men depend upon the thoroughness of his teaching. This is a sobering thought and one that should spur all officers to become the best instructors it is possible for them to be.

Through the intelligent action of the War Department in making a careful study of all aspects of training we are blessed with such a wealth of training material as has been enjoyed by no other Army in history. Field Manuals, Technical Manuals and other publications of all sorts plus an unexcelled supply of teaching aids and visual material in the form of films and film strips brings to us an official stock of teaching material which, if used correctly, will enable us to do our part in rapidly and correctly instructing the organization for which we are responsible. In addition the unofficial publications of various service schools and the magazines of the various arms and services provide another authentic source of material too often overlooked by officers in search of training information.



nis poster, submitted by Lt. Col. R. R. Knox, Chemical Officer, Camp Roberts, Califor-
, represents an excellent example of what can be done to increase teaching efficiency.

FM 21-6 AND FM 21-5 SHOULD BE THE INSTRUCTOR'S BIBLE

In FM 21-6, "List of Publications for Training," the War Department has catalogued publications and visual material available for training. Several W.D. Training Circulars, notably TC 23, 1942, and TC 33, 1942, supplement this manual and list much new material. In FM 21-5, "Military Training," the War Department has provided a handbook of teaching information for experienced officers and beginners alike. This manual takes up methods of teaching, points out good and bad instructional practices and provides a fund of information which will help the good instructor to become an excellent instructor and aid the poor, or inexperienced, teacher in rapidly improving the quality of his work. This manual is one of the most important publications of the Army and is a MUST item for the private library of every officer in the armed forces of the United States.

While this manual offers a fund of help to all officers it cannot make an officer do a good job of instructing unless he realizes the importance of his job and has the will to carry it through. It is rare indeed that a daily schedule of training, no matter how carefully thought out, is carried through without unnecessary loss of time. To some extent this loss is unavoidable but the alert officer can minimize such losses if he has his plans carefully laid in advance. The time allotted for training men for battle is never too great and every minute must be made to count. If some obstacle suddenly arises to prevent an officer from completing the work called for on his training schedule he should have an alternate plan that will enable him to utilize the period for some equally essential instruction; preferably for something called for later on the schedule so as to assure an open period when the work being missed on this day can be made up. It is very important for the instructor to make sure that the substitute instruction is not a phase of progressive unit of instruction in which some of the basic periods have not been finished.

NEVER LOSE SIGHT OF THE PROGRESSIVENESS OF TRAINING

Let us assume that a field exercise on chemical agents has been scheduled, but for some unknown reason, the "Set, Gas Identification, Detonation, M1" is not on hand when the group arrives at the point of instruction. However a noncommissioned officer reports to the officer in charge of the training detail that the gas chamber is available for use and that the present period could be used for the gas chamber exercise; this being called for on the training schedule at a slightly later date. This seems to be a good opportunity but the officer knows that the men have not had sufficient gas mask drill to properly prepare them for gas chamber exercise. Hence, in this situation, he should substitute gas mask drill for the gas identification exercise and should not take his men through the gas chamber until they are really ready for this important phase of their training. (Army instructors must never lose sight of the progressiveness of training, i.e., they must see that all steps in training are logical with ordered advance from the simple to the more complex and from what is now known to the unknown.)

Officers can do a great deal to secure a progressive and ordered course of training by never leaving anything to chance or depending too much on the action of subordinates. Our hypothetical officer with his gas identification exercise should have made it a point not only to arrange for the detonation set well in advance but should have checked again on the day of the exercise to make sure that there had been no slip in the arrangements. In spite of all his efforts a last minute failure of transportation or other unforeseen happening might have occurred, but no officer

Member of a series of four posters designed for use as training aids by an alert chemical officer. (Submitted by Lt. Col. R. R. Knox, Chemical Officer, Camp Roberts, Calif.)

should have to face the realization that an obstacle to training has risen through fault of his own. The most reliable assistant will fall down on the job occasionally and while the officer can occasionally clear himself by passing the buck to the assistant this is small compensation for the training which the men have missed.

TOO MUCH ABUSE OF REST PERIODS!

Another great waste of valuable training time results from the tendency of many instructors to give numerous rest periods at times when they are not called for by the training schedule. Practically all schedules provide for a ten minute break at the end of every fifty minutes of instruction. It is very important that this break be given on time, but unless the weather is extremely hot or the work very strenuous, the ten minute period will provide all, or nearly all, the rest needed by the men under instruction. Of course no sane instructor would expect to keep men at close order drill at attention for fifty minutes, but the period should be so broken down that a variety of movements and facings are carried out, some of them at attention, some of them at ease. (If 100 men are undergoing instruction and only five minutes of the instructional period are wasted this means 500 minutes of waste time, or more than the equivalent of a whole day of instruction for one man. Time so lost can never be regained and the additional five minutes of instruction might have provided just the information which would have been the means of saving the life of one of the men at a later date on some distant battlefield.) Men should never be driven to the point of exhaustion but neither should they be given more time for rest than the situation really demands.

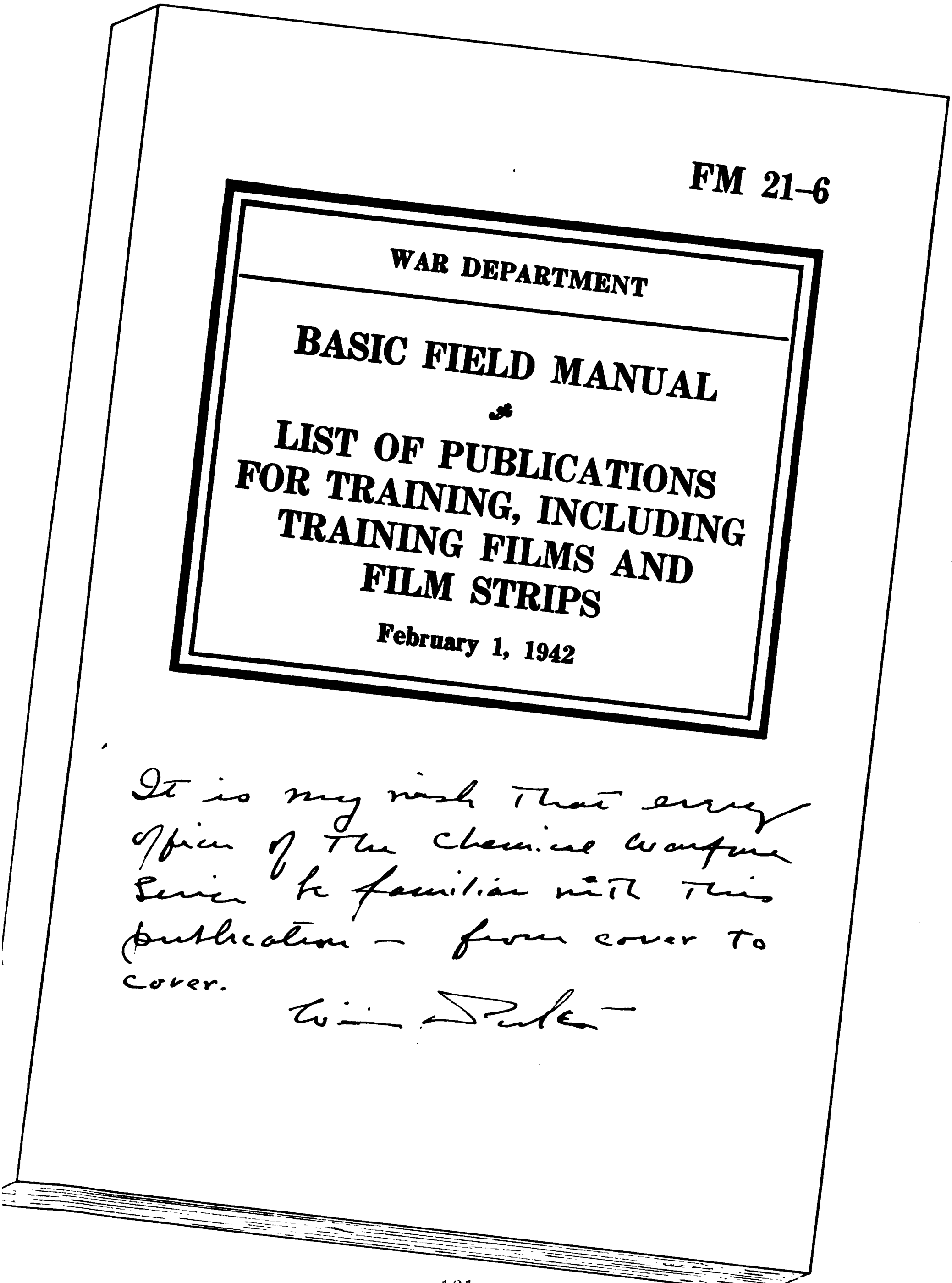
CAREFUL PLANNING IS IMPORTANT

When an officer goes before a group of men on the field or in the classroom he should have the work of the period carefully planned. He must be thoroughly conversant with the subject matter involved in the teaching job at hand and must know how to put this information across to his men. The two things do not necessarily go together. A good instructor certainly must know his subject thoroughly but the knowledge of subject matter does not, in itself, make him a good instructor. Yet nearly every officer who has a thorough mastery of subject matter can develop the characteristics which mark the good instructor if he is willing to put forth the effort to do so. (In Field Manual 21-5 will be found the formula for this improvement.)

TIME IS LIMITED!

Proper instructional methods are just as important for the military instructor as they are for the teacher in high school or college. More so perhaps, for the military instructor normally has pupils of all degrees of intelligence with all kinds of educational backgrounds while the civilian instructor deals with classes in which the members have much the same degree of intellectual attainment. In spite of the differences of individual pupils the military instructor who has a sympathetic understanding of men, a good knowledge of subject matter and of the fundamental teaching process best suited to a given job will have little trouble in doing a piece of work of which he can be proud. Above all the military instructor must never lose sight of the fact that Old Father Time is busily engaged in harvesting the minutes as the training periods pass and that every minute wasted is a minute contributed to the Axis; an Axis which has no minutes of its own to waste. A minute lost today in an American training camp may readily be translated into a life lost in a few months from now.

As military instructors this responsibility is yours and mine and the responsibility of every officer in the Army. We must accept it with full realization of the fact that the men who pass through our hands will see the day when they will thank us for the bit of extra effort we put forth in preparing them for battle.



For the officer who needs a guide in preparing general talks on chemical warfare, the Bulletin publishes:

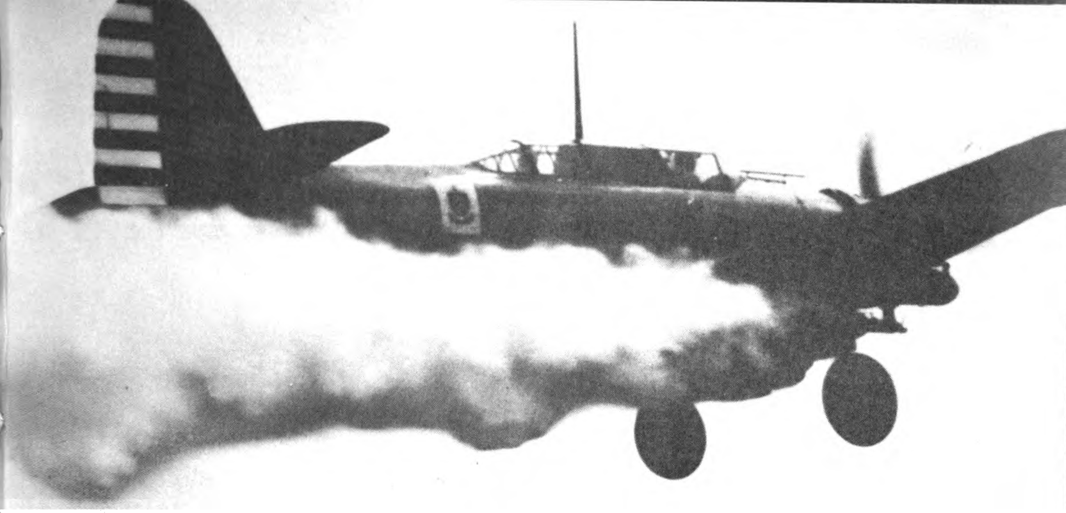
WHAT THE CHEMICAL WARFARE SERVICE IS DOING

Recent Lecture Delivered by a Chemical Warfare Service Officer

The Chemical Warfare Service has a fourfold mission: 1. Research and development, 2. Production, 3. Instruction, 4. Chemical troops for combat. This is a really big program and, even though poison gas has not yet been used to any great extent, the constant threat of its extensive employment places a heavy responsibility upon our Service in order that we may not be caught napping. So many times we hear the question: "Why has poison gas not been used in this war?" that I think it fitting to digress for a moment to consider that question.

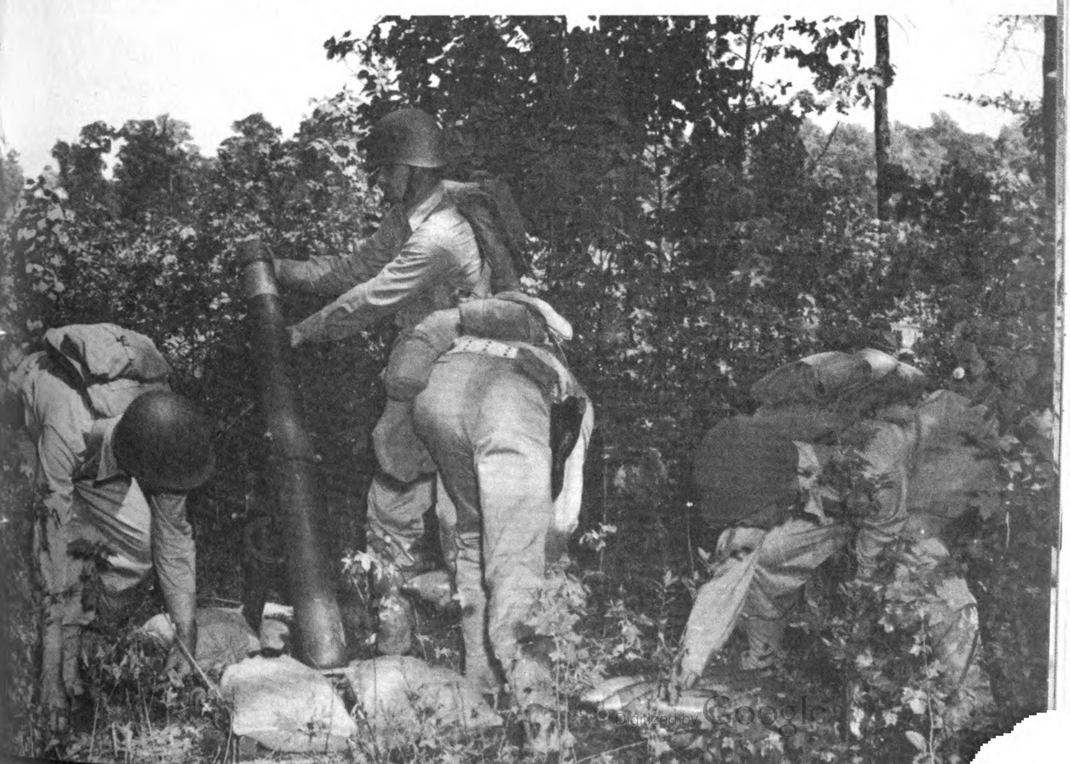
All American citizens are interested in the activities of their Army and Navy, particularly at this time. You, as chemists, are likely to have a special interest in the Chemical Warfare Service because it is more closely related to your profession than are the other branches. As soon as our Service is mentioned the average person at once thinks of chlorine and other poison gases, yet the program assigned to the Chemical Warfare Service is so inclusive and diversified that few

The Chemical Warfare Service has many responsibilities which are peculiar to this branch of the service. Among these are the development, manufacture, and use of smoke munitions, flame throwers, and chemical mortars. Photographs on these pages illustrate each of these weapons in action.



civilians have any adequate conception of its ramifications. It is my purpose to try to give you a general picture of our activities in the present war program.

Poison gas has not been used in Europe for the following probable reasons: 1. To date, the campaigns have been rapid advances in a war of movement, whereas poison gas could be employed to the greatest advantage in a condition of stabilized warfare. Should a condition of stalemate result in trench warfare, as on the western front of World War I, we may see the employment of poison gas on a wide scale. 2. The fear of reprisal, particularly against civilians, may have been a deterrent. Airplanes on either side can spray mustard with terrible effect unless the civilian population is well trained in protective measures. Knowledge that the people of Great Britain are all supplied with gas masks may have deterred Hitler from using toxic



"I have seen photographs of Chinese soldiers whose bodies bore large blisters caused by some vesicant agent," says the lecturer. The above photograph of Wei Tso-Kan, Commander of a Chinese Machine-Gun Platoon, is one of the pictures referred to. The officer was gassed with a Lewisite-Mustard mixture in the Battle for Ichang.

gases. 3. Conscientious scruples against the use of gas may have prevented its employment but I believe that our enemies have given very little consideration to scruples or humanitarianism in the present conflict.

Poison gas has been used by the Japanese against the Chinese in the present conflict. Not on a large scale, to be sure, but sporadically, when they were hard pressed or, apparently, when they wished to experiment or try out some of their chemical munitions. Mustard, Lewisite, and chlorpicrin have all been reported as being used by the Japanese, while I have seen photographs of Chinese soldiers whose bodies bore large blisters caused by some vesicant agent.

The Italians used mustard with terrible effect against the bare-footed and defenseless Ethiopians in 1936. Numerous instances have been reported that both sides in the present conflict have plentiful supplies of chemical agents on hand ready to retaliate should poison gas be used against them. No one can foresee when poison gas will be used, but there is not only a possibility but even a probability that a desperate Germany with its highly developed chemical industry may resort to the use of poison gas to stave off defeat. As to the Japanese after Pearl Harbor, we can expect anything.

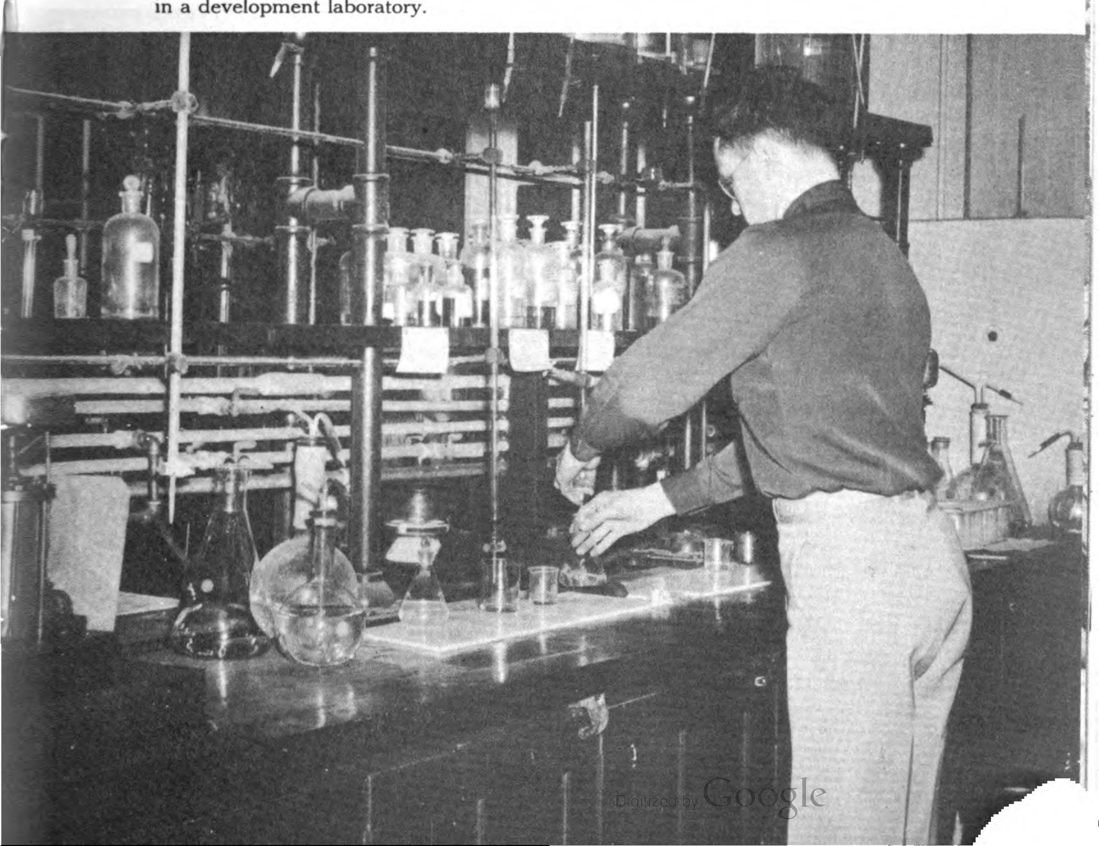
In this connection, I want to correct a common misunderstanding. The United States is not a party to any treaty prohibiting the use of poison gas. The Geneva Protocol was not adopted by the United States Senate so our armed forces are free to employ chemical agents should our Government decide to do so. Our armed forces are prepared to retaliate should poison gas be used against us.

Constant research is essential for success in modern chemical industry but is of even greater importance in chemical warfare because surprise is one of the fundamental principles of successful combat. Starting from scratch with feverish haste in 1915, research and development in chemical warfare has been carried on by all leading nations since that time. Our own Chemical Warfare Service is specifically charged with research and development which we are carrying on at the Technical Laboratories of Edgewood Arsenal, as well as at our Development Laboratory at the Massachusetts Institute of Technology, and Incendiary Laboratories at Columbia University. In addition, nearly a hundred of the most prominent chemists at our leading colleges and universities are carrying on research problems in cooperation with the Chemical Warfare Service.

In general, the research problems may be grouped under three headings ... 1. Weapons, 2. Munitions, 3. Protective devices. To give you a better idea of the research problems, I can list the following as typical: 1. Improvements in the design of weapons, 2. Investigations of possible new agents, 3. Toxicity tests, 4. Improved methods for detecting chemical agents, 5. Studies in catalysts, 6. Production methods for agents, 7. Improvements in activated charcoal, 8. Absorbents and filtering materials, 9. Development of new decontaminants, 10. Physiological effects under field conditions. The above list includes only a few of the hundreds of research problems being carried on by the Chemical Warfare Service.

Throughout the World War I, the lists of known organic and inorganic compounds were combed repeatedly by chemists of the highest caliber to find effective chemical warfare agents. It is interesting to note that all of the agents successful under field conditions were compounds that had been known for many years. Research

"Constant research . . . is of even greater importance in chemical warfare because surprise is one of the fundamental principles of successful combat." In the photograph below is shown a Chemical Warfare Service officer at work in a development laboratory.



has been going on constantly since 1918. Possibly new compounds or new derivatives of well-known compounds have been developed but no public announcements have been made. Should some new compound be suddenly employed in the battlefield, it is probable that our present protective equipment, possibly with slight modifications, will protect our troops against casualties. In chemical warfare, as in all types of combat, there is the continuous race between offense and defense, guns versus armor, fire power versus vulnerability, chemical agents versus protective devices. It is only by constant research and developmental work that our Nation can be prepared for both offense and defense in chemical warfare, - and this we are carrying on.

GAS MASKS WERE READY ON DECEMBER 7

Our biggest task at present is production. Gas masks, protective clothing, chemical weapons, flame throwers, chemical agents, shells, grenades and smoke pots, as well as incendiary bombs, are needed in prodigious quantities for our rapidly expanding Army. Through the foresight of the Service in preparing detailed procurement plans during peacetime, we were able to go into production rapidly as soon as the present emergency arose. We are very proud of the fact that we had a gas mask ready for each individual soldier as soon as he began his training. A part of our production program is being carried on at our arsenals but the greater part is being produced by private industry working under contracts. All of the materials manufactured for the Army are subjected to close inspection throughout each stage in their processing to make sure that they conform to exact specifications. I am happy to say that we have had excellent cooperation from the many industrial firms, without whose assistance our program would certainly have fallen down.

The manufacture of gas masks is not simple. Our service gas masks have about 100 individual parts, each of which must function perfectly or the value of the mask becomes nil. Rubber facepieces that are fully molded in one operation have been developed, while laminated, gas-resistant fabric can be used if rubber is not available. In addition to supplying our armed forces, the Chemical Warfare Service is producing gas masks for distribution to civilians by the Office of Civilian Defense. Production becomes a big task when you talk, not in thousands, but in millions. The problem is multiplied enormously when each item is made of many separate component parts.

OFFENSE FOR DEFENSE

Wars are not won by defensive measures but rather by offensive operations. Hence, we must produce large quantities of materials to be used should occasion require. Here we enter a field of particular interest to the chemist. Besides smoke-producing chemicals, such as chlor-sulfonic acid and titanium tetrachloride, various toxic gases are required. Production of such items cannot take place overnight; consequently, plants must be constructed and in operation long before the probable need for such munitions on the battlefield. While we purchase chlorine, acids and various other commercial chemicals, the manufacture of chemical agents is for the most part carried on at chemical warfare arsenals. There are several reasons why these agents are produced at our arsenals rather than by private industry.

Chemical warfare agents form a highly specialized branch of chemistry which is nonindustrial in nature. Industrial firms are not experienced in the manufacture of such agents nor are their plants equipped to carry on the various operations. Since the demand for chemical warfare agents exists only in time of war, it would not be profitable for a firm to devote time, money and equipment or factory space

"We have had excellent cooperation from the many industrial firms, without whose assistance our program would certainly have fallen down." One of the loyal factories referred to is pictured above.

to these products. In addition, the manufacture of chemical warfare agents inevitably involves certain industrial hazards which make it advisable to carry on the operations at Government Arsenals where proper safeguards, dictated by years of experience, can be maintained.

While the manufacture of the common chemical warfare agents is described in such text books as Prentiss' "Chemicals in War," a brief outline as to how we make phosgene and mustard, two of the most important, may be of interest.

PREPARATION OF PHOSGENE

Phosgene, at ordinary temperatures and pressures, is a heavy colorless gas which condenses at 46° F. It was discovered by Davy in 1812; thus, it was known for more than one hundred years prior to the first World War. Phosgene is prepared by the direct synthesis of chlorine and carbon monoxide, with the aid of carbon as a catalyst. Carbon dioxide is first produced by burning coke. After cleaning and purifying, the carbon dioxide is stored in a holder. Oxygen is prepared from liquid air and is stored in a holder until required. Carbon monoxide is prepared by the reduction of carbon dioxide passing through a coke furnace. Sufficient oxygen is admitted to maintain the required temperature for the endothermic reaction.

Carbon monoxide and dry chlorine are admitted in proper proportions to a mixing chamber, from which the mixed gases are led to the catalyst chambers. After passing through the catalyst boxes the phosgene is condensed by means of refrigerating coils, while the uncondensed gases pass on to an absorption plant.

Phosgene is not difficult to make at low cost and is an efficient lung irritant gas for war purposes. A considerable problem in the manufacture of this agent is the corrosion of steel and other metal parts by traces of hydrochloric acid vapor produced by hydrolysis.

"THE KING OF WAR GASES"

Mustard, which is technically known as beta, beta, dichlor-diethyl sulfide, is considered one of the most effective chemical warfare agents. Besides a powerful lung irritant action, mustard has a vesicant action on the skin, producing large water-filled blisters when the skin comes in contact with either the liquid or vapors. Mustard was first prepared in 1822 by Despretz, who prepared it by the action of ethylene or sulfur chloride. It was later prepared by Guthrie in 1860, and also by Niemann in the same year. Meyer prepared mustard by the chlorination of thiodyglycol in 1886, and his method was used for the preparation of this agent by the Germans during the first World War. It is interesting to note that in spite of the enormous advances in chemistry, particularly in organic synthesis from the time of Kekule on, mustard, sometimes called the "King of war gases," was prepared, like phosgene, another very successful war gas, much more than a century ago.

The American method of producing mustard is to bubble ethylene gas through sulfur monochloride with careful control of temperature. The ethylene is produced from ethyl alcohol and is then scrubbed, dried and stored until needed. Sulfur monochloride is produced by reacting chlorine with sulfur. The reaction by which the mustard is produced, like so many others on paper, appears simple but in large-scale production there are a number of production difficulties. During the last war, Conant, now President of Harvard College and head of the National Defense Research Council, worked out methods to overcome these production difficulties.

The third major responsibility of the Chemical Warfare Service is to instruct all of the armed forces of the United States in chemical warfare. Our Service cannot instruct each separate unit, but does train officers and enlisted men of the Army, Navy, Marine Corps, and Coast Guard, who will in turn instruct the members of their units. This instruction is given at the Chemical Warfare School, which is located at Edgewood Arsenal in Maryland. The aim is to provide at least one graduate of the Chemical Warfare School for each of the larger components, such as a regiment, in order that our armed forces, down to the newest recruits, may be thoroughly grounded in defense against chemical attack. While chemical agents are capable of producing casualties, the greatest effect is psychological, and one can only overcome man's instinctive fear of something new and strange, such as "gas," by constant drill and thorough instruction. If we can build in the mind of the soldier confidence in his gas mask and see that he knows how to wear the mask properly, we can lick the psychological factor easily.

CWS OPERATES CIVILIAN PROTECTION SCHOOLS

The present war has demonstrated that everybody - civilians, as well as soldiers - are subject to enemy attack. The devastating air raids which the Germans launched upon the English cities and towns have shown the need for training the civilian population in methods of defense against high explosives, incendiaries and toxic gases. In order that our civilian population may be properly trained, the War Department Civilian Protection Schools have been organized under the control of the Chemical Warfare Service. Intensive ten-day courses are conducted for firemen, policemen, public utility employees and other civic representatives at the five such schools now in operation; and two more will be organized shortly. These schools are located at Amherst College in Massachusetts, University of Maryland, University of Florida, Texas A. and M. College, Stanford University in California, while the two new schools will be located in the Great Lakes Area and the Pacific Northwest. Just as in the instruction of our armed forces, the aim is to train leaders who will in turn train the citizens in their home communities. The importance of this work cannot be overemphasized. We may be subjected to enemy attack, particularly along the Atlantic and Pacific coastline, while the concentrated industrial area of Detroit would certainly be a prize target for our enemies. During 1937 and 1938, the British public displayed a considerable amount of apathy towards civil defense. The raids against London in December, 1940, caused widespread destruction.

One of the War Department Civilian Protection Schools referred to above is conducted at the University of Maryland. Shown here is one of the first classes which this school graduated.

Later, raids in the Spring of 1941 against the English Midlands cities produced only one-quarter as much damage per bomb dropped. This improved showing, from our point of view, resulted from the added impetus given to civil protection training. Let us hope that our Nation will profit by the experience of Great Britain and give sufficient attention to civilian protection before the raids occur.

SOME CHEMICAL TROOPS ALREADY "GOT THEIR JAPS"

The Chemical Warfare Service is also a combat arm of the Army in that we have chemical troops. These units include Weapons Companies, Decontamination Companies, Field Laboratory Companies, and Depot Companies. In addition, we have chemical companies assigned to duties in cooperation with the Air Forces. When the attack on Pearl Harbor occurred, one of our Chemical Companies was on the "alert" and used machine guns with telling effect upon the Japanese attackers.

The principal weapon of the Chemical Warfare Service is the 4.2-inch chemical mortar. This is a muzzle-loading, rifled weapon which nicely combines portability, rapidity of fire, and accuracy. Shells from this mortar can be fired a considerable distance. The filling of the shells can be white phosphorus, mustard, phosgene, or other toxic gases, as well as high explosive. The weapon was developed by Chemical Warfare Service officers and we are proud of its performance.

Livens projectors which fire a large watermelon-shaped projectile from a ground emplacement are valuable for laying down a heavy concentration of gas on a particular target. Chemical cylinders and smoke pots are other weapons of chemical troops.

The spraying of smoke or other agents from spray tanks fastened to the fuselage of airplanes is a method of dispersing our agents that is not being neglected.

Decontamination companies specialize in the decontamination of areas which have been gassed with persistent agents. Depot companies, as their name implies, are supply companies for issuing the various chemical warfare supplies to chemical troops and other branches of the field forces.

CHEMICAL LABORATORIES IN COMBAT

Of particular interest to chemists are our Field Laboratory Companies. These units operate in the field close to the front lines. The purpose of the Field Laboratory Companies is to make analyses of chemical agents projected against our troops. The supplies and equipment can be quickly unpacked and set up. Bottled gas supplies fuel for Bunsen burners, while electric power is available from an accompanying truck generator to operate exhaust fans, electric furnaces and other apparatus. It seems strange to see complete analyses performed in a tent that is set up in a wooded area to provide concealment from enemy planes, but I can testify that the personnel perform creditable work under these field conditions. The Field Laboratory Companies are the most highly educated companies in our Army. More than half of the personnel are graduate chemists, while Ph.D's are as common in these companies as Corporals' chevrons in an infantry rifle company. By performing analyses on the spot, the Field Laboratory Companies are able to advise the Army Commander as to appropriate protective measures against new or surprise gases.

The Chemical Warfare Service has expanded at least as fast as other branches of our Army in the last two years. To take care of increased production, new Chemical Warfare Service arsenals have been constructed in Huntsville, Alabama, and Pine Bluff, Arkansas, while our original "Mother Arsenal" at Edgewood has been modernized and greatly expanded. Several plants have been constructed for manufacturing special chemicals for our Service, and a Proving Ground is under construction in Utah, where firing tests of our munitions can be carried on far from congested cities.

The incendiary bomb program of the Chemical Warfare Service is a tremendous undertaking that is one of our main activities. Incendiaries have played a big part in the present conflict and our program calls for the production of prodigious quantities which would certainly send chills down the backs of residents of Tokio and Berlin if they knew of the extent of our plans. Newspaper accounts from Tokio indicate that Japan has already had a taste of what is to come.

Chemists, particularly, are interested in technical developments resulting from the war. After the conflict is over we shall be able to publish many interesting technical developments which cannot be discussed at present. The conservation of critical materials is a subject that is being carefully studied. New alloys to conserve tin are being developed, new bearing metals have been produced, while the Chemical Warfare Service is now using some plastic parts for gas masks instead of brass. The substitution of plastic parts has resulted in faster quantity production, fewer finishing operations, conservation of brass; and has also produced parts that are nontarnishing, and require no paint or lacquer. The use of cellulose acetate lenses for gas masks instead of glass presents certain advantages. Laminated paper containers have been substituted for metal for packing cases, while Parkerizing has replaced cadmium plating for some metal components. In the manufacturing field expensive glass-lined containers and reactors have been replaced by black iron vessels with corrosion-proof coatings of synthetic plastics. These are but a few of some of the technical developments which the war is bringing forth in our field.

In conclusion, let me repeat that the Chemical Warfare Service has a fourfold mission: - Technical development, production, instruction, and chemical troops for combat. Our attention is devoted to carrying out each one of these missions. Together, they explain "What the Chemical Warfare Service is Doing."

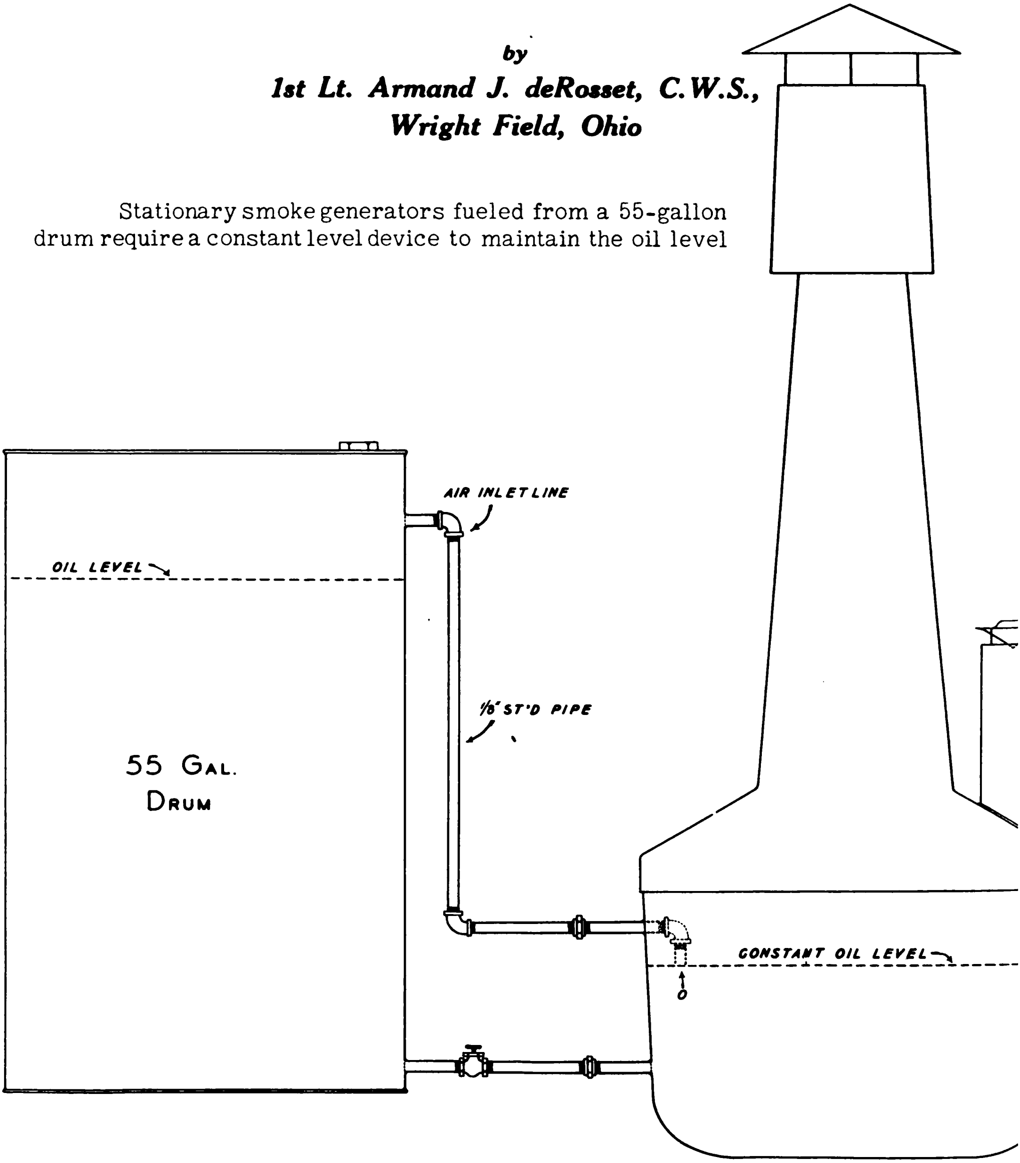
"The incendiary bomb program ... is one of our main activities." Charged with the development and manufacture of incendiaries, the Chemical Warfare Service is constantly improving designs of this type munition. Below is shown the explosion of a gasoline-filled incendiary during testing procedures.

CONSTANT LEVEL DEVICE

A Simple Apparatus which can be Made for Use with Stationary Smoke Generators

by
1st Lt. Armand J. deRosset, C.W.S.,
Wright Field, Ohio

Stationary smoke generators fueled from a 55-gallon drum require a constant level device to maintain the oil level

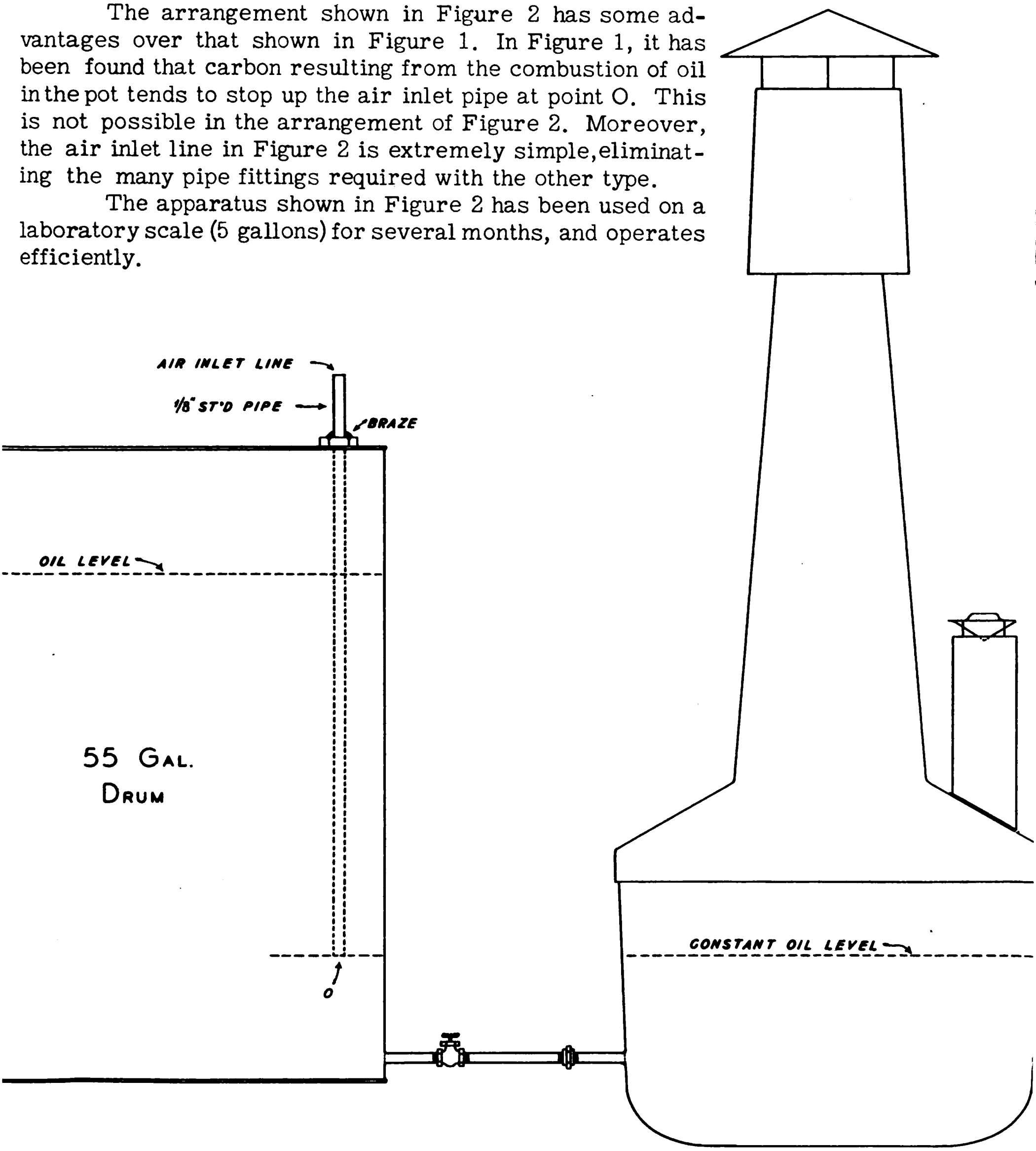


within the generator pot at the proper height. The constant level device demonstrated by the 71st Smoke Company to the 1st Special Aviation Class of the Chemical Warfare School, is shown in Figure 1. An air inlet admits air from the pot to the space above the oil level in the drum. When the oil level in the pot rises above the point O, oil feed from the drum to the pot ceases.

Figure 2 shows a simplified arrangement which accomplishes the same purpose. The air inlet line consists of a length of 1/8" standard pipe, open at both ends, which extends through the top of the drum to a depth corresponding to the oil level required in the generator pot.

The arrangement shown in Figure 2 has some advantages over that shown in Figure 1. In Figure 1, it has been found that carbon resulting from the combustion of oil in the pot tends to stop up the air inlet pipe at point O. This is not possible in the arrangement of Figure 2. Moreover, the air inlet line in Figure 2 is extremely simple, eliminating the many pipe fittings required with the other type.

The apparatus shown in Figure 2 has been used on a laboratory scale (5 gallons) for several months, and operates efficiently.



Many officers have asked questions on this subject and seldom received adequate answers. Try reading -

THE LAW OF CHEMICAL WARFARE

A Discussion of the Historical and Legal Aspects of Chemical Warfare in International Law

by

1st Lt. Cyrus Bernstein, A.S.C.,
(Member District of Columbia Bar)

(This article originally appeared in the June, 1942, issue of THE GEORGE WASHINGTON LAW REVIEW (Vol. 10, Page 889), and portions are reprinted here by special permission of that publication. The original carries an extensive set of footnotes which would be of interest to any officers particularly concerned with this subject. In a letter of appreciation to Lieutenant Bernstein, Maj. Gen. William N. Porter has said that this article ' . . . should prove enlightening to many who are under serious misconceptions about the matter.')

It may seem anomalous to write on the law of chemical warfare, indeed on the law of any kind of warfare. War seems to be the method of settling disputes which hurdles restraining regulations. And the subject may seem anachronistic when one recalls that the great bulk of so-called civilized humanity is now at war. Warfare is not, however, a completely unfettered adventure. There are laws of warfare. More particularly, in the sense that warfare encompasses chemical warfare, there are laws of chemical warfare.

The laws of warfare fall into two classes: written and unwritten. The written laws of warfare are the various treaties, conventions, and other agreements which, although often honored in the breach and through fear of realization, are binding on the ratifying and adhering powers, and are also respected in some measure by non-signatory powers as declaratory of civilized custom and usage. The unwritten laws correspond to an extent to the common law of our own jurisprudence.

The unwritten laws are as binding as the written laws, and it cannot be said that a nation can relieve itself of obedience to them.

> . . . It is . . . not necessary to prove for every single rule of International Law that every single member of the Family of Nations consented to it. No single State can say on its admittance into the Family of Nations that it desires to be subjected to such and such a rule of International Law, and not to others . . .
>
> On the other hand, no State which is a member of the Family of Nations can at some time or another declare that it will in the future no longer submit to a certain recognized rule of the Law of Nations. The body of the rules of this law can be altered by common consent only, not by a unilateral declaration on the part of one State - Oppenheim, International Law (5th ed. 1937).

"Gassed." This one word composes the title of this famous picture showing the effect of a gas attack upon one soldier whose mask failed to function. It was posed near the front lines in France during World War I by Major Evarts Tracy, Eng. Corps, and is familiar to many in connection with the long controversy over the "humaneness" of chemical warfare. There was discussion at that time as to whether this picture should be permitted publication.

The accompanying article should help to crystallize the opinion of its readers concerning the "humaneness" of chemical warfare.

The principal unwritten laws of warfare, which form the background for all the other unwritten and written laws, are three in number:

First, a belligerent is justified in applying any amount and any kind of force which is necessary for the purpose of the war, that is, the complete submission of the enemy at the earliest possible moment with the least expenditure of men and money. Second, the principle of humanity, which declares that all such kinds and degrees of violence as are not necessary for the purpose of the war are not permitted to a belligerent. Third, the principle of chivalry, which demands a certain amount of fairness in offense and defense and a certain mutual respect between opposing forces.

It is obvious that these three principles are difficult to reconcile. The principle of military necessity indicates license; the principle of humanity would curb those efforts within "humane" bounds. The principle of chivalry would apply restrictions regarding the manner of conducting the war; the principle of military necessity suggests unrestrained latitude.

Subject only to the ethical level which strikes a balance between the principle of military necessity on the one hand and the principles of humanity and chivalry on the other, the formulation of rules of warfare is influenced by contemporary notions regarding the available instruments of war. The rules of warfare should be based not on fancy but on facts, and codification of principles should be attempted only after the facts have been sifted and evaluated.

There are only a small number of chemical agents suitable for military purposes. Not all of these have physiological effects on the body; some are used as smoke or incendiary agents.

It should be remarked that these chemical agents under field conditions seldom kill. When an adequate defense is provided, chemical warfare is far less terrible than the other instruments of war. As Lieutenant Colonel White once wrote in the Chemical Warfare Bulletin:

> I would not preach the "humaneness" of chemical warfare, for there is nothing "humane" in war; and it is, of course, purely incidental, and admittedly not a factor in the choice of methods of waging war, that chemical agents are also less permanently disabling than are other modern warfare munitions. For proof that chemicals are less permanently disabling, we need only look at the other side of the picture; and it would seem necessary only to mention the loss of limbs, the deformities, and the mutilating wounds of the head and trunk, so frequently resulting from nonchemical munitions and constituting disabilities from which there can never be recovery, injuries which are practically nonexistent as results of chemical agents. Certainly these facts, and they are facts, do not warrant the unreasoning horror with which the uninformed so often regard chemical warfare.

Against this backdrop of fact, there must be portrayed the various psychological factors that create an aura around the factual core.

The Eighteenth and Nineteenth Centuries witnessed tremendous technological advances. Frontiers of knowledge were pushed in all directions. Combinations and permutations of new knowledge wrought changes in studies far afield, and military science inevitably felt the impact of the strides made elsewhere.

The benzene ring was "discovered," and the fascinating game of tacking chains of atoms to it was begun. Synthesis became an art. Exploration for new substances increased. All branches of chemical science leaped forward. Pharmacology achieved a rational basis; chemists probed into the actions of special groups of atoms which imprinted their own personalities on the molecule as a whole. The concepts of toxophores and auxophores gave new impetus to the science of toxicology, long diabolical art.

CHEMICAL WARFARE IS NOT NEW

It is hornbook psychology that that which is not understood is apt to be feared; that that which operates subtly is apt to be feared more than that which operates openly. So there grew up a polytheistic apotheosis of Science during the Nineteenth Century; and Chemistry, as one of the deities was accorded, because of its less obvious reactions, a more exalted position. Chemical warfare was dreaded as an inhuman weapon of terrifying potency.

Part of the reason for this fear of chemical warfare is the unfounded belief that it is a new measure, and therefore is apparently the more sinister. The fact of the matter is that warfare employing chemical means is extremely old. The Bible speaks of the "mad man who casteth firebrands, arrows, and death," clearly an intimation of chemical warfare in the Eighth Century, B.C. The early Grecian empire witnessed incendiary arrows and "Greek fire" (combustible oils). Genghis Khan made tactical employment of balls of pitch and sulfur. The siege of Platea and Velium (431-404 B.C.) utilized irritant gases. Admiral Lord Dundonald suggested the use of sulfur fumes as a military weapon in 1855, but the idea was rejected by the English command. Screening smoke was brought to President Lincoln's attention by Professor Sheppard of Yale University. Incendiaries were present in the siege of Charleston during the Civil War. John W. Doughty of New York City on April 15, 1862, suggested chlorine shell to the War Department. Irritant gases were employed in the Russo-Japanese War.

Another element in the fear of chemical warfare is the vicious circle of a fear feeding upon itself. The tangible accomplishments of the past decades have led many to attribute a Mephistopholean character to science. The embers of this latent fear have been whipped into open flame by sensational journalists. These journalists either know as little as their readers or, worse yet, deliberately fabricate for the purpose of an exciting narrative.

Typical of these is the following excerpt from Carl W. Spohr:

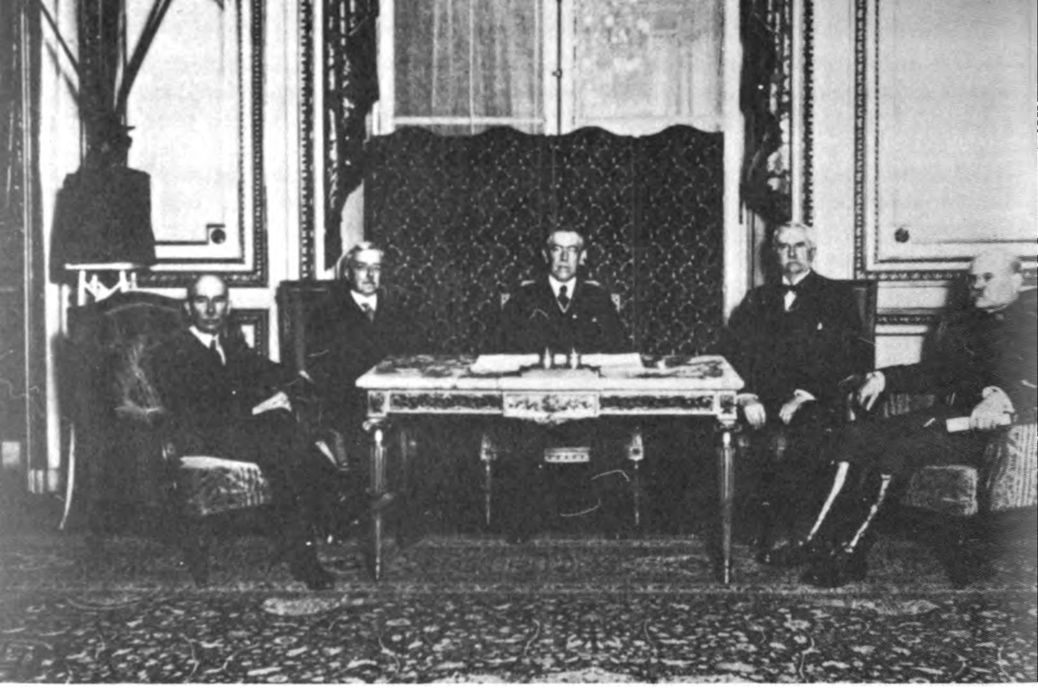
> The air raid had been terribly effective. The raiders had succeeded in silencing the ground defenses in the beginning of the raid. Gun batteries and searchlights had been blown to pieces by a tremendous expenditure of a new type of radio-controlled air torpedoes. After that the bombing had taken place methodically and thoroughly with thousands and thousands of tons . . . . All transportation means were utterly destroyed. About seventy percent of the human beings who had been in Liberty during the raid, three million people, were killed within twenty minutes, mostly by CBX gas. Only a little over one percent were wounded. The rest, who escaped, were front soldiers in field equipment and persons who had been lucky enough to be in gas-proof basements. Some of the latter were rescued weeks later when the debris had been cleared away, or tunneling parties had reached them.

And this from H. G. Wells:

> Steadily but surely it (mustard gas) killed every living substance with which it came into contact; it burnt it, blistered it, rotted it away . . . . It is doubtful if any of those affected by it were ever completely cured. Its maximum effect was rapid torture and death; its minimum prolonged misery and an abbreviated life.
>
> . . . .
>
> (Lewisite was) the discovery of a Professor Lewis of Chicago, which came too late for actual use before the end of 1918. This was one of a group of arsenical compounds. One part of it in ten millions of air was sufficient to put a man out of action. It was inodorous, tasteless; you only knew you had it when it began to work upon you. It blistered as much as mustard gas and produced a violent sickness . . . .
>
> Other war poisons followed upon this invention, still more deadly, merciful poisons that killed instantly, and cruel and creeping poisons that implacably rotted the brain. Some produced convulsions and a knotting up of the muscles a hundred times more violent than the once dreaded tetanus. There is a horrible suggestiveness in the description of the killing of a flock of goats for experimental purposes in these researches: "All succumbed to the effect of the gas except three, which dashed their brains out against the enclosure."

The alarmists point, too, to the provision of the Versailles Treaty which provides: "The use of asphyxiating, poisonous or other gases and all analogous liquids, materials or devices being prohibited, their manufacture and importation are strictly forbidden in Germany."

Behind all this there lurks a fear that chemistry will unloose new substances upon an unprepared populace. In general, the substances most recently employed today have been known for years. It is true that lewisite was discovered too late for use in World War I, but it was the only one of a vast number tried considered satisfactory. And it must be remembered, too, that science generally is a slow, tedious process.



Much discussion was made of chemical warfare and its place in international law at the peace conferences subsequent to the Armistice. Here is shown a group of U. S. peace conference officials in conference at Hotel Crillon, Paris, France, December 18, 1918. Left to right: Col. E. M. House; Robert Lansing, Secretary of State; Woodrow Wilson, President of the United States; Henry White, former United States Ambassador to France; and General Tasker H. Bliss, U. S. Army.

There must be added at least two other factors in the fear of the populace: there are the correlative elements of the enemy seeking to frighten the civilian population by tales of chemical weapons more terrifying than ever before, and of the home propagandists seeking to augment the hatred against the enemy by declarations that the foe are using chemical warfare.

It is the above admixture of fact and fancy that one must examine to determine the status of chemical warfare in the minds of diplomats --- the ones who codify the international rules. It must be remembered that the rules of international law as codified at the various meetings were expressions of the current concepts, and were manifestations of the popular notions as revealed through the formal acts of the diplomats. The diplomats, alas, were themselves usually no better than the horde in regard to chemical warfare. They were subject to the same detachment from reality, and were prone to respond to the same fears.

The actual stature of chemical warfare was replaced by the lengthened shadow of the fear. During the Nineteenth Century there were consequently various attempts at codification of prohibitions against certain chemical agents. Lieber in his General Orders No. 100 (1863) declared that "Military necessity does not admit . . . of the use of poison in any way." In another portion of the same General Orders, Lieber declared: "The use of poison in any manner, be it to poison wells, or food, or arms, is wholly excluded from modern warfare. He that uses it puts himself out of the pale of the laws and usages of war."

. . . .

Although the world called the conferences at The Hague "Peace" Conferences, war did come again. Alliances fulfilled pledges; armies marched in their heavy boots.

World War I settled into a static affair. The initial German blitzkrieg had failed, and a munitions crisis arose. The development of high explosives and powerful cannon had led military leaders to adopt defensive tactics of trench warfare with huge systems of underground fortifications. This new weapon was chemical warfare which, although ancient, had not been developed to the advanced stage of ordnance.

Before the war, the French as early as 1912 were employing a 26-mm. cartridge filled with ethyl bromoacetate, a slightly suffocating but nontoxic tear gas, which had been efficacious in the underground tunnels of Paris in control of the Apaches. Inasmuch as this shell contained tear gas, which was not "asphyxiating or deleterious," the French claimed that its use did not contravene Declaration II of the First Peace Conference. (Declaration II provided that: The contracting Powers agree to abstain from the use of projectiles the sole object of which is the diffusion of asphyxiating or deleterious gases.) It was a bit far-fetched, in any event, to assert that it was illegal to use in war against an enemy what was legal to use to suppress civil commotions. These cartridges were ideal for attacks on loopholes of the flanks of permanent fortifications. The nonpersistent gas would temporarily inactivate the defenders, while the attacker could surge past. The Germans knew of the gas shells of the French, and of the preparations being made by the French. Coming through devious channels under war circumstances this information doubtlessly was no small factor in turning the attention of the Germans to consideration of gas warfare, although it had been considered previously.

GAS ATTACK AT YPRES PROBABLY EXPERIMENTAL

The Germans employed chlorine in the second battle of Ypres on April 22, 1915. The decision to use chemicals was reached only after repeated persuading by that great chemist, Fritz Haber. Even then the militarists were not fully convinced, and permitted its use as a diversion while troops were deployed on the Eastern front. The Germans were not prepared to follow up the break in the lines caused by the successful use of chemicals against unprepared troops, and on that lack of foresight probably hinged the fate of the war.

The story of that first chemical attack has been told many times, often emotionally. The important part of the story may be summarized: On the afternoon of April 22, 1915, on the northeast Ypres salient the wind turned favorable (blowing from the German to the French and British lines). The order for the discharge was delivered, and there arose a heavy whitish-yellow cloud wall southward which developed along the German trenches. The chlorine issued from about 6,000 cylinders arranged in groups about ten feet apart by lead pipes bent over the top, and was wafted over to the enemy lines. Because of unpreparedness of the Allies, the gas was able to take a casualty toll of several thousand in a few minutes.

The surprise effect of the chemical attack was its principal value. The Allies were totally unprepared, despite warnings from various sources that the Germans were preparing for such an attack. The Allies had relied on the belief that gas would contravene international law, and that therefore it would not be employed. The French and other allies hastened to set their best scientific minds at work on defensive measures. Further, they set to work on retaliatory offensive measures.

NO GAS PROJECTILES EMPLOYED AT YPRES

The German use of chlorine cylinders did not literally contravene Declaration II, for there were no projectiles employed.

The Germans had developed a gas-filled artillery shell by modifying a 10.5 cm. shrapnel. The matrix was replaced by sulfuric dianisidin, which was dispersed as a fine dust upon explosion of the base charge. This was the "10.5-cm.

Ni-shrapnel," tested to the extent of 3,000 rounds at Neuve-Chapelle in October, 1914. As the lacrimatory potency was too low, it was discarded. This gas projectile was not within the interdiction of Declaration II, for diffusion of asphyxiating or deleterious gas was not its sole object. Its main purpose was that of shrapnel against personnel. Further, it dispersed a fine dust of solid and not a gas.

The Germans also developed a heavy field howitzer 15 cm. tear gas shell, with both an H. E. charge and a chemical filler of T-Stoff (a mixture of xylyl bromide and xylylene bromide). This shell, "12-T," was truly a chemical projectile. It was used against the Russians at Balimow on January 31, 1915, and on the Western Front at Nieuport in March, 1915. The German T-shells were definitely in violation of the Declaration. So were the tear grenades of ethyl bromoacetate and chloracetone used at about the same time. Partly because no tactical advantage was secured, neither side objected to the use by the foe.

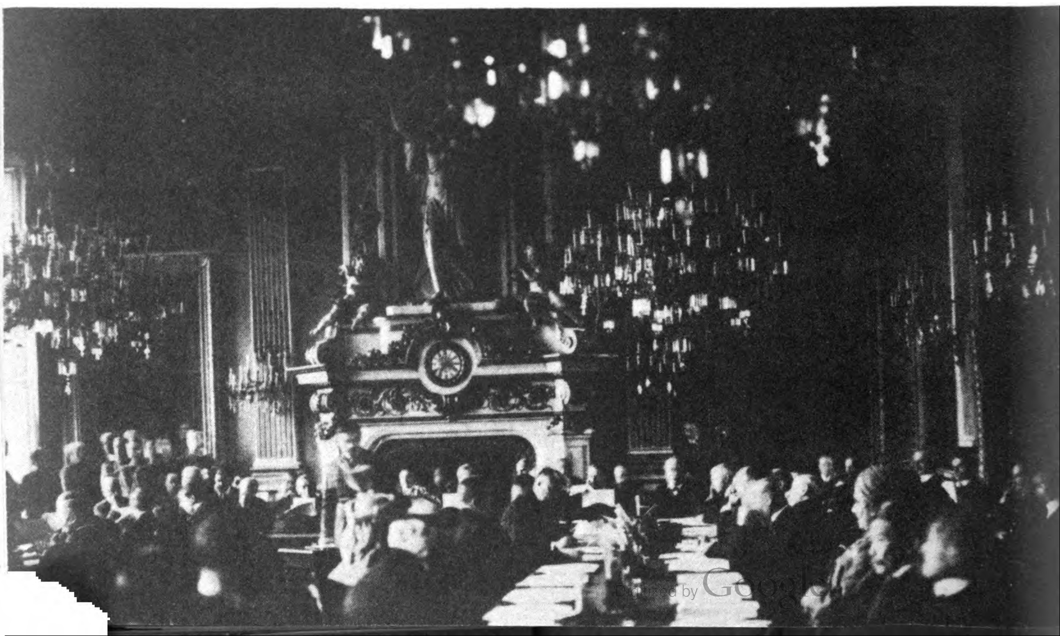
YPRES ATTACK CONTRARY TO "SPIRIT" OF TREATIES

It was the dramatic chlorine cylinder episode on April 22, 1915, on the other hand, which induced the cry of outlaw and violator of treaties.

The Declaration forbids projectiles whose sole object is the diffusion of gases. The chlorine attack of the Germans, then, is not literally encompassed in the words. But the Declaration was promulgated at a time when the weapons it was seeking to interdict had not yet been developed, and therefore of necessity had to be prescribed in general rather than explicit terms. Still, chlorine had been known for over a century, having been discovered in 1774 by Scheele. Obviously chlorine could not be considered an unknown material. Nevertheless, inasmuch as it did have the poisonous effect intended, was it banned by paragraph 23 (a) against poison or poisoned weapons, or by paragraph 23 (e) against material calculated to cause unnecessary suffering? The United States never considered those provisions as applicable to chemical warfare.

There is the claim then that even though it was not forbidden, the use of chlorine was contrary to the spirit of the various treaties. The argument has been

Large groups like these, representing many countries and races, have helped to formulate the present "laws of chemical warfare." Here President Poincare is delivering an opening address at the Peace Conference of January 18, 1919.



advanced that Declaration II was not mentioned by the Second Peace Conference, and that it therefore continued in force; it was the intent that new conventions should replace, but otherwise the old should continue in force. It is argued that Declaration II, taken with the other acts, "clearly shows the spirit of the two Conferences, and that the provisions of the two Conferences were declaratory, not amendatory, of international law. Being declaratory, they were binding on all nations, even on nations not technically bound by signature, ratification, or adherence. Thus, although the "general participation clause" provided that the treaties were to be binding "only if all the belligerents are parties to the Conventions," the nations were bound nevertheless by international "common" law.

But the conferences cannot be considered to have codified international "common" law. There was the express clause stipulating binding effect only if all the belligerents were ratifying powers. This would be unusual in a document intended to be not amendatory but declaratory of existing law. Indeed the provision that "in cases not covered by the regulations adopted by them, the inhabitants and belligerents remain under the protection and the rule of the principles of the law of nations, as they result from the usages established among civilized peoples, from the laws of humanity, and the dictates of public conscience," clearly implies that these conventions are not declaratory. Further, one of the declarations, by its own terms, expired in five years; this, too, is not declaratory.

GERMANY DID NOT VIOLATE INTERNATIONAL LAW BY USE OF CHLORINE

This all points to the logic of a strict construction. Brutal as she otherwise was, Germany did not violate international law by the use of chlorine on April 22, 1915.

Nevertheless, it was believed that Germany had violated the spirit if not the letter of the treaties. After this time chemical warfare proceeded as rapidly as the respective nations could produce chemical munitions. By September 25, 1915, the Allies had retaliated with gas. Phosgene was introduced by the Germans on December 19, 1915. Mustard gas was first used by the Germans at Ypres on July 12, 1917. Lewisite was discovered toward the end of the war, but was never used; a cargo was dumped in mid-ocean on the signing of the Armistice.

When the United States entered the war in April, 1917, gas warfare was already in full use. Nothing had been done in this country, however, other than some research in defense aspects by the Bureau of Mines under Van H. Manning. Upon this country's entry into the war, gas warfare functions were performed by the Trench Warfare Section of Ordnance.

GENERAL FRIES AND GENERAL SIBERT TAKE COMMAND

On August 17, 1917, General John J. Pershing appointed Lt. Col. (later Maj. Gen.) Amos Fries, Chief of a newly created Gas Service. The War Department shortly thereafter promoted Fries to Colonel of the 30th Engineers, later the First Gas Regiment. Although nominal commander, Fries never acted in that capacity, as his Gas Service duties occupied all his time and energy, but Col. E. J. Atkisson creditably filled that role. Lt. Col. (now Col.) J. Enrique Zanetti was made chemical warfare liaison officer with the French in October, 1917.

Chemical warfare was participated in by every branch of the Army, but except for the activities in the field there was no central coordinating point. Maj. Gen. Wm. L. Sibert was therefore appointed Director of a unified Chemical Warfare Service on May 11, 1918, with Brigadier General Fries in charge of the Overseas Division.

Shortly thereafter, acting under the Overman Act, passed on May 20, 1918, President Wilson on June 28, 1918, created the Chemical Warfare Service, effective July 1, 1918, as a temporary organization to remain in force not longer than six months after the termination of the war emergency. On July 11, 1919, continuance until June 30, 1920, was authorized pending reorganization of the Army.

After the war, opinion was much confused regarding the proper place for chemical warfare in the peacetime military establishments of the various powers. In the Treaty of Versailles, itself, there was a provision that Germany was not to manufacture or import "asphyxiating, poisonous, or other gases and all analogous liquids, materials, or devices." This provision, however, is to be construed as intending the complete disarmament of Germany, for it appears in connection with a corresponding prohibition against the manufacture or importation of "armored cars, tanks and all similar constructions suitable for use in war."

Nations were reluctant to provide openly for chemical warfare in their military budgets. Nevertheless, owing largely to the recommendation of General Pershing, chemical warfare was definitely established as a permanent branch of the United States Army. In the National Defense Act of June 4, 1920, Congress provided for a separate Chemical Warfare Service with these powers:

> There is hereby created a Chemical Warfare Service . . . The Chief of the Chemical Warfare Service under the authority of the Secretary of War shall be charged with the investigation, development, manufacture, or procurement and supply to the Army of all smoke and incendiary materials, all toxic gases, and all gas-defense appliances; the research, design, and experimentation connected with chemical warfare and its material; and chemical projectile filling plants and proving grounds; the supervision of the training of the Army in chemical warfare, both offensive and defensive, including the necessary schools of instruction; the organization, equipment, training and operation of special gas troops, and such other duties as the President may from time to time prescribe.

In accordance with this enabling act, the War Department issued an order from which the following is extracted:

> . . . The following duties are assigned to the Chemical Warfare Service:
>
> a. Supervision of the training of the Army in chemical warfare, both offensive and defensive, including the necessary schools of instruction; the organization, equipment, training, and operation of special gas troops.
>
> b. Research, design, and experimentation connected with chemical warfare and its material.
>
> c. Investigation, development, procurement, and supply to the Army of all toxic gases, smoke, incendiary material, and gas-defense appliances. Gas-defense appliances will include all measures for protection up to the time that a soldier becomes a casualty . . .
>
> d. The filling of all projectiles and containers with all gas, smoke, and incendiary material, including the marking and painting, all of which will be subject to the concurrence of the Ordnance Department.
>
> e. Concurrence in the approval of specifications for the size, shape, and materials of bursting charges of all chemically filled projectiles.
>
> f. Concurrence in the approval of designs for all parts used in connection with the filling of gas, smoke, or incendiary projectiles, including boosters, adapters, fuses, shells, grenades, and drop bombs.
>
> g. Design and procurement of all containers for bulk shipments of gases.
>
> h. The preparation of requirements programs for all material that is issued by the Chemical Warfare Service or that is used exclusively by the Chemical Warfare Service troops.

i. Recommending to the Secretary of War the proportion of the various types of gas shells to be used, including the proportion of the various types of fuses, boosters, and empty shells to be supplied by the Ordnance Department for such gas ammunition.

. . . .

j. The storage and issue of all chemical warfare material except artillery chemical ammunition, chemical grenades, and chemical drop bombs.

Secretary of State Charles Evans Hughes, on July 8, 1921, sent out feelers to Great Britain, France, Italy, and Japan to determine their attitude regarding participation in a conference to discuss limitation of armament. The replies were favorable, and the delegates of the Disarmament Conference began their deliberations in Washington, November 6, 1921. Article V, signed at Washington, February 6, 1922, reads:

> The use in war of asphyxiating, poisonous or other gases and all analogous liquids, materials or devices, having been justly condemned by the general opinion of the civilized world and a prohibition of such use having been declared in treaties to which a majority of the civilized Powers are parties.
>
> The signatory Powers, to the end that this prohibition shall be universally accepted as a part of international law binding alike the conscience and practice of nations, declare their assent to such prohibition, agree to be bound thereby as between themselves and invite all other civilized nations to adhere thereto.

This treaty was signed by the representatives of the five powers, and was ratified by the United States, Great Britain, Italy, and Japan. France did not ratify. Inasmuch as there was express provision that "the present Treaty . . . shall take effect on the deposit of all the ratifications," no binding agreement was entered into. Soon after her signature, indeed, Japan purchased three complete gas manufacturing plants in France, and began manufacture of phosgene, mustard, and tear gas at her naval base at Sasebo, with French engineers to assist in management and instruction at the beginning.

At the Fifth International Conference of American States, held in Santiago, Chile, in 1923, the delegates of the United States, Venezuela, Uruguay, Ecuador, Chile, Guatemala, Nicaragua, Costa Rica, Brazil, Salvador, Colombia, Cuba, Paraguay, the Dominican Republic, Honduras, Argentina, and Haiti declared their intention --

> To recommend that the governments reiterate the prohibition of the use of asphyxiating or poisonous gases, and all analogous liquids or devices, such as are indicated in the Treaty of Washington, February 6, 1922.

This was merely a recommendation. Further, as by other terms of the resolution it was to have no effect unless all agreed, this resolution did not have even the solemnity of a unanimous recommendation, and is a complete nullity in international law.

In the same year there was an agreement entered into by Guatemala, Salvador, Honduras, Nicaragua, and Costa Rica. At a conference on Central American Affairs in Washington, these nations on February 7, 1923, signed a convention of which Article V reads:

> The contracting parties consider that the use in warfare of asphyxiating

gases, poisons, or similar substances, as well as analogous liquids, materials, or devices, is contrary to humanitarian principles, and to international law, and obligate themselves by the present convention not to use said substances in time of war.

This convention, between nations having a total population of eight millions, is the only binding agreement regarding chemical warfare in existence at the present time.

In 1925, there was a conference for the supervision of the international traffic in arms, generally known as the Geneva Conference. Before the opening session on May 4, Secretary of State Kellogg sent instructions to the American delegates in a letter dated April 16 containing the statement:

> . . . The Department (of State) would desire to see an article inserted absolutely prohibiting international trade in asphyxiating, poisonous or other gases for use in war . . . as this Government and various other governments are clearly committed to the principle that poisonous gases should not be used in warfare, there is every reason for you to press for the inclusion of an article prohibiting the shipment of such gases in foreign trade for possible use in time of war.

The Geneva Conference, upon the introduction of the matter by the American delegation, adopted a "Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare" on June 17:

> Whereas the use in war of asphyxiating, poisonous or other gases, and of all analogous liquids, materials or devices, has been justly condemned by the general opinion of the civilized world; and
>
> Whereas the prohibition of such use has been declared in treaties in which the majority of Powers of the world are Parties; and
>
> To the end that this prohibition shall be universally accepted as a part of International Law, binding alike the conscience and practice of nations;
>
> Declare:
>
> That the High Contracting Parties, so far as they are not already Parties to treaties prohibiting such use, accept this prohibition agree to extend this prohibition to the use of bacteriological methods of warfare and agree to be bound as between themselves according to the terms of this declaration.
>
> The High Contracting Parties will exert every effort to induce other States to adhere to the present protocol.

The Protocol contained a provision that it was to come into force for each signatory Power "as from the date of deposit of its ratification, and, from that moment, each Power will be bound as regards other Powers which have already deposited their ratifications."

The United States had initiated discussion on the subject in the belief that France would ratify the 1922 pact, thus binding the five largest powers. This France failed to do. Further, inasmuch as the conference had been called for the limitation of traffic in munitions, the acts were likewise circumscribed. It early became apparent that to forbid traffic was merely to give an advantage to those nations with a domestic industry. The proper approach would have been a complete ban -- but this the delegates were not empowered to do by their instructions. The delegates therefore prepared a treaty dealing solely with exporting of munitions -- with no mention of chemical agents. The Protocol was intended merely to show the senti-

"On August 17, 1917, Gereral John J. Pershing appointed Lt. Col. (later Maj. Gen.) Amos Fries, Chief of a newly created Gas Service . . ." The accompanying photograph of General Fries was made at Tours, Indreet Loire, France, August 17, 1918.

ment of the delegates. The United States among several others did not ratify, and consequently the Protocol was never binding on this country.

For some years there had been functioning, albeit rather unostentatiously, a Temporary Mixed Commission which reported annually to the League of Nations until this Commission was supplanted in 1926 by a Preparatory Commission for the Disarmament Conference. This latter Commission drafted the agenda for the General Disarmament Conference 1932. The Preparatory Commission had considered renouncement of chemical warfare, but in 1930 the British delegation inquired whether or not lacrimators were to be included in such a prohibition. The United States representative, Hugh Gibson, declared:

> . . . We seek a maximum prohibition of inhumane agencies but at the same time should not be led to bring into disrepute the employment of agencies which not only are free from the reproach of causing unnecessary suffering, but which achieve definite military or civil purposes by means in themselves more humane than those in use before their adoption.

The view of the United States representative influenced the Preparatory Commission to let the Disarmament Conference render the final decision. The United States suggested a restriction on lethal gases; Italy was opposed to aggressive chemical warfare. There was no universal agreement on the subject and the Conference adjourned without action in that regard.

During all these years the great powers of the world have maintained chemical warfare establishments. Advocates of chemical warfare have maintained that it would be naive to imagine that chemical warfare could be suppressed by arguments which had been ineffectually advanced against other weapons of war when first introduced, that chemical warfare is more humane than most of the other recognized implements of war; that the only arguments which may be advanced against chemical warfare are those which may be advanced against war itself. Our American people have never been a militaristic goose-stepping herd. We work hard at peace, and only slowly are we aroused to war. But we are not an isolated part of the universe, and we can therefore be thankful that the Chemical Warfare Service, under intelligent and capable leadership of Generals Wm. L. Sibert, A. A. Fries, H. L. Gilchrist, C. E. Brigham, Walter C. Baker, and William N. Porter, can point with pride to a record of resourcefulness and preparedness.

The Chemical Warfare Service has rendered significant contributions to the cause of civilization. Tear gases used as war agents are necessary for the protection of society in quelling civil disturbances. Through focussing attention on industrial toxicology, chemical warfare has been a factor in Workmen's Compensation legal history. Its research has been of aid in saving lives in mines, in fire fighting, in industry. It has been of assistance in chemical technology, in aeronautics, and in the home, factory, and farm. There is hardly a field of peaceful human endeavor which does not owe a debt to the Chemical Warfare Service.

"The law of war can no more wholly dispense with retaliation than can the law of nations, of which it is a branch. Yet civilized nations acknowledge retaliation as the sternest feature of war. A reckless enemy often leaves to his opponent no other means of securing himself against the repetition of barbarous outrage." Article 27 of General Orders No. 100, (1863).

Maj. Gen. Amos A. Fries, after writing of the dreadful suffering of the French at the battle of Ypres, April 22, 1915, when the Germans released their chlorine cylinders, declares: "It must be said here, however, that this was true only because the French had no protection against the gas. Indeed it is far from being the most horrible form of warfare, provided both sides are prepared defensively and offensively. Medical records show that out of every 100 Americans gassed less than two died, and as far as records of four years show, very few are permanently injured. Out of every 100 American casualties from all forms of warfare other than gas more than 25 percent died, while from 2 to 5 percent more are maimed, blinded or disfigured for life. Various forms of gas . . . make life miserable or vision impossible to those without a mask. Yet they do not kill.

"Thus, instead of gas warfare being the most horrible, it is the most humane where both sides are prepared for it, while against savage or unprepared peoples it can be made so humane that but very few casualties will result." - Fries and West, Chemical Warfare (1921).

TEAR GAS GENERATOR

An Improvised Device for Use in Lengthy Gas Chamber Exercices

by

2d Lt. R. S. Anthony, C.W.S., Plattsburg Barracks, N. Y.

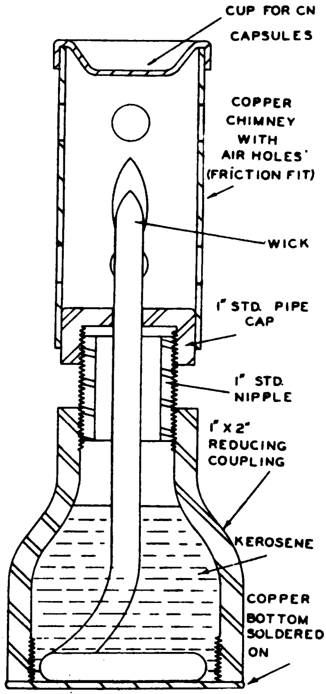
Various types of improvised CN generators are used in gas chambers, and are generally satisfactory for small classes. However, when the number of men to participate in the exercise is quite large, necessitating the continued use of the gas chamber for a few hours, it has been found difficult to maintain a sufficiently high concentration without considerable loss of time in replacing burned candles.

The accompanying drawing of a simple heater, which can be quickly constructed from materials at hand, illustrates a solution to this problem. The chimney and chimney cap are of light gauge copper (20-22 BS). The chimney joints need only be crimped, the diameter being such as to give a light friction fit over the top of the lamp.

A copper plate is soldered on, and constitutes the bottom of the lamp. (To solder copper to black iron, clean the iron by filing the point of contact, use a saturated solution of neutral zinc chloride as a flux, and preheat the fitting to the melting point of the solder. Use a regular 50-50 solder.)

The hole in the pipe cap is of such diameter that a 1/4-inch wick is supported by friction. The wick may be made by twisting several lengths of soft cotton cord together. Either kerosene or alcohol may be used as a fuel. The CN should be emptied from the capsule before it is placed in the heating cup, to prevent fouling from charred capsules. The individual who removes the CN from the capsule should wear rubber gloves, as well as a gas mask.

Using this device it is necessary only to add the contents of CN capsules to the heating cup when the concentration gets low, thus causing no break in the gas chamber exercises.



Out of Japan's ruthless invasion of China comes information concerning -

JAPANESE USE OF CHEMICALS

A Report on Chemical Warfare Tactics Used against the Chinese People

The Chinese Government has made extensive claims that lethal and toxic chemicals have been employed in battle against Chinese troops since hostilities started. Investigations indicate that smoke and tear gas compositions were employed by Japanese from the start of the war, but no proof exists that lethal or toxic chemicals were employed prior to the fall of 1939.

The lethal chemicals definitely appeared on the battlefield in the summer of 1941 and were used extensively wherever the Chinese were applying pressure

This photograph, reproduced from a Japanese newspaper, is an actual view of the Japs using flame throwers against a fortified pill-box on Corregidor on or about the 4th of May, 1942.

and the Japanese desired to conserve man-power. Vast quantities were used in very restricted areas -- generally to support Japanese counterattacks. The chemical actions were never widespread, seeming to be concentrated in definite areas and to be repeated in those areas. This, of course, may be due to the tactical situation and the terrain; generally the Chinese were exerting the greatest pressure on those fronts.

The ICHANG area and the CHANGSHA area received the bulk of the attacks. The chemical actions in those areas were studied by American observers.

CHEMICALS USED IN BATTLE FOR ICHANG

In the ICHANG action of October, 1941, a heavy attack was launched by the Chinese to take the city and carry the heights beyond where a defensive position could be organized. Chinese reinforcements were moved into the area in late September and early October. This movement was observed by Japanese planes and new dispositions were made on the defensive side, but no great number of additional troops were moved up. Artillery and mortar fire increased in intensity and considerable quantities of lachrymatory and sneeze gases were reported mixed in with the HE firing (none reported as mixed in shell with HE). Between October 5th and 8th some additional mortar companies were reported and indications are that from these new locations, the bulk of chemical munitions were fired. Chinese soldiers reported eye trouble and stomach sickness from the gas, but no deaths were reported prior to October 8th. The Chinese Chemical defense officers report that lethal chemicals were not used prior to the Chinese attack which was initiated about October 8th.

The attack was launched and was a success as far as taking the city of ICHANG. The Japanese retired to heights beyond the city, fighting a delaying action. They organized and held a semi-circular ridge outside the city. Lethal gases were not reported as being used during the basic attack, but records, dates and times are rather confused. However, when the Chinese pressed the attack to take the ridges necessary to hold the city proper, the Japanese launched counterattacks from both flanks and great quantities of lethal gas were placed on the attacking Chinese and in the low areas behind them. On October 10th - 12th planes came in and dropped lethal gas bombs all over the area. The Chinese were either barefoot or wearing straw sandals and no gas masks or protective clothing were available. In the attack they were severely gassed and burned. Chinese in reserve were heavily gassed and received many casulaties, most of which proved fatal. Retiring from the attack the Chinese had to proceed through low areas to avoid machine gun fire, and thus passed through very heavily concentrated gas barriers.

TESTS INDICATED THE GAS WAS MIXTURE OF MUSTARD AND LEWISITE

It is very difficult to obtain accurate strength figures from the Chinese, but it appears that there were over 2,000 casualties due to gas and gun fire. Of the casualties who came out of the area, 29 were gas cases, twelve of whom died enroute to hospital. Later six were located in hospitals and were able to give an account of the action. Only two of the six lived to return to their units.

Laboratory tests of samples of the gas and parts of shells and bombs showed the gas to be a mixture of mustard and lewisite. All the symptoms noted on the casualties were those of persistent lethal gas.

A Chinese war communique reported two major gas attacks by the Japanese on the CHEKIANG front during the latter part of May. Attempting a forced crossing of the SINAN RIVER near KIENTEH, three Japanese planes dropped gas bombs on Chinese positions while land batteries fired gas shells at the defenders. With one third of them falling victim to the gas attack, Chinese defenders of PAISHAPU evacuated the riverside town.

Another gas attack, according to newspaper reports, took place at TANGKI, WEST of KINHWA. After an unsuccessful assault against the WESTERN CHEKIANG railway town, the invaders released a large volume of gas on the defenders to open a way for their attack. The Chinese were forced to evacuate the town because of the gas.

According to a survey gas used by the Japanese on the CHINA front can be classified into six groups, three belonging to the irritant category and three to the toxic. In 1937 and early 1938, the Japanese used mostly tear and sneeze producing irritants. Since the Chinese victory at TAIERCHWANG, toxic gases have been used with greater intensity. Gas units were attached to each Japanese regiment and storm unit and gas tactics were resorted to with much greater frequency. Lethal and blistering gases are the main agents employed by the invaders in recent years.

SUMMARY OF JAP CHEMICAL MUNITIONS

The Japanese have used a 110-lb. gas bomb, filled with a mixture of lewisite and mustard in recent bombing operations in CHINA. This is reported to be their chief chemical bomb. It has a double exploder mechanism said to be designed to throw the liquid container into the air on impact, whereupon it bursts and scatters its contents. Other chemical bombs are: 33 lb., 55 lb., 220 lb. and 440 lb. The gases used in these bombs are: mustard, lewisite, phosgene and diphosgene.

Their incendiary bombs of the thermite type weigh between 15 and 50 lbs. They have also a phosphorus bomb weighing 120 lbs. The filling consists of a large number of small rubber pellets impregnated with phosphorus. The nose cap and exploder are filled with TNT and the fuse is of the instantaneous type. Upon explosion, the pellets may be thrown as far as 50 yards. On exposure to air they burst into flame burning 5 - 7 minutes with a flame 4" to 6" high. They can be easily extinguished by water or wet sand.

JAPANESE CHEMICAL WARFARE TACTICS

The essential tactics of the Japanese gas attack, based on reports on the employment of gas in CHINA and captured orders, are: concentration on the most important section of the objective; use of nonpersistent gases on the offense, persistent gases on the defense; achieve surprise by shelling with HE followed immediately by chemical shells; using smoke to hide gas clouds, or precede them; sudden gas attacks; dawn or evening bombardments with maximum wind speed of 11 m.p.h.

View at right shows a Japanese shell hole fortified with mortar squad. New relief for the squad can be seen arriving over the top of the shell hole. This type mortar was used to project chemicals during Japanese action against China.

HOW DOES SMOKE SCREEN?

Some Elementary Considerations of the Screening Power of Various Smoke Agents

by

Maj. James W. Boynton, C.W.S., Chemical Warfare School

From the point of view of structure, screening smokes are made up of particles of solids or droplets of liquid. The average size of the particles is about 10^{-4} cm. in diameter, and they range from 10^{-6} to 10^{-3} cm. in diameter. Therefore, many of the particles are of colloidal dimensions, and exhibit many of the characteristics of an aerosol.

In order to understand the screening effect of smokes, one must understand the behavior of light in passing through a transparent medium. When light passes through a transparent medium, at an angle of 90°, a small portion of it is reflected from the surface, a small portion is absorbed, and the remainder passes through. There is, of course, an alteration in its direction, due to refraction. The important property of transparent media, however, is that the rays pass through it undeviated in relation to each other. This is the reason for its transparency. As the direction of the rays remain the same in relation to each other, they give, therefore, an image on the retina of the eye that is the same as would have been formed if a transparent medium had not been interposed between object and observer.

Everyone is familiar with the fact that transparent ice may be broken up so finely that it appears to be white. In this case, each particle is transparent, but the air filled cracks reflect and refract the light so that it is scattered equally in all directions. The ice, as a whole, is no longer transparent. If light from an object is directed toward an observer and must pass through the finely divided ice to reach him, the rays are scattered or deviated in all directions and the observer does not see any image but whiteness.

WHITE SMOKE OBSCURES BY REFLECTION, NOT OBSTRUCTION, OF RAYS

White smoke obscures by virtue of its ability to scatter light. In addition, light falling on the cloud of white smoke is reflected and dazzles the observer.

It can be easily seen that the obscuring power of a smoke is partly dependent upon the number of particles. The greater the number of particles per unit volume of air the more efficient will be the obscuring power of the smoke. It is likewise evident that particle sizes play a part. If the particles are too small light will be but slightly effected. If the particles are very large the cloud will lose its whiteness. Hence, the obscuring power of a cloud is a function of the number of particles per unit volume, and their size.

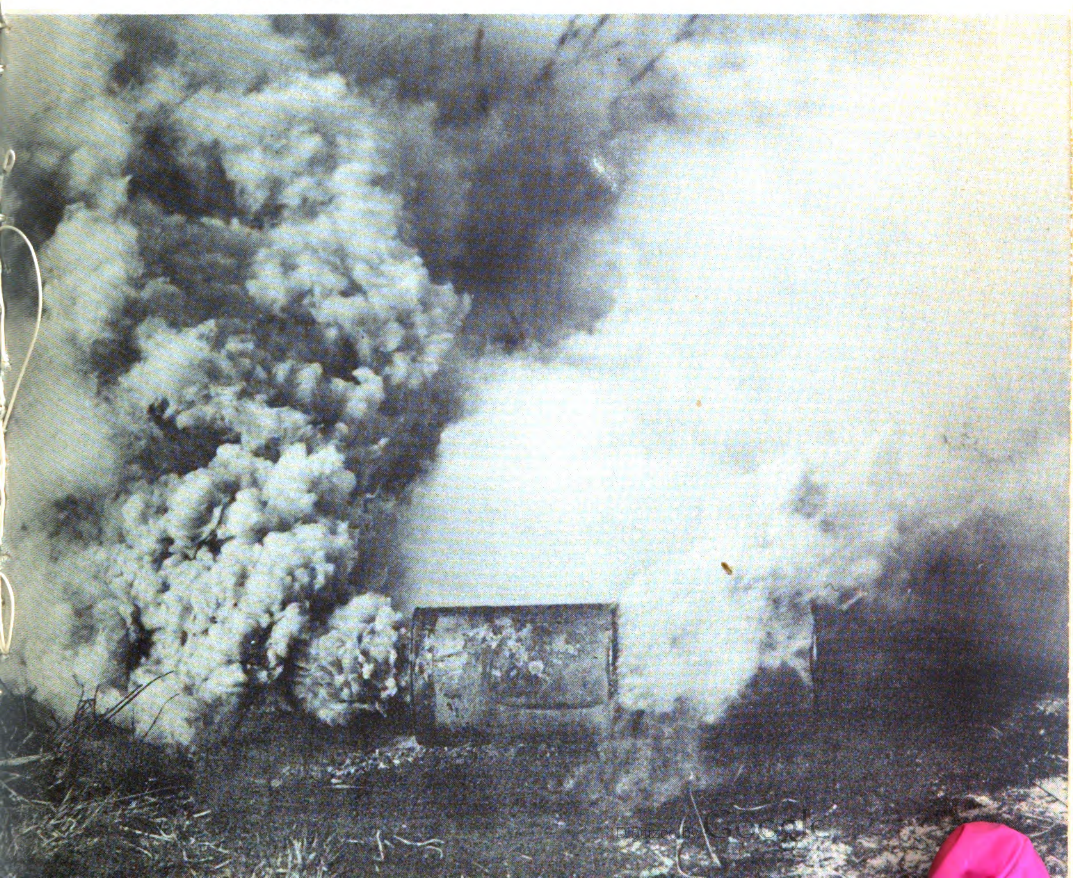
During the formation and existence of a cloud the number and size of the particles are constantly changing. Some of the particles coalesce, forming larger ones. The large droplets of liquid grow at the expense of the little ones. Water vapor is picked up from the air and all particles grow in size. The large particles settle out, and some of them impinge upon and adhere to the vegetation, causing a slight dilution of the cloud. Wind blows the cloud about, mixes more air with it, and, consequently, dilutes the cloud. All of the factors listed above continuously change particle size and distribution.

Black smokes obscure by absorbing light, and a higher percentage of undeviated rays pass through than in white smokes. It is for this reason that black smokes are not as efficient in the daytime as white smokes. Black, or grey smokes are very effective at night, when viewed from above and, for that reason, are employed on moonlight nights to obscure industrial areas from aerial observation. Black smokes (or grey) are made up chiefly of droplets of unburned fuel oil. The droplets have the effect of breaking up the critical outlines of terrain and establishments, thus confusing the aerial navigator.

TOP - A NUMERICAL VALUE FOR SCREENING EFFICIENCY

One device for comparing the obscuring power of smokes is the TOP value, which is an abbreviation of total obscuring power. The TOP value for a screening agent may be considered as the theoretical area in square feet of a smoke cloud resulting from one pound of the agent, if the cloud were flattened or spread out to a thickness just barely capable of completely obscuring vision. The TOP value of white phosphorus smoke is given as 3500, meaning, of course, that the area of such

HC Smoke Pots provide a convenient and ready source of smoke. Here is illustrated an arrangement for increasing the burning time of these "canned smoke screens."



One of the most versatile of weapons is smoke. Illustrated here are two of the many uses which may be made of this type munition. Above is shown a river crossing being made under cover of a smoke screen, and below are shown soldiers at Ft. Belvoir, Va., charging through a protective smoke screen during maneuvers.

a cloud would be 3500 square feet when one pound of WP is burned. Of course, the above method is not the actual process of measuring the total obscuring power, but is a method of visualizing the meaning of the value.

White phosphorus is a yellow solid. It burns to produce solid P_2O_5, which, in turn, picks up water vapor from the air to some extent to produce phosphoric acid. A WP smoke cloud is composed of particles of solid P_2O_5 and droplets of phosphoric acid. As has been said before, it has a TOP value of 3500. WP smoke has a tendency to rise high in the air, due to the fact that heat is generated in burning. The heat so generated warms the adsorbed air (about 10^{-3} cm. thick), which acts as a balloon and makes the cloud rise. Intense sunshine has the same effect. If the smoke cloud is generated when the sky is overcast, and the ground and air are cool, each particle will give off heat to the surrounding air and the cloud will hang closely to the ground. WP screening smoke is projected by means of grenades, artillery, chemical mortars, and airplane bombs.

FS - SULPHUR TRIOXIDE IN CHLORSULPHONIC ACID

Another valuable screening smoke is FS. FS is the chemical warfare symbol for a solution of sulphur trioxide in chlorsulphonic acid. The composition of this solution by weight is SO_3, 55%, and $HClSO_3$, 45%. It is projected by artillery chemical mortar shell, and airplane bombs, and is standard for airplane spray. When the solution is scattered in the air it picks up water vapor, hydrolyzes, and forms droplets of hydrochloric and sulphuric acid. FS has a TOP value of 2240 square feet.

The HC mixture is an agent for producing screening smokes for training purposes. The HC smoke mixture consists of hexachloroethane, metallic zinc, ammonium perchlorate, calcium carbonate, and ammonium chloride. The smoke-producing reaction is $3Zn + C_2Cl_6 \rightarrow 3ZnCl_2 + 2C$. The smoke consists of particles of solid zinc chloride, plus water that the particles pick up from the air. It is to be noted that free carbon is liberated and, consequently, imparts a grey color to the smoke. In order to reduce the amount of free carbon formed, ammonium perchlorate is added to oxidize it. The ammonium chloride decomposes and absorbs some of the heat of reaction. The calcium carbonate present stabilizes the hexachloroethane. HC has a TOP value of 2000. It is used in burning types of munitions only, such as grenades, candles, smoke pots and smoke floats.

REACTION WITH MOISTURE OF AIR MAKES SCREEN

FM is a liquid and from a chemical point of view is titanium tetrachloride. The liquid is dispersed by means of airplane spray, bombs and special munitions. It may be dispersed by artillery shell and chemical mortar shell, and is used for training purposes. The liquid droplets react with water in the air forming titanium hydroxide, and hydrochloric acid, which is the real smoke screen. FM has a TOP value of 1900 square feet.

The last smoke to be considered here is crude oil (fuel oil). It is a grey or black smoke, and is produced by burning fuel oil with an insufficient amount of air. The smoke itself consists chiefly of droplets of unburned oil and a little free carbon. It has a TOP value of only 200 square feet.

We have considered the general character of smokes, how they bring about obscuration, and some of the characteristics of individual smoke-producing agents. A knowledge of these should serve as a background for their tactical use.

Optically clear, high-glass, pear-shaped lenses, injection molded of cellulose acetate, are used in the training, service and diaphragm gas masks.

Keeping pace with changing conditions in war production, and with improvement in design, we now use -

PLASTICS IN GAS MASKS

A Discussion on Plastic Parts in, and a Complete History of the Modern Gas Mask

(Reprinted from the article "New Materials Meet an Old Threat" in the June issue of MODERN PLASTICS magazine, by special permission of that publication.)

For the second time in the lifetime of many of us, newspapers are carrying banner headlines proclaiming the threat -- and, according to some sources -- the reality of the uses of poisonous gases in the present conflict. But this time, thanks to the vigilance of our own Chemical Warfare Service, aided by the resource and cooperation of the plastics industry, the tragedy of unpreparedness may be avoided.

Since May, 1937, the Chemical Warfare Service has been working assiduously with plastics material manufacturers and molders to perfect a gas mask material that would be proof against the lethal qualities of known poison gases; and at this writing thermoplastics (cellulose acetate) are integral parts of combatant masks, training masks, officers' speaking masks and civilian masks . . .

. . . .

Eating or resting while wearing a mask is impossible, so that some method had to be developed which would make periodic respites possible, and which would enable special duty men to carry on their functions without the restrictions imposed by the wearing of a gas mask.

FIRST GAS MASK DESIGNED IN 1854

The first development of the gas mask was recorded in the 19th Century. Designed in 1854 by a physician, and primarily intended for industrial use, the first mask on record had the appearance of a small fencing mask of fine wire gauze which covered the face from chin to bridge of nose, leaving the eyes and forehead unprotected. The purifying apparatus consisted of two plates of wire gauze separated from each other by a small space of approximately 1/8 in. to 1/4 in., filled with small pieces of charcoal. The frame was made of copper with soft lead edges lined with velvet so that it would fit the cheeks tightly and enclose the mouth and nostrils. No air could enter the lungs without passing through the wire gauze and charcoal. An aperture in the outer plate was provided with a sliding screw valve, which, when removed, made possible the emptying and replenishing of the charcoal chamber. These masks were worn by men who worked in large chemical plants as protection against lung-irritating gases or vapors; by men who worked in the large drains or sewers of London as protection against sewer gases and obnoxious odors; and by attendants at sickbeds where there was danger of contracting an infectious or contagious disease.

Further developments in gas masks for industrial uses followed as requirements broadened, but military aspects were considered only as an aftermath of the debacle at Ypres. Less than 48 hours after the attack, British troops received their first masks, which consisted of cotton cloth pads soaked in a solution of sodium carbonate, sodium thiosulfate and water. These materials were supplemented by cotton pads which each wearer stuffed into his mouth and nostrils before putting on the "mask." This form of protection was an emergency measure, followed shortly afterward (May 10, 1915) by the "Black Veil Respirator," so called because it was comprised of a fourfold piece of black veiling about 1 yd. long and 8 in. wide, which was tied about the face. The center portion was padded with cotton and saturated with sodium carbonate, glycerine and water, the glycerine having been added to keep the pads moist. Because of the elementary nature of the design, it was difficult to secure the mask tightly enough for adequate protection, which obviously limited the usefulness of this model.

FIRST USE OF PLASTICS IN GAS MASKS

The next refinement in gas warfare was the introduction of tear gas in shells, which made it necessary to work out some means of protection for the eyes of combatants. This need led to the development of the British Hypo Helmet. This was a flannel helmet in the form of a sack which could be put over the head with the open ends tucked inside the blouse. The cloth was dipped in sodium thiosulphate, washing soda and glycerine. Since the helmet covered the head and neck completely, some provision had to be made for vision, and a rectangular piece of cellulose nitrate (celluloid) was inserted for this purpose. Here we have the first use of plastic materials in gas masks.

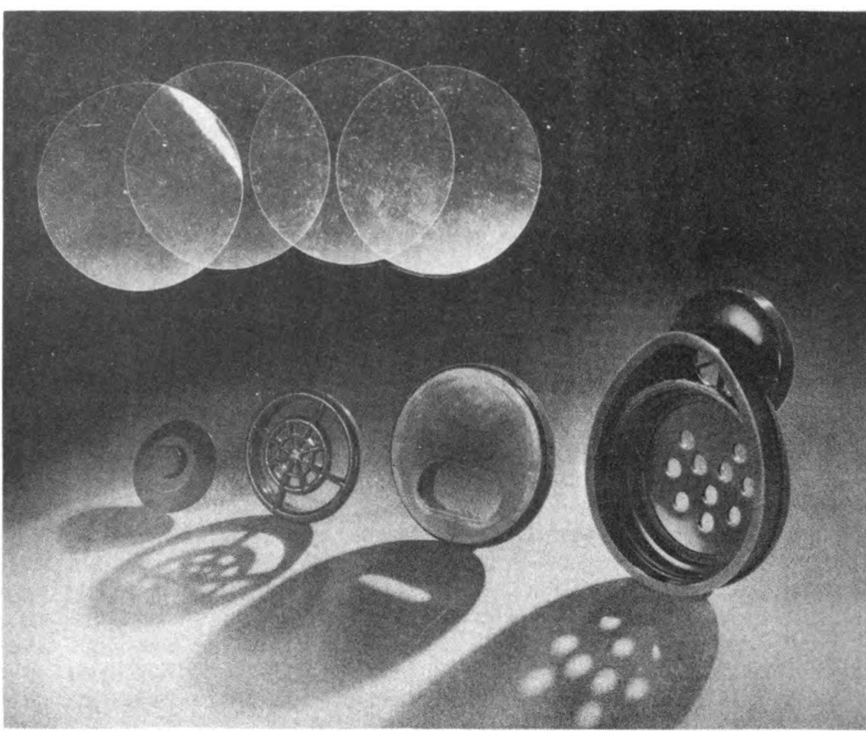
The subsequent introduction of phosgene, chlorpicrin, mustard gas and toxic smoke necessitated further developments for adequate protection. These gases were so potent that it was essential to contrive a more efficient method of filtering the gases out of the inhaled air than existed up to that time. The result was the first "polyvalent" respirator of the canister type -- the British "Standard Box Respirator." This new mechanism incorporated the principle of the oxygen apparatus used in mines, and it involved the use of a canister filled with highly sensitive adsorbent charcoal mixed or alternating with oxidizing granules of alkaline permanganate.

CANISTER AND OUTLET VALVES USED

It was constructed with a canister attached by a flexible tube to a facepiece or mask. The facepiece was made of rubberized fabric and fit the face snugly so that there was little or no leakage. It was secured by means of elastic bands which fit over the head. The nose was closed by means of clips covered with rubberized fabric and gauze. Breathing was achieved through a mouthpiece of rubber; the teeth closed on the rubber tabs and a rubber flange lay between the teeth and the lips. The expired air was exhaled through a rubber flutter valve in an angle tube just outside the facepiece. This arrangement provided double protection, because if the facepiece should be punctured or torn, the gas-containing air could not be inhaled so long as the nose clip and mouthpiece were in position.

No longer does the soldier look like a ma from Mars in his gas mask. Large plasti lenses permit some view of his face and als enlarge his range of view. This close-u shows the diaphragm, or speaking masl There are 10 aperatures on the valve body t permit transmission of voice without liftin the mask. A Y-tube attaches valve to canist hose. Valve guard is of M-8 valve desig

Thin disks of cellulose acetate, sealed air-tig within the valve, keep gases out but allo passage of sound. Below, left to right (low row) are rubber valve, valve guard diaphrag retainer, and diaphragm body (inside view



There were many disadvantages inherent in the construction of this type of mask: extreme discomfort of the apparatus itself; obvious difficulty of wearing the nose clip for sustained periods and discomfort of the mouthpiece; lack of ventilation in the facepiece chamber, causing men to perspire most profusely; unnatural method of respiration and lack of ventilation; entrapped heat and retained moisture which condensed on eyepieces, thereby impairing vision.

The French Tissot mask resembled the British box respirator in that it consisted of a canister unit and rubber facepiece. The mouthpiece and nose clip were eliminated. The inhaled air came from the canister through two tubes which opened directly under the eyepieces. As this air swept across the eyepieces it removed the condensed moisture so that clear vision was maintained. Circulation of air in the mask also removed the dilute lachrymatory gases which might filter through. Exhaled air escaped through a simple outlet valve. The advantages of this type of mask were that its facepiece was tight and comfortable, its lenses nondimming, and that it permitted speaking and eliminated salivary difficulties because there was no mouthpiece. The one great disadvantage was that the mask was fabricated from thin rubber, which was very flexible but not sufficiently durable to be relied upon as the sole protection of the wearer. The canister on this Tissot mask was not only different from previous developments but was actually a forerunner of the present-day types. This canister was carried against the body and connected with the facepiece by means of flexible rubber fabric tubing. The use of highly hygroscopic chemical adsorptives and an easily operated one-way inlet valve made possible easier and more natural breathing.

DEVELOPMENTS SINCE 1919

Following the United States' entry into the war in April, 1917, the gas mask adopted for American use was modeled in principle and construction after the British Standard Box Respirator, and this was the model in use at the close of World War I.

Since then research and experiment have continued unabated toward the end of improving the 1919 model Army service gas mask, as well as toward providing additional types of specialized masks such as the diaphragm mask (which permits telephone messages to be communicated while the mask is being worn), optical mask and aviation mask (for airplane pilots).

Gas mask development since World War I has been based upon certain practical requirements which control the design of the mask. These requirements may be summarized as follows:

The mask must protect against all chemical warfare agents
It must have low breathing resistance
It must be light in weight
It must be comfortable
It must be simple in design, easy to operate and repair
It must not interfere greatly with vision
It must be rugged enough to withstand field conditions
It must be reasonably easy to manufacture in quantity
It must not deteriorate appreciably in storage for at least several years
It must have a service life in the field of at least several months

Judged most satisfactory at present to meet these requirements, cellulose acetate was selected as the material for lenses, outlet valve guards, diaphragm and Y-tubes because it is chemically resistant, light in weight, comfortable (being a nonconductor of heat), capable of rapid production by injection molding and stable.

Today cellulose acetate is being used exclusively in the service, diaphragm, training, noncombatant and all other masks being currently manufactured.

The lenses of some of the earliest types of gas masks were clear cellulose nitrate sheet; but since this material after a few months' storage cracked and split at the slightest provocation, glass was substituted. The obvious danger of serious injury from shattering glass soon made way for the use of mica, and then for the adoption of safety glass. Its high cost, and the hazard of fine splinters of safety glass entering the eye led to further developments and the present use of nonfogging cellulose acetate. These latest eyepieces meet the rigid specifications for high light transmission, freedom from haze, absolute uniformity, optical perfection and color.

The present cellulose acetate lens, standardized for use in the service, training and diaphragm masks, is pear-shaped and curved (Fig. 2). It is injection-molded, emerging from the mold curved and optically satisfactory.

HIGH OPTICAL STANDARDS REQUIRED FOR LENSES

At the widest portion of the top, which is semi-circular with 47/64-in. radii on each upper corner, it is 3-3/32-in. wide, the sides tapering down with an overall height of 3 in. to a bottom radius of 1-7/64 in. There is a 1/8-in. wide land (flat surface) all around the outside specified as being .090 in. thick minus .010 in. plus nothing, and a sharp step-up from this land to a thickness of .100 in. minus .020 in. plus nothing for the center panel. The radius of the lens from side to side is constant at the center line and calls for 3 in. plus 1/64 in. minus nothing.

The high optical standards for these cellulose acetate lenses make it necessary to maintain the best possible control in the various operations from first to last. The basic raw materials are subject to minute scrutiny. All the steps in the manufacturing process are monitored under laboratory control -- some photoelectrically. Filtered air guards the entire process to exclude all foreign matter, and this air conditioning keeps the product sanitary despite the plant's location in a heavily industrial area. Flow tests and analyses are made regularly right up to the sealing of the drums, and just before the covers are applied a sample of powder is removed from each drum and molded into a test plaque which must be laboratory-approved and compared with the rigid specifications of the Chemical Warfare Service before shipment. Upon arrival at the molding plant, these materials are carefully guarded to prevent possible contamination, and are conditioned against moisture by infrared lamps or ovens. At one producer's plant, when the materials are thoroughly dried, they are sealed in airtight containers and stored until placed directly into the injection machine's hopper. Because of the optical specifications, the molding dies for the production of these lenses must not only be practically perfect but also maintained in this condition. In addition to a flawless, highly polished cavity finish, the mold must incorporate exceptionally accurate and identical dimensions for all cavities. When the mold is closed in the machine, it must be held absolutely tight and rigid regardless of the high pressure on the injected materials, because any tendency on the part of the mold to spring open or flash would of course destroy the dimensional accuracy of the molded parts and eliminate optical clarity. After molding, the gates are clipped while the parts are still warm, and each lens is very rigidly inspected and carefully packed so that it can be shipped undamaged to the gas mask manufacturing plants, where lenses are sealed into airtight metal frames in the masks.

PLASTIC LENSES LIGHTER AND NONFOGGING

These plastic lenses permit a weight-saving of 55 percent and are practically nonbreakable as compared to the glass lens formerly used. Furthermore, since cellulose acetate is a poor heat conductor, there is less tendency for these plastic lenses to fog with moisture when subjected to quick temperature changes or because of the moisture in the wearer's exhaled breath.

The success attained by these molded lenses prompted further investigation regarding the use of cellulose acetate in the noncombatant -- or civilian -- gas masks. Inasmuch as cost and weight were more dominant factors in this application than were accurate optical qualities, a round lens was specified (see specifications, page 43) of clear colorless cellulose acetate polished on both sides.

ELIMINATES USE OF ANTI-DIM PREPARATIONS IN CIVILIAN MASKS

Five years ago, after several years of pioneering, one materials supplier developed a nonfogging transparent material which was submitted to the Chemical Warfare Service for consideration. At that time, C.W.S. was experimenting with a gelatin-like unguent that had to be rubbed on lenses of civilian masks which were not equipped with a circulating air stream (as are all combatant, training and officers' masks). This was an obviously unsatisfactory expedient. Almost immediately following the procedure, the breath moisture condensed on the sticky film and blurred the vision all over again. The nonfogging cellulose acetate for eyepieces eliminated all this. Produced in wafer-thin dimensions of .015 in. thick, it is claimed that this material will not haze or blur, no matter what the provocation. These lenses are 3-1/2 in. in diameter, perfectly round and are required to have a thickness of .018 in. minus .004 in. plus nothing. They can be die-cut most economically from sheet stock -- but in this method, too, rigid precautions must be exercised to avoid scratching or marring during the production operations.

VALVES AND GUARDS MUST BE CAREFULLY DESIGNED

Because all combatant, training and officers' masks must be designed to allow normal breathing under such widely diversified conditions as running, scaling a wall in arctic cold or tropical heat, and at the same time be capable of exercising their primary function of resisting war gases, enough cannot be said in praise of the all-important valves and guards. One of the first gas masks developed in 1915 in-

Left, close-up of the service gas mask, with canister joined by flexible tube. Note the wide scope of vision made possible by the plastic lenses. Right, civilian or noncombatant gas mask with canister attached to the facepiece, and the M-10 outlet valve on the left side of the facepiece.

corporated an outlet valve. Such a one-way valve is very important to the efficiency of the present-day gas mask. It must function with the slightest pressure during exhalation but must positively seal upon inhalation by the wearer, and must not be affected by moisture. In sub-zero weather, if such moisture freezes, the valve must still operate successfully. The latest rubber outlet valve was of butterfly type protected by a metal guard. Now the metal guard for these valves has been replaced by cellulose acetate because it is lighter, cheaper and noncorrosive.

The new M8 outlet valve which has now been universally adopted is perfectly round, incorporates more outlet area and is more sensitive and efficient than the old type. The cellulose acetate in this design forms the seat and a round rubber disk (or flutter valve) anchored to the center or collar button on the seat remains in a closed position until opened by exhalation pressure. There are three acetate parts in this assembly: the seat, collar button and valve guard.

The bottom, or seat, is perfectly round with a straight shank on the underside 11/16 in. long, the main outside diameter of which is 1.062 in. minus .005 in. plus nothing with a sharp 1/8-in.-wide ledge around the bottom, 1/16 in. thick on the outside and tapering to 1/8-in. thickness on the inside. The top of the seat is 1-15/16 in. outside diameter, and there are inside threads for the assembly of the guard. To allow for the maximum air space and support for the collar-button boss, there are six slender spokes. The seat proper for the flutter disk is slightly beveled and approximately 3/16 in. wide.

The collar button, molded separately, is acetoned into the seat boss and is 11/32 in. long incorporating 3 diameters. The top is .375 in. in diameter and .050 in. long; the shank is .235 in. in diameter and .155 in. long; and the bottom is .126 in. in diameter and .139 in. long. Close tolerances must be maintained during the assembly of these collar buttons in the seat bosses, due to the fact that the height of the button determines the position of the rubber valve flange or lip.

DELICACY OF MANUFACTURE PRESENTS CERTAIN PROBLEMS

The guard, which is assembled to the seat by threads, performs no definite function other than to protect the flutter valve. However, the fit of the threads is most important because of the standardization of the units and consequent interchangeability. The perfectly balanced pattern of the grille on the combination valve and guard actually forms a scientifically balanced air vent. The plastic struts on the guard give precisely the necessary strength -- no more, no less. A silken strand's thickness more might make exhalation difficult! This grille protects the flutter valve that fits over the valve seat in the lower section. Without the cover grille, this lightweight flutter valve might be accidentally lifted and expose the wearer. Both parts are injection molded and completely threaded.

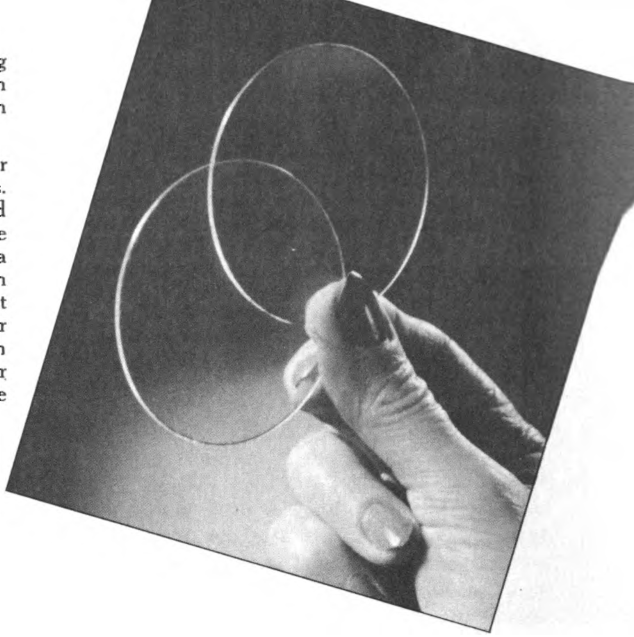
The fact that there are a number of injection molders who will furnish these parts, and that parts are standardized for use on both service and training masks, presents a problem in manufacture and interchangeability of parts. Not only must the materials be maintained in the same formulations, flow and shrinkage characteristics, but it is necessary that the various producers mold the parts with similar temperatures, material pressures, cycles and die temperatures. As a continuous dimensional check on these parts for proper fit, each molder will be furnished with "go" and "no go" gages.

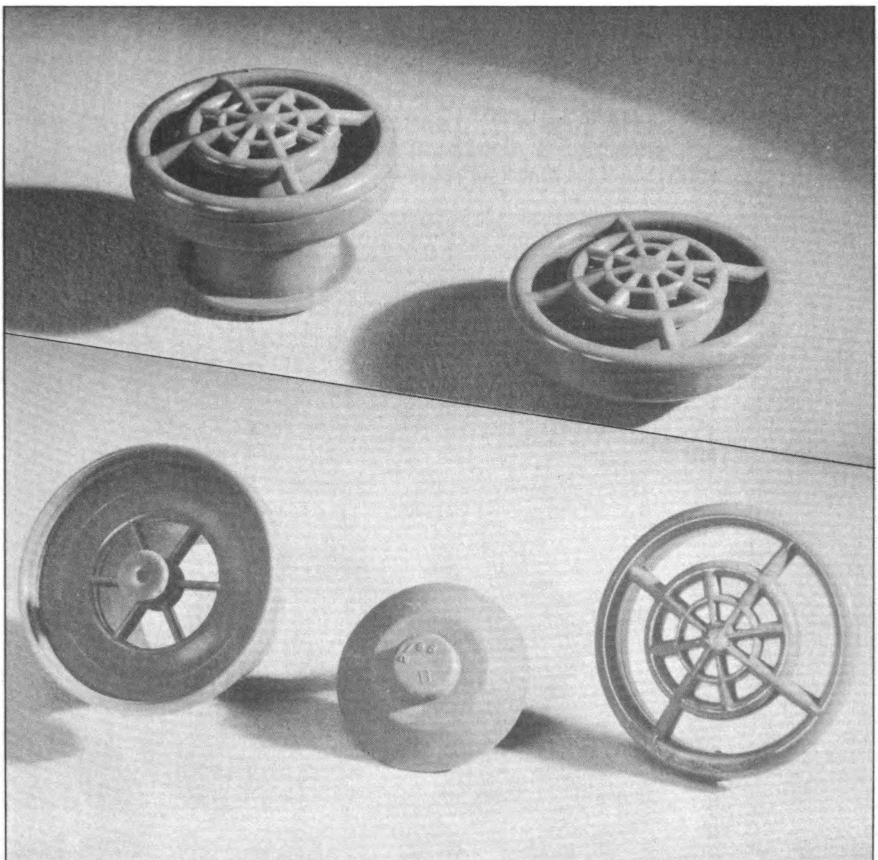
The M10 outlet valve for use on the noncombatant type of gas mask is identical to the M8 except that the shank on the underside of the seat is almost 1/2 in. shorter in length.

The diaphragm mask is especially designed to meet the requirements of administrative or other personnel of the Army who require a form of protection that will not interfere with commands, duties, etc. The mask is identical with the serv-

Round lenses, die-cut from clear nonfogging cellulose acetate sheet stock and polished on both sides, used for civilian masks, are shown at right.

Below appears: The M-8 outlet valve (upper left) used on training and service gas masks. Has a long shank, as it must extend beyond the apparatus below it. The M-10 valve (upper right) is similarly constructed but has a short shank to fit on the side of the civilian mask. Inside view of the outlet valve seat (lower left) shows, attached in center, collar button which holds rubber flutter valve. Thin ribs permit maximum air venting. Rubber valve is in the center and the grille-like valve guard at extreme right.





ice mask except for the facepiece, which includes a diaphragm to facilitate the transmission of the sound of the voice. The angle tube, valve and guard combination has been perfected so that orders can be given without raising the mask and risking exposure. This gives complete protection and yet permits passage of sound. The cellulose acetate diaphragm facepiece is designed to be molded in five parts: body, valve seat, collar button, valve guard and diaphragm retainer.

The body is elliptical in shape and incorporates the same round design as the M8 valve case in the bottom. It is approximately 4-1/8 in. high and the top circular portion is almost 3 in. in diameter. Due to the necessity of coring the M8 case design, the valve seat is molded separately and acetoned in the assembly. The collar button is also assembled in the same manner as in the M8 valve previously described. The standard M8 valve is assembled to the valve housing by means of the threads. The diaphragm retainer is a perfectly round part 2-9/16 in. in diameter, including the outside threads. The outside threaded portion is similar to a flat cup 5/16 in. overall and the inside 1/4 in. deep. There are two rectangular-shaped lips 1/16 in. high and 1/8 in. long, diametrically opposite on the inside for convenience in assembly with a spanner type wrench. In the bottom half of this retainer is an oblong, shaft-like opening 15/32 in. high, at the top of which is a 1/32-in. bead running half way around the opening and another similar bead 9/16 in. long at the bottom. To make the sound openings in the diaphragm body airtight, round disks of cellulose acetate sheet stock .001 in. thick are fitted into the body. The diaphragm, cemented around the edges, is inserted under the perforations and a rubber gasket is used underneath the retainer to seal the assembly when the retainer is screwed into place. The whole acetate diaphragm assembly is approximately 59 percent lighter than the metal it replaces, in addition to being more efficient because of the use of the new M8 valve design.

Old style molded cellulose acetate outlet valve guards (shown below)
formerly used in gas masks were smaller, less efficient.

PLASTIC Y-TUBES SAVE WEIGHT AND EXPENSE

In the diaphragm mask it is also necessary to use a Y-tube which is shaped almost like the letter Y itself. Formerly a die-cast part or one made from other noncorrosive metal, this part was not only heavy but expensive. Although the Y-tube was originally designed to be made in cellulose acetate in three parts, there is now an alternate design for two-piece production. The original acetate design comprised a round tubular shaped T, onto the arms of which were acetoned two tubular elbows, parallel with each other. The two-piece Y-tube incorporates an oblong shaped opening at the bottom 1-1/16 in. long by 9/16 in. high inside and it is 17/16 in. along the center line of this part of the piece to the center line of the two round tubular legs, which are 9/16 in. inside diameter. These legs are parallel 3/4 in. long and 45 deg. to the main or oblong part. In this design the Y-tubes are molded in two halves, the parting line following the 45-deg. angle. Small 1/32-in. radius beads are incorporated on the outside of the three extreme ends to render them more secure in the assembled mask. Inasmuch as these two halves must be acetoned together and airtight, a tongue and groove design is proposed for a better joint.

IMPROVEMENTS RESULT OF MUCH EXPERIMENTATION

The adoption of cellulose acetate for these various gas-mask parts represents a distinct advance in design and performance. In the service mask it has resulted in a weight saving of 70 percent as compared to the glass and metal parts previously used, and in the diaphragm mask 58 percent on the same basis. While proof against corrosion, these parts must be carefully molded and controlled so that they will not warp or become distorted in service. Considerable difficulty was previously experienced by the fogging of the glass lens because glass is a good conductor of heat, but since the acetate is a poor conductor, its fogging tendency is not nearly so acute. All of these parts are molded by the injection method and consequently can be produced very rapidly. They will not tarnish and no painting or lacquering for protection is required. They are more economical than the parts replaced, and save considerable amounts of critical metals (brass and aluminum) previously required.

More than that, they represent thoughtful and unflagging experimentation on the part of men who were determined to find the solution to seemingly insuperable problems. Men like Colonel Barker, Colonel Kuhn and Dr. Katz of the Chemical Warfare Service; men like Harry Husted, whose vision, combined with a great fund of knowledge of thermoplastics, molds, machines and techniques, is directly responsible for much of the progress that has been recorded to date; and a host of anonymous chemists, technicians, laboratory workers, all of whom labored against odds to achieve a victory over one of the greatest hazards of war. Above all, they are a tribute to the Chemical Warfare Service, which was prepared for a grim emergency even before the emergency became a reality.

From the IV Army Corps comes a worthy contribution -

GAS SCHOOL ON WHEELS

or How One Large Organization Used Initiative and Solved Its Training Problems

by

Col. Hugh M. Milton, C.W.S.,
Chemical Officer, IV Army Corps

The recent emphasis placed upon training in "Defense Against Chemical Attack" has necessitated more schools within the Divisions and created numerous problems for smaller units of Corps, Army and GHQ troops. If, during this period of war, a Division could remain stable in its personnel the training of gas officers and gas noncommissioned officers would follow the routine of school and the training of troops would produce a reserve pool of gas personnel and maintain a high degree of proficiency with troops. But cadres are withdrawn from Divisions, officers are sent to schools of their respective services, and noncommissioned officers are sent to officer candidate schools. Thus, during the last year it has been almost impossible for a Division to have at any one time a complete complement of gas personnel.

LACK OF FACILITIES AND PERSONNEL TO BE OVERCOME

Corps troops and those attached from Army and GHQ have equally as serious a problem with personnel turnover, and added thereto is the lack of facility for training their gas personnel. Chemical Warfare differs from other forms of military training in that it requires a certain amount of technical knowledge which can only be taught by competent officers and absorbed by men whose intelligence rating is above the average. This latter requirement is no doubt responsible for the loss of noncommissioned staff to officer candidate schools.

FM 21-40 indicates that the qualifications of a unit gas officer or unit gas noncommissioned officer shall include the successful completion of a course embracing the subjects covered in Par. 65, FM 21-40 of not less than thirty hours. This course must be given by an officer of the Chemical Warfare Service. Obviously then, no unit smaller than a Division can conduct a qualifying school as no Chemical Warfare Service officer is available for such instruction.

COMBINED CLASSES TOO LARGE FOR DIVISION STAFFS

In the IV Army Corps the units of the Army, GHQ and the Corps stationed at camps with tactical Divisions were directed to send their officers and noncommissioned officers to the Division Schools. While all Divisions cooperated, there was evoked the valid criticism that the groups were too large to be effectively instructed. Certainly they were too large for one instructor as the enrollments of some of these schools reached 375 to 400. It was found impossible to divide the

HOUR	MONDAY June 22	TUESDAY June 23	WEDNESDAY June 24	THURSDAY June 25	FRIDAY June 26	SATURDAY June 27
9-9:50	METHODS (1) Lt. Col. GEIGER Alternate Col. MILTON Bldg. 912	PROTECTION Gas Mask Drill Gas Chamber Area Capt. OLSEN Alternate Lt. BROWN	TACTICS (1) Use of Lethal & Nonlethal gases Lt. Col. GEIGER Bldg. 912	TACTICS (2) Smoke Lt. Col. GEIGER Alternate Lt. Col. BARNES Range	WEAPONS (2) Lt. Col. BARNES Alternate Capt. KING	TANK PROBLEM Lt. Col. GEIGER Capt. HOLMES, 58th Tank Group Anti Tank Co. of 82d Division
10-10:50	AGENTS (1) Capt. MEIGHAN Alternate Capt. King Bldg. 912	PROTECTION Decontamination T/Sgt. JONES Alternate Cpl. KING	PROTECTION (5) Care & Repair & Maintenance of Gas Masks T/Sgt. JONES Alternate Cpl. SIKES Bldg. 912		TNG. PROCED. & SUPPLY Capt. KING Alternate Lt. Col. GEIGER	
11-11:50	PROTECTION (1) Capt. OLSEN Alternate Lt. BROWN			TACTICS (3) Chem. Intell. & Weather Lt.Col. GEIGER Lt.Col. BARNES	INCENDIARIES Capt. KING Alternate Lt. Col. BARNES	
1-1:50	AGENTS (2) Capt. MEIGHAN Alternate Capt. King Bldg. 912	AGENTS (4) Detonation Gas Chamber Area Capt. MEIGHAN Alternate Capt. King	WEAPONS (1) Lt. Col. BARNES Alternate Capt. KING Gas Proof Area	TACTICS (4) Before, During & After. Lt.Col. GEIGER Alternate Lt.Col. BARNES	DUTIES Capt. KING Alternate Lt. BROWN Bldg. 912	
2-2:50	AGENTS (3) Capt. MEIGHAN Alternate Capt. King Bldg. 912		LANGLEY PROTECTION Gas Proof Shelter Capt. OLSEN Alternate Lt. BROWN	FIELD EXERCISE Lt. Col. GEIGER Alternate Lt. Col. BARNES	FINAL EXAM Capt. KING	
3-3:50	PROTECTION (2) Alarms Protect. Capt. OLSEN Alternate Lt. BROWN	PROTECTION Gas Chamber Capt. OLSEN Alternate Lt. BROWN				

school into smaller groups or classes and to instruct at different times, due to conflict with other phases of training and the possibility of an alert.

Normally a Division Chemical Officer will call upon other graduates of Edgewood to assist him in his instructions, but the rapid depletion in the number of officers so trained has denied him this assistance. It develops, therefore, that a Division Chemical Officer finds himself confronted with the impossible task of teaching between 350 and 400 students for a period of thirty hours without assistance other than the noncommissioned personnel of his section. Now that the T/O calls for two officers to the section, this will be somewhat alleviated, but even so, it is too much for the two. Furthermore, the effect upon the student is not conducive to best results. Colleges and universities have found that the best results are obtained when students spend one hour with one instructor and then move on to another. When a student listens to one instructor six (6) hours per day for five (5) days, his mind wanders and he loses many valuable points.

A SOLUTION TO THE PROBLEM

To correct these deficiencies, the IV Army Corps has organized a Mobile Corps School for gas officers and gas noncommissioned officers. One officer of the Chemical Warfare Section of each Division was ordered to temporary duty with Corps Headquarters and all commissioned personnel of the Chemical Section of the Headquarters, plus these divisional officers, composed the staff, consisting of nine officers of the C.W.S. Thus, there was assembled a highly trained group of instructors. Each was assigned a subject and each served as an alternate in another subject. This group spends a week at each camp at which Corps and attached troops are stationed. If the assigned students at any one station are so numerous that the school is cumbersome they are divided, and 2, 3, 4, or as many as 9 sections, may be running at the same time. Following is the schedule which is pursued if the school has a small number of enrollees (see page 207). When the number is excessive and many sections are formed the schedule is modified for successive groups. As an illustration, if there are two sections of students, Agents (1) will be given at 10:00 a.m. to Section (A), and to Section (B), at 11:00 a.m., etc.

DEMONSTRATION TEAMS PROVE EFFECTIVE

(By this plan, (1) more effective teaching is accomplished thru smaller groups)
(of students, (2) the interest of students is accentuated by rotation of instructors, (3))
(instructors pool their ideas and suggestions to better the program.)

In addition to the school the Corps team has fifteen enlisted men who comprise three demonstration teams. These enlisted men come from Corps and Division Headquarters. One team demonstrates the proper technique of decontamination of ground and material, using the chloride of lime in solid form and in slurry, and the simulated DANC. Impermeable clothing has been provided, as has also all the equipment authorized.

Another team demonstrates the first aid treatment of gas casualties. Men simulating exposure to the lung injurant gases are treated in the field. Another soldier with simulated mustard on his arm is given field treatment. The third team conducts gas mask drill and gas chamber exercises. All officers who are not engaged in the school assist in this instruction.

While the school for gas officers and gas noncommissioned officers is in progress the three teams are giving their demonstrations and training to the troops. At each camp, units not to exceed the size of one infantry regiment are assigned a period of three consecutive hours. These units are divided into three groups, each group witnessing each demonstration and participating in the drill. When it appears that the groups are too large for effective teaching they are broken down into smaller groups and another series of demonstrations given.

When the Corps team is stationed at a particular camp the Chemical Officer of the Division at that camp is released from his teaching duties to coordinate the troop training and to arrange necessary details for the school. The alternate in his subject substitutes for him in the teaching program.

This method of solving the problem was found very successful, and plays an important role in our training program.

An anecdote of parabolic context illustrates one of the outstanding powers of chemical warfare - that of threat and fear: Once upon a time, according to an old Arab legend, a pilgrim who had just left Alexandria met another traveler on the road going toward the city. "What are you going to do?" cried the pilgrim who recognized the other to be the Plague. "I am going to take three thousand lives in Alexandria," answered the Plague. The pilgrim considered the number and, so as not anger the Plague into killing even more of the faithful, said nothing. On his return from his pilgrimage he met the Plague again, but meanwhile he had had news of what had happened in Alexandria. "Why did you lie?" he cried. "You said that you were going to take three thousand lives .... but they tell me that thirty thousand died! Why, in the name of the Prophet, did you do that?" The Plague looked sadly at the pilgrim and answered: "What they told you is true. But I did not break my word. I took only three thousand. The others died of fright." - Ley, Bombs and Bombing (1941) 3.

"In the matter of making an end of the enemy's forces by violence it is an incontestable and self-evident rule that the right of killing and annihilating, in regard to hostile combatants is inherent in the war power, and its organs, that all means which modern inventions afford, including the fullest, most dangerous and the most massive means of destruction may be utilized.

"These last, just because they attain the object of war as quickly as possible, are on that account to be regarded as indispensable, and, when closely considered, the most humane." Taken from the German War Book -- 1910. Cited by Col. (now Maj. Gen.) H.L. Gilchrist, A Comparative Study of World War Casualties from Gas and Other Weapons (1928).

BOOK REVIEWS

GAS WARFARE, by Colonel Alden H. Waitt, (now Brigadier General). Duell, Sloan & Pearce, Inc., New York, 1942. 327 pp. and index. $2.75.

This is a most extraordinary volume. It is of a highly technical nature, yet written with all the simplicity of McGuffey's first reader. It is concerned with one of the most horrible methods of waging war, yet the author, Brig. Gen. Alden H. Waitt, Chief of Field Division, Office, Chief of Chemical Warfare Service, begins his first chapter with these words: "Every sensible man is agreed that war should be resorted to only when all peaceful methods have failed."

General Waitt's book can either be regarded as a literary curiosity, or as required reading for all those who bear any direct relationship to the conduct of the war. I prefer to accept the latter estimate, and if I had my way, every isolationist, every politician, military leader. and air raid warden would be compelled to use it for required homework.

The important features of this book are not the detailed information concerning the nature of gas warfare and the chemical agents which all nations are readying against the time when unrestricted warfare will blaze out against human society in a white-hot fury of destruction. It is rather the horrifying inferences these facts give rise to. Says the author:

When the full power of air chemical warfare is revealed, the orthodox military mind will receive as great a shock as was caused by the success of German mass attacks with tanks and airplanes, or the Japanese air assault on Pearl Harbor with its final proof that airplanes can actually sink battleships ... the problem of protection against gas is tremendously complicated by the airplane; no longer will there be any areas where anti-gas measures are unnecessary.

Whole industrial areas can be covered by deadly chemicals sprayed or dropped from airplanes. Entire cities can be attacked by these terrible means, or in combination with high explosives.

The implications of this situation are most unpleasant to those who have kept abreast of modern technology, and who are aware of the new shape war is assuming. If Russia should falter, enabling the Germans to organize the resources of three continents for an all-out attack on Britain, the United States would find itself caught like a peanut in a nutcracker, surrounded by the land masses of the Old World and with its southern appendage below the Rio Grande potentially as much a liability as an asset. The considerations which now restrain the military leaders of the Axis would evaporate. They would hardly refuse to utilize this potent weapon so conveniently at hand, and with the tactical position so markedly to their advantage. This type of possibility must give every thinking American pause, and convince him of the need for swift offensive action now, before the Axis plan of campaign succeeds in isolating the Americas and places them under a state of siege which includes an unrestrained chemical and demolition attack by great swarms of night-flying planes.

To understand the technical means by which this purpose could be achieved would make General Waitt's book worth reading alone. In general, it deserves respect as a brilliantly organized estimate of the nature of gas warfare -- an authoritative, hard-hitting treatise which will make the ordinary lay reader shudder, and delight the heart of the military scientist. This whole complex subject is carefully covered. The chemical weapons themselves, and their use in battle, as well as the methods of protection against them are completely entered into. The book is sufficiently technical to serve as a handbook for officers in the field, but, as has been indicated above, can be read with interest and profit by anyone.

- ***William B. Ziff, in THE SATURDAY REVIEW OF LITERATURE.***

INDUSTRIAL CHEMISTRY by Prof. Emil R. Riegel, University of Buffalo, Reinhold Publishing Corporation, New York City. 835 pp., 15 by 23 cm., Appendix, and Index. 4th Edition, 1942. $5.50.

The author has the ability to write in a style that is entertaining and will appeal to the general readers as well as the industrial chemist. Introductory remarks at the beginning of the chapter are of value for orienting the reader in the subject about to be discussed. One who reads this book soon realizes that industrial chemistry is a business subject to the laws of economics as well as a series of scientific processes. "What Things Are Worth" gives some basic figures, while the data on production and costs are the latest available at the time of preparation of the book. The fifty chapters include those usually found in a volume on industrial chemistry. The fourth edition besides many minor changes over previous editions brings up to date the work on the technology of petroleum, synthetic rubbers, synthetic textile fibers, paper and pulp, and Portland cement.

The principal fault in the book is the line drawings. The lines are too fine and the labeling of the diagrams is inadequate. A few minor errors or inaccuracies were noticed, as would be inevitable in a book of this type. The book is highly recommended for the personal library of any chemist or chemical warfare officer.

WAR GASES, by Morris B. Jacobs. Interscience Publishers, Inc., New York, N.Y. $3.00.

The technicalities of detection, sampling and identification of chemical warfare agents are compacted into 163 pages, plus 16 pages of tables and subject and author index. Methods of decontamination of materials and areas are described. The author is a former lieutenant in the CWS, and served as a chemist with the U. S. Department of Agriculture and the New York City Department of Health.

INDUSTRIAL CHEMISTRY OF COLLOIDAL AND AMORPHOUS MATERIALS, by Warren K. Lewis, Lombard Squires, and Goeffrey Broughton. 540 pages. The MacMillan Company, 60 Fifth Avenue, New York, N. Y., 1942. $5.50.

This textbook is an enlargement and revision of the material presented in loose leaf form by the senior author under the title "Industrial Chemistry of the Amorphous Chemical Industries," and is prepared expressly for the needs of advanced undergraduates and graduate students contemplating a career in industry. The first twelve chapters present scientific study of those phases of the physical chemistry of colloidal and amorphous states of matter which are likely to become of major importance in industry. These introductory chapters with excellent clarity and adequate mathematical treatment discuss structure of liquids, viscosity, surface tension, surface tension and orientation, adsorption, suspensoids, amorphous solids, emulsoids, the electrical behavior of colloids, gelation, emulsions and foams, and crystalline and amorphous states.

The last nine chapters apply the foregoing scientific studies to thermoplastics, glass, plasticization by solution, covering liquid adhesives and protective coatings, paper, the plastic fibers, leather, rubber, ceramic industries, synthetic resins and plastics, and textile fibers.

In addition to a carefully chosen bibliography at the end of each chapter, citations to the original literature are given where pertinent throughout the text. Author and subject indexes complete the book.

This text book, which will test the mettle of the best students, is well written, edited and printed.

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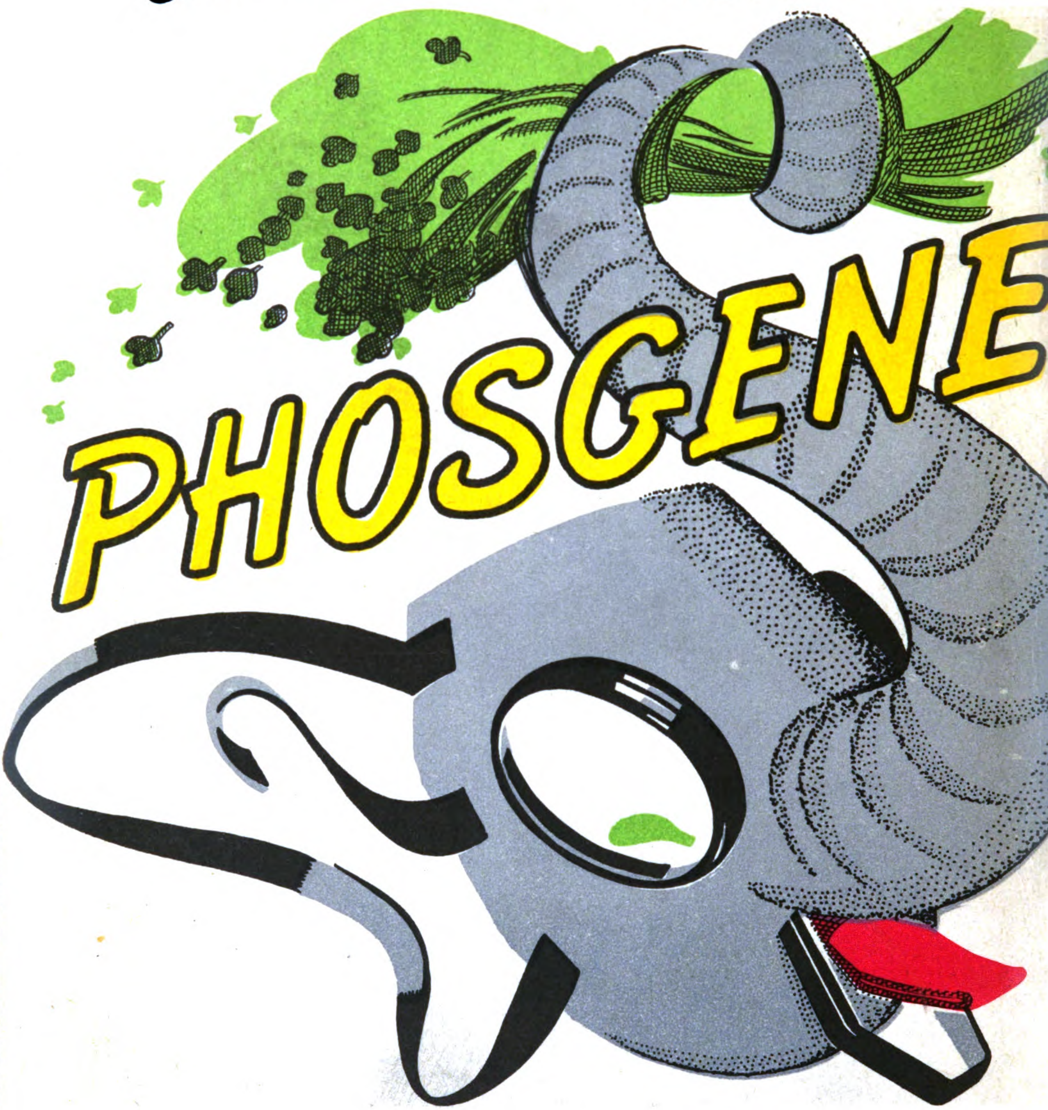
HIT HITLER HERE!
BULLETS NOT BULL!
A PLANE EVERY 8 MINUTES IN 1942!
HE WHO RELAXES IS HELPING THE AXIS!
U-TMOST S-PEED A-HEAD!
NOT DEFENSE, BUT OVER THE FENCE AND AT 'EM!
LET'S ZINC THE HELL OUT OF THEM!
PRODUCE, PRODUCE, PRODUCE, AND COOK THE AXIS GOOSE!
ALL OUT NOW OR ALL IN LATER!
YOUR BONER CAN COST A BOMBER!
IF WE EQUIP THEM OUR BOYS WILL WHIP THEM!
YOU CAN'T SIT AT EASE TO BEAT THE NIPPONESE!
PASS THE SCHEDULE NOT THE BUCK!
DAMN THE BOTTLENECKS!
COME ON BOYS LET'S GO WITH PEAK PRODUCTION WE'LL SHOW HOW TO ELIMINATE TOKIO!
A GRENADE IN TIME KILLS NINE!
LISTEN LET PRODUCTION TALK!
MINUTES SAVED HERE MEAN LIVES SAVED THERE!
HE WHO NAPS HELPS THE JAPS!
SAVE ON SCRAP AND GET YOUR JAP!
AMERICA CO-ORDINATED THE ENEMY ELIMINATED!
W. D. CIVILIAN PROTECTION SCHOOL
TEXAS A. & M. COLLEGE
TEXAS

SMELLS LIKE MUSTY HAY



OR GREEN CORN · LUNG IRRITANT · CAUSES INCREASED DOPEY FEELING · COLORLESS GAS

end