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CHEMICAL WARFARE

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

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

THE CHEMICAL WARFARE SCHOOL

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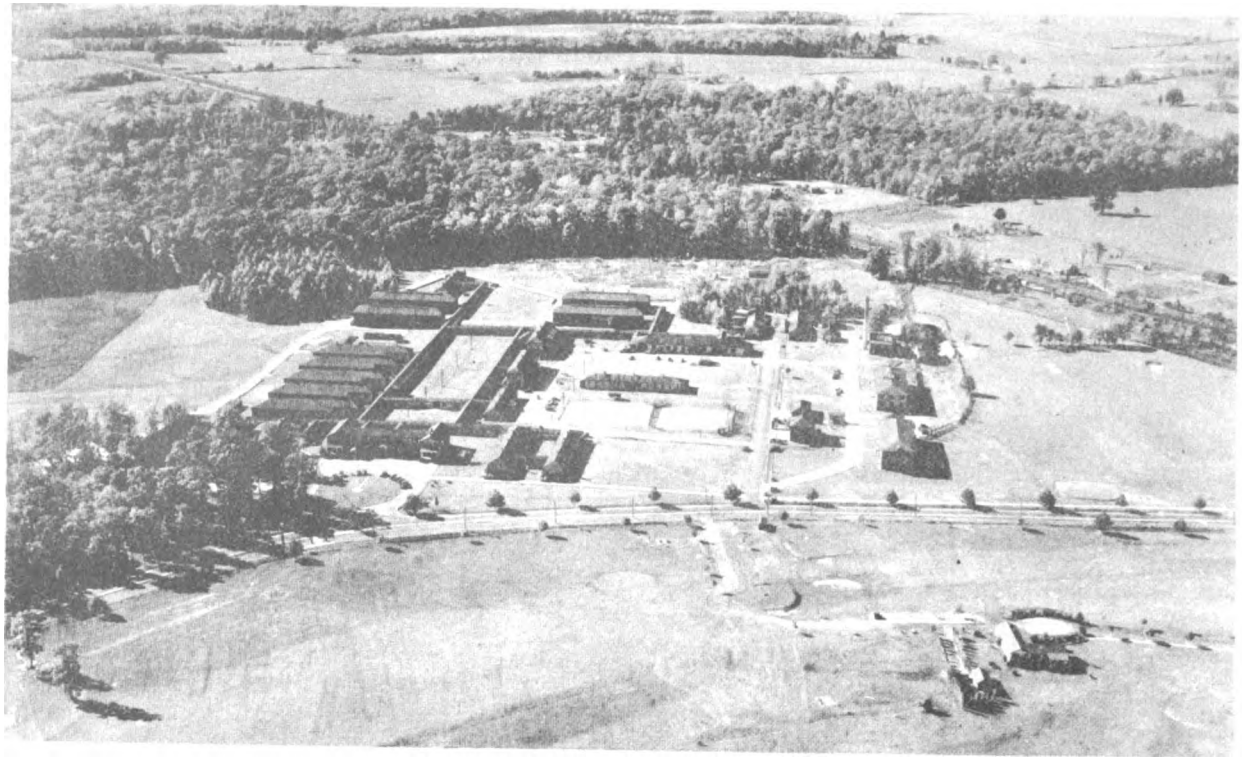

Headquarters Area Edgewood Arsenal

CHEMICAL WARFARE

VOL. 18 APRIL, 1932 NO. 2

THE 15TH LINE AND STAFF OFFICERS' COURSE, 1932

The 15th Line and Staff Officers' Course, The Chemical Warfare School, commenced on February 7th and will end on April 29th. The following officers are in attendance:

Lt. Colonel

Choate, Roland H., Inf., Mass. N.G.

Majors

Phelps, Frederick C., Inf.
Cain, David E., F.A.
Potts, Adam E., C.A.C.
McGuire, Maurice J., Inf.
Kincaid, James B., Inf., W.Va. N.G.
Perrine, Nat S., Inf., Tex. N.G.
McNicholas, Thomas G., Inf., Md. N.G.

Captains

Young, Sidney H., Inf.
Kerr, Creighton, C.A.C.
Lloyd, Claudius L., Inf.
Gallier, Robert H., Cav.
Hodge, John R., Inf.
Baker, Paul T., Inf.
Tydings, William L., Inf.
Barnett, Theodore T., Q.M.C.
Nolan, John P., Inf.
Gantt, Henry P., F.A.
Field, E. Lewis, Inf.
Flanagan, Francis M., Inf.
Sherman, George C., Inf., Wis. N.G.
Benda, Charles J., Inf., Haw. N.G.
Leslie, Roland R., CW-Res.
Gilliatt, Leland W., CW-Res.

1st Lieutenants

Makinney, Fred W., Jr., Cav.
Whitesides, Sterling E., Jr., C.W.S.
Goff, John L., C.A.C.
Hankins, Milton T., Sig. C.
Lamb, Samuel S., Sig. C.

NOTICE TO CHEMICAL WARFARE RESERVE OFFICERS

ARM AND SERVICE ASSIGNMENT GROUP

Announcement is made of the following change in the policy of selecting Chemical Warfare Reserve Officers, Arm and Service Assignment Group (formerly B.A. Group) for training, commencing with the summer training season, 1932.

Reserve Officers (A.S.A. Group) will be selected by the Office, Chief of Chemical Warfare Service for summer training, based primarily on previous active duty training. A form letter, advising them of their tentative selection for training, the place and date of the detail, together with application blanks, will be forwarded to each officer designated for training, through the Corps Area Chemical Officer early in the year. If the officer concerned can accept the detail, he will execute the blanks and return promptly through the Corps Area Chemical Officer. If an officer selected is unable to go on an active duty status, an alternate will be selected in the same manner.

This procedure will greatly reduce the amount of routine correspondence with regard to applications for summer training, enable funds to be expended to better advantage and War Department policies on the training of reserve officers can be more closely adhered to.

ORGANIZATION AND OPERATION OF THE A.E.F. FIELD LABORATORY

By: Professor Frederick G. Keyes, Lt. Col., C.W.S., Reserve

(A Lecture to Reserve Officers' Class, Mass. Institute of Technology, August 1931)

My purpose in attempting to revive my recollections of the organization work and events connected with the American Expeditionary laboratory has two objectives. First, I hope to sketch for you, however briefly, some elements of the situation confronting the U.S. Army in 1917 in its need of comprehending the supreme importance and significance of an entirely new arm in warfare. The task, as you now know, of fully comprehending was very many sided, for besides the purely military aspects involved in the use of "gases" a vast amount of new technical and highly scientific information as well as practice had to be brought together in a form readily available to more than one army branch. In these matters few, if any, United States Army officers had any training or previous interest. To make matters more difficult, the American procedure of appointing a civilian Secretary of War, while an excellent plan in many respects, has the disadvantage that initiative and foresight in a crisis are expected of one whose technical education and instinct are undeveloped in matters which may become of vital importance to the country. Thus, although a chemical arm was indicated as needed at the time of the first German gas attack in April, 1915, the United States Army was totally unprepared two years later when the United States entered the war. Of course the information and scientific foundation upon which an army chemical arm rests was in a state of rapid flux fourteen or more years ago, but this placed a greater and not a less responsibility on the leaders upon whom the country depends for its existence in a crisis. It seems, therefore, little short of a miracle when I see the well knit chemical arm which the Chemical Warfare Service has succeeded in giving the country, for I know to my cost from the A.E.F. experience the amount of enthusiasm, good will and industry which must be applied to overcome the obstacles which human nature has ever abundantly placed in the path of new enterprises.

But I must return to our more immediate subject to say that the second purpose of this talk will be to present in the form of a resume the method by which the A.E.F. laboratory was equipped, organized and operated. The kinds of problems encountered may be of interest also, for I fancy much the same sort of problems will appear for solution in the next war. Finally, I

would like to refer to some suggestions which may be helpful in connection with the operation of an expeditionary laboratory when circumstances require it. I make these suggestions with some hesitation, for I see before me my friend Captain Barker, whose judgment in these matters I trust infinitely more than my own.

I was an engineer of a Westinghouse subsidiary company, living in France, when war was declared in 1914. I remember the tension in Paris and London furing that month of July, followed by an unforgettable August ushered in with a declaration of war between France and Germany. One hears occasionally that France wanted the war, a statement which does not accord with my observation. On the contrary, the nation was fearful, anxious and most uncertain of a conclusion favorable to France. No country, it seems to me, ever went into a war with more misgivings, and may I add with more resolute and intelligent courage. The world forgets as easily as it misjudges, and it is therefore just to recollect from time to time the debt owed to a nation of unexcelled intelligence and patient courage. Indeed, it is easier to imagine than to express the extent of the ultimate disaster to our country had these qualities not proved sufficient to offset the brute force of a material equipment probably unexcelled since the days of Caesar's armies.

Early in the period following the entry of the United States into the war I was called upon to solve some problems (I was at this time a member of the staff of the Research Laboratory of Physical Chemistry at the Massachusetts Institute of Technology) connected with the project to extract helium from the natural gases, some of which contain almost one per cent of this rare gas. But activity along chemical lines was growing rapidly responsive to repeated communications from General Pershing urging the growing importance which the use of chemicals was acquiring. One morning in the autumn of 1917 a telegram appeared from Professor W. H. Walker asking that I report at Colonel Potter's office in Washington at the earliest moment. The upshot of the conference was briefly that I was to gather equipment for a modest expeditionary laboratory in France. Following the conference I pondered what interpretation was to be put upon the word "modest". It was not a time to ask for much detailed instruction of either Professor Walker or Colonel Potter,and reliance was placed on that sometimes treacherous ally - one's imagination.

Evidently the practice of war had become an extraordinarily complex technical affair, resting on a foundation as broad as existing scientific knowledge. Moreover, the United States Army was to operate over three thousand miles from home. Should a laboratory under such conditions be equipped merely to do some simple chemical testing of Chemical Warfare Service materials such as gas masks, canisters and "gases"? Or should it be assumed that it might be called upon to investigate, design and develop? If all these functions were to be operative should there be facilities for only strictly Chemical Warfare Service activities, or would it be wise to provide for the widest possible range of research, control and development work in the interest of any of the varying services? Well, I elected to choose the latter as a proper objective on the general assumption that it is better in an emergency to provide for every eventuality that may arise rather than run the risk of having too meagre equipment.

You may ask where was the good sense in setting up a large laboratory equipped for such diversified work when a better organization could be more easily organized and more effectively operated in the United States. I would like to have the time for a long dissertation on this subject, but some of the items of a reply to the query will be evident in the succeeding references to services which the laboratory rendered at a time when detailed communication was really an impossibility and when time entered as an element of vital importance. My own experience indicates, and I believe my old comrades will agree in the statement, that in the event of a war where American troops must operate outside the borders of the country a fully equipped expeditionary laboratory similar to the old A.E.F. laboratory, but perhaps larger, will be needed as well as the extensive home laboratory. The lines of communication in modern war are so strained that it would be very dangerous, perhaps fatal, for the army to be dependent on the uncertain and trying conditions attending the inter-communication of complicated scientific and technical requirements. But all this, as Kipling says, is another story.

The laboratory equipment was designed to be complete with supplies and facilities for inorganic, organic and physical research. In addition, facilities were included for technical testing and examination of cement, fabrics, metals and practically all industrial materials. A modest biological equipment was included for water or other bacteriological examinations that

might be required. Of course, a well equipped machine shop,with small tools and stock was a prime necessity, and glass blowing facilities with the personnel to operate. Refrigerating facilities,even to liquid air, were included. Liberal supplies of all liquefied and compressed gases in drums and cylinders would be needed. As complete a stock of chemicals was collected as could be found in the United States. A library of reference books was an absolute necessity, and I had my own library packed and sent to Pittsburgh,the assembling point. Typewriting machines,office files, stationery,pens, pencils and like articles were not omitted; nor a good photographic, drafting and blueprinting outfit. This briefly was the material equipment which went into the 1460 cases which constituted the A.E.F. laboratory. The assembly point was Pittsburgh, at the Plant of the Fisher Scientific Company. It is a pleasure to take this opportunity, the first I have had, to call attention to the invaluable and untiring service rendered by Mr. C. G. Fisher and his brother,who,time after time when the need arose,placed their entire organization at the task of assisting Lieutenant Norris F. Hall and myself in the task of gathering together, packing and shipping to Hoboken a vast and complicated array of material.

The cases were at last ready and the next step was to obtain priority freight orders through the Chemical Warfare Service Chief's Washington office. The fates were kind, for the shipment was kept intact and arrived at Brest more promptly than could have been expected. From this port it was guided by Chemical Warfare Service officers over the railroad to the site of the laboratory, which was 120 Ave. St. Germain, Puteaux, a suburb some miles from Paris, and near Fort Valerian. One case was "lost", which is one way of stating that an Engineer Corps got possession by "mistake" and were ever afterwards unable to locate our milling machine. This,however,was our only "casualty".

The first group of Chemical Warfare Service officers had been sent to France in the late autumn of 1917,and constituted the first group of advisors trained in chemistry which General Fries had at his disposal. The French government had assigned the quarters in Puteaux which originally were an old and abandoned factory location, but had, before August 1914, served as a biological laboratory. There were five buildings and a good dog kennel,besides a quantity of laboratory apparatus which the chemists of the early group, G.N. Lewis, Joel H. Hildebrand, Ben Nicolet and others put to immediate use for solving problems

which were already beginning to come before General Fries' organization. General Pershing must have had divine guidance or colossal good luck in choosing his chief of the service,for General Fries, although entirely unfamiliar with chemical warfare, as in fact were all American army officers, secured very quickly the British and French information and organized with the slenderest resources in material and personnel an increasingly effective service. The laboratory was part of his plan,and important results were forthcoming months before the equipment described above was available. Of course what laboratory material was available im Paris was sought,but there was pitifully little to be had.

I had asked Colonel Potter to secure a plan of the assigned quarters for the A.E.F. laboratory, and General Fries promptly sent a comprehensive sketch. This was of the greatest help, since it enabled me in the course of my journey to Puteaux to plan where and how the material could be stored and the laboratories equipped in a manner best suited to their respective functions. I arrived in Liverpool and proceeded to Le Havre, where the officer in charge wanted to send me to one of those "horrors" of modern war - a rest camp. The officer,I discovered, knew little about France, geographically or otherwise, never having heard of Puteaux, and as a particular favor he routed me through Paris. I arrived at 11:00 P.M. in a city as dark as a pocket,but my familiarity with the city was sufficient to enable me to proceed to my old stopping place, the Hotel Crillon, where I had a good night's rest. In the morning,instead of proceeding, I telephoned to General Fries, whose headquarters were in Tours. He promptly said: "I'll be in Paris before noon. Meet me at the Continental Hotel". I did so. My orders were changed and I found myself in Puteaux,which was the end of the rainbow for me.

I found Captain Joel H. Hildebrand in charge of the laboratory. My old Massachusetts Institute of Technology colleague, Major G. N. Lewis, was by this time in Tours, where he could advise General Fries on chemical matters. Captain Hildebrand and the other officers were making excellent progress and carrying out important work in spite of the lack of adequate equipment. The recollection of what was accomplished under the conditions existing prompts me to remark on the importance of excellent personnel in any undertaking. Had General Fries been sent in this early period officers less resourceful, intelligent and active, he would have been unable to surmount the technical

difficulties connected with the lack of material equipment for scientific work. The import of this is clear, and your presence here is part of the guarantee that in another emergency the Service will be perfectly prepared to plan the right man in the right post with certainty and without delay.

My main job was now to plan and supervise the necessary changes, additions and preparations, to quickly install and make available the equipment which was enroute. It seemed likely that before the war was over (Christmas seemed, by the way, the favorite time to have the war over, but no one seemed to know which Christmas), we would need a staff of about forty at Puteaux, and mess and sleeping quarters were prepared for about that number. Toilets and lavoratories were installed and, in short, everything ready for the great day when the army trucks brought in the supplies. I leave it to you to imagine the bee-hive activity which took possession of that outfit when 1459 cases jammed every available bit of free space in that high stone-walled enclosure. No doubt everyone likes to unpack, and these cases must have looked like Christmas packages from home. In a short time the storage bins were filled, the laboratories equipped,the machinery installed, the office functioning with its new equipment, and a library available. The shafting pulleys and belting for the machine shop had all been laid out from the sketch of the location sent by General Fries, and it fitted together without a hitch except for one pulley, which could not be found. A French firm made up a very satisfactory wooden pulley.

At about the time the equipment was installed General Fries had succeeded in securing a proving ground and A.E.F. Gas Defense School at Hanlon Field, near Chaumont. Unfortunately,so it seemed to me,this was quite a distance from Puteaux. Captain Hildebrand, now Colonel, was made Commandant, and a variety of most important work was organized and successfully carried out.

The laboratory as finally organized (June 1918) consisted of the following divisions: Administrative Division, under which was included the Adjutant, Office, Intelligence, Stock Rooms, Supplies, Mess, Guards, Medical and First Aid; Chemical Research Division, including Organic and Inorganic; Physical Research Division; Control Laboratory Division, covering all testing and examination of materials; Miscellaneous Research Division; and a General Facilities Division,embracing glass-blowing, Machine Shop, Cryogenic and Refrigerating Laboratory, Drafting

and Photography.

The problems coming in for solution were of a most varied kind, for General Fries had made known to the other branches of the Army the fact that a laboratory existed, and had offered its services. Amongst others, the Ordnance,the Camouflage Service, the Air Service, and the Medical Corps applied. I recollect one of our first "outside" problems was in connection with an airplane machine gun. It seems the gun had been designed to be kept warm by means of a neat storage battery outfit calculated to perform perfectly - however, under conditions very different from those obtaining under air warfare. The gear was not reliable and the gun jammed because of the freezing of the oil at the low temperatures encountered at high altitudes. We built an insulated chamber and refrigerated it to -30 degrees C. with the liquid ammonia that had been brought over with the equipment in tanks, and shortly worked out a specification for a non-freezing oil, thus eliminating the storage battery and heater. A shipment of rifles proved to have defective trigger springs. The metallographic equipment enabled the fault to be located and a communication made with the home service which led to a correction of the difficulty. The Camouflage Service found that the cost and difficulty of procuring pigment in the large quantities required was about insuperable. A study of natural clays and earths available made it possible by simple processes to "fix" the muds and thus overcome this obstacle. Fabrics were being purchased for airplane use,and the fabric testing machines came into use, enabling the quantity of purchases to be controlled and exact specifications written. Waterproof glue, casein glue,was desired which would give adherence of maximum strength. Woods of the kinds used for airplane propellers were made up in the figure eight form, fitting the cement testing machine, and a glue developed superior to any available, and at a lower cost. Curious hollow spheres, apparently dropped from enemy planes and thought to contain bacteria, were brought in and given bacterial examination. Thus I might extend samples to indicate the convenience, not to say imperative need, of a thoroughly equipped expeditionary laboratory.

The main work of the laboratory, however,bore directly on Chemical Warfare Service problems. Gas masks of a certain number from each lot shipped from the home base required testing to determine whether deterioration had been suffered in the rubber, valves and other parts. Canisters and filling material re-

quired constant testing. Dud shells required examination to keep abreast of new types of fuses, shell design and shell contents employed by the enemy. The amount of this effort was considerable, and the results evidently valuable only if obtained promptly and reported accurately. New "gases" were suggested by the home laboratory. They were synthesised and thus an independent and immediate acquaintance with their properties and possibilities was realized by the expeditionary service. The efficiency of enemy absorbents could also be tried on the new gases without loss of time. The first stages of developing counteractants and defensive measures for enemy gases could be compassed, and thus intelligent and exact information communicated to the home organization, thereby saving time - that all-precious factor in the conduct of war operations. To illustrate, the so-called "sneeze" gases were being actively used by the enemy in the 1918 period. The Organic Division was able to analyze and synthesize and become fully acquainted with these compounds, whereas had it been necessary to wait for the home laboratory to send samples and information over three thousand miles of ocean much time would have been lost, and complete information but slowly accumulated. Well, it would have made an impossible and senseless situation to be avoided at any cost. I remember, to illustrate, enthusiastic communications that came in from Washington about Lewisite. We synthesized the product and were able to indicate some of the restrictions to its use under the climatic conditions prevailing in France, for in war as in peace one must always bear in mind the observation of the Master of Ballantry in Stevenson's novel of that name who remarked in effect "What is a good trick in one country may be a d--- poor one in another". Suggested protective and detective devices of all sorts were tested under actual war conditions and reported upon, but I must content myself with the brief references made hoping they will give a sufficient idea of the range of activity of the laboratory as well as its imperative need as a part of an expeditionary force.

The development and research work carried on was not unimportant at the time, although none of it excepting a small portion on adsorption by Captain Harned has ever been published. However, the records of much of the work have been available to Edgewood Arsenal since the close of the war,and whatever benefit the results may be to the Service constitutes a sufficient satisfaction to the men of the laboratory force who gave their best effort without thought of credit or reward of any kind.

Some amusing incidents contributed to relieve the strain of the hectic A.E.F. days. I recollect General Fries telephoned from Tours one day, stating that he had just received a Washington telegram that we should use snails to test for mustard gas in the field. He said he'd send the telegram down,which he did, and we were informed that the snails in the presence of mustard gas vapor would "wave their tentacles wildly in the air". None of us were familiar with the physiological properties of snails,but I knew that if anybody did know it would be Doctor Mayer, the French Physiologist. Forthwith, Captain Nicolet was dispatched to Doctor Mayer who, after reading the telegram burst out laughing with "Why, the soldiers will eat them". He refused to take the matter seriously, so we diligently sought snails and more diligently watched for the "wildly waving tentacles", but not a "wave" was observed. Major Connell and Captain Mills afterwards carried out a similar investigation at Hanlon Field,but French snails must be of a different race from American snails, or more conservative in their impulse to demonstrate. The sequel to this story is not without interest,for one evening a year ago we were entertaining among others a noted biologist at dinner in my home, and as the men were smoking their cigars after dinner I related the snail story as tellingly as possible. As the biologist was leaving, he turned to me with an amused smile and said: "You might like to know,Keyes,that I was the one who suggested that snail test".

In the event of a future emergency,mobile field laboratories would be an absolute necessity, but in the case of a war outside the borders of the United States and possibly in any event these, in my opinion,should be part of a central fixed laboratory at a suitable place in the permanent supply depot area. The function of the central laboratory would be to maintain and re-equip the field laboratories, besides correlating the data contained in the regular reports of the latter. Items of investigation which required immediate attention could be taken in hand with the larger and more abundant resources of the central laboratory, and in case the nature of the problem warranted the utmost in resources,it could be passed back with full and accurate information to the home laboratory corresponding to the American University in the last emergency.

From the experience already available there remains no doubt regarding the vital necessity of providing for a very carefully thought out plan of laboratory and scientific organi-

zation to function during war time. To the organization already briefly alluded to, there should also be added a small scale manufacturing laboratory conveniently located with respect to the home manufacturing, where processes or parts of processes could be studied and manufacturing and engineering data secured. Time does not permit on the present occasion to go into details, but sufficient has been indicated to bring forward some aspect of the general problem, the importance of which it is difficult to over-emphasize.

PROTECTIVE WORK IN THE RESEARCH DIVISION, CHEMICAL WARFARE SERVICE, IN THE WAR

By: Dr. Warren K. Lewis

(A Lecture to Reserve Officers' Class, Mass. Institute of Technology, August 1931)

Major Maddux has asked me to tell you something of my experiences during the war. I am anxious to give you, not those things of merely personal interest, but something of the picture of the situation with reference to Chemical Warfare as it actually existed in 1917, when war broke out, to help impress upon you the seriousness of the problem we faced, because this will help you to appreciate the importance of your own function in the Service today - the prevention of a similar emergency should war break out again.

War was declared early in April, 1917. A few days later my telephone rang and I was asked to come to the office of the president of the Massachusetts Institute of Technology. The president threw across the desk a telegram signed by Van H. Manning, Director of the Bureau of Mines, - "Have W. K. Lewis report this office tomorrow morning". In view of the atmosphere existing in those troubled days, you will understand that without further ado I packed my bag for Washington.

Mr. Manning was the vigorous executive in charge of the Bureau of Mines, and he was anxious to have the Bureau do its bit. Gas warfare had received great publicity, but in this country very little was known about it in detail. For a number of years the Bureau had worked on various problems connected with toxic gases, and Mr. Manning felt that this background should make it possible for them to help the Army and Navy in connection with the technical problems, both defensive and offensive, in connection with the use of gases in war. Mr. Manning had had

as a subordinate in the Bureau Mr. G.A. Burrell, who had resigned to go into consulting work in Pittsburgh a couple of years before. His work in the Bureau had won the confidence of Mr. Manning, so that he recalled him to Washington to secure his cooperation in the program he was trying to organize. In Pittsburgh Mr. Burrell had met Mr. Bradley Dewey, and took him to Washington with him. Mr. Dewey knew me, and he it was who had Mr. Manning send the telegram.

These men, together with certain others, gather in Mr. Manning's office a couple of days later and blocked out a program of action. I am anxious to emphasize the fact that this conference, which, so far as I am aware, initiated all technical work for the American Army on Chemical Warfare other than along medical lines,was held, not in the War Department,but in a civilian department of the government. Mr. Manning has been accused of butting in. The accusation is justified, but, in my opinion, he deserves great credit for it.

Mr. Manning was in contact with Major Williamson of the Medical Corps and,as soon as the work was undertaken, I visited his office. He turned over to me the technical reports of military attaches with the allied armies on other than medical subjects. These reports contained a mass of data, and of course represented the only authoritative information available in this country at that time. The difficulty with them lay in the fact that there were extremely important gaps in the information furnished, so that it was impossible to formulate a clear and dependable analysis of the whole situation. We had to start work in the dark. The War Department is to blame for the fact that it had not digested the information available to it on the developments in Chemical Warfare and had formulated no program of action. The initiation of such a program before we were drawn into the war would have required the support of Congress, but its formulation at least in preliminary outline was in the power of the Department, and it failed to act. That failure was the major cause of our early difficulties, delays and mistakes.

Our first requirement was to assemble a technical staff. The authorities told us to interfere with industry as little as possible,and in consequence almost the only place left to turn was to the universities. At the start we had very little money,but we went to all accessible educational institutions and asked individual professors,instructors and graduate students to

undertake specific problems. This they did with enthusiasm and devotion. At the same time we started work in our own laboratories, first commandeering the staff of the Bureau of Mines,and later expanding that staff as the work grew. The first laboratory of our own was that of the Bureau in Pittsburgh, but work was started in Washington at almost the same time, and later the Pittsburgh activities were transferred entirely to Washington, after space for expansion of that laboratory had been found at the American University.

Our first problem was obviously that of defense. We had to try to give the American soldier some sort of protection against gas. That required a mask. It is difficult for you, with the background and knowledge you possess, to appreciate the depths of our ignorance. However, on the basis of our study of attache reports,together with such other information as we could secure, we decided that the canister mask should be adopted. Consequently, we plunged into the study of the preparation of soda lime and charcoal. It was clear that the latter presented the most serious problem. I had had some contact with the Research Laboratory of the National Carbon Company in Cleveland, which convinced me that they possessed the background and ability needed for the development of an absorbent char. Consequently, I approached them through Mr. M. W. Allen, at that time superintendent of their Cleveland plant, and through him secured the help of their research laboratory. This is the way in which Dr. Chaney was drawn into the work.

I have mentioned the fact that the information from abroad was inadequate. This is well illustrated in the situation with regard to charcoal. We had descriptions in considerable detail of the methods of manufacture employed by the British, involving what we would today call an activation treatment by reheating in a special type of obsolete gas retort. However,the reports gave almost no detail as to the method of heating and said nothing as to its purpose or the character of the changes in the charcoal brought about by the operation. Reports of the type employed were not available in this country, and it was clear that we would have to undertake a thorough study of the technique of charcoal manufacture. This is the problem which I turned over to the National Carbon laboratory.

We did not know how to test the charcoal once it was made. At that period in the war its major function was to pro-

tect against chlorpicrin,but we did not know how to test the effectiveness of its absorption of that gas,particularly on a laboratory scale,at the low concentrations involved. We finally decided to develop a charcoal of high absorbing capacity for chlorine on the ground that such a charcoal would probably also be effective in absorbing other gases. That was mistake number one. We also decided to test for chlorine in the air leaving the char by its oxidizing power. That was mistake number two.

Dr. Chaney soon discovered that ordinary charcoals were low in chlorine absorptive capacity, but that by special low temperature carbonation the chlorine absorption could be tremendously increased. He found cedar wood peculiarly responsive to this treatment,and in a few weeks he was sending us samples of charcoal which were strong and tough, and of an absorptive capacity for chlorine so great that it was certain a mask containing it would never let that particular gas through under any conditions likely to be encountered in the field.

Meanwhile,experimental work along other chemical lines was progressing reasonably well, but we were making no progress at all in the solution of the mechanical problems of mask construction. Major Dewey, who by that time had accepted a commission in the Medical Corps, finally convinced the Department that to make progress it was necessary to build some masks,and an order was put through for the construction of twenty-five thousand. That order has been drastically criticized, and the construction of the masks condemned in no mild language. Certain it is we did not know how to make them. The masks were worthless, and were never worn in action. Nonetheless, the construction of that first twenty-five thousand masks was a wise thing, because it showed us as no other experience could have done what our problems were and how to go to work to solve them.

It would take a week to tell you the things that were wrong with those masks. I have mentioned our early work on charcoal,and will use it as an illustration of the mistakes we made. Dr. Chaney's charcoal had been carbonized at low temperature,and contained large quantities of residual hydrogen, perhaps present as adsorbed hydrocarbons. The chlorine reacted with this hydrogen to form hydrochloric acid. While this was held by the charcoal to a certain extent,its capacity for absorption of the acid was far less than the amount of chlorine taken up. Consequently, long before the chlorine absorptive capacity had disappeared,the

mass began to give off volumes of hydrochloric acid,a gas almost as bad as the chlorine itself. However, this gas was missed entirely by our testing method. Meanwhile,carbon of this type was completely useless for the absorption of the relatively inert gases against which it was its real function to protect. Lack of detailed knowledge, information which was available on the other side of the water, had made us make fools of ourselves.

However, those masks did us one extremely important service. They loosened up the sources of information abroad. A number of them were sent to Pershing and the criticisms which came back were voiced in no uncertain terms. None the less,those criticisms contained exactly the information we needed. They told us what was wrong,and in many cases how the British and the Germans had overcome the difficulties in question. For the first time our objectives became reasonably clear, so that intelligent and effective programs of actions could be formulated. However, to this day it makes me sick to think of what could have happened had our men had to go into action with those masks for protection.

In the case of another emergency we shall not run into that situation. It will not be eleven months before we are able to start turning out masks fit for use. However, it is upon you and your associates in the Reserve Corps that the Army must in large degree depend to prevent such a contingency. The effectiveness of our national protection will depend primarily on the quality of your training and your appreciation of the exact part which you must play in the whole program of defense.

If we ever get into war with a major power the problem of this country will be speed. The United States possess a greater potential war-waging capacity than any other nation on earth. The enemy will fully appreciate this fact,and will strike swiftly to break our primary defense before this potential capacity can be brought into action. As I see it, the function of the Reserve is to furnish as leaders a group of men so familiar with the problems and the plan of action that these delays of which I have been speaking, and which in the aggregate constituted a national disgrace in 1917, may be reduced to a minimum in times of future trouble.

The time is not available to tell you the whole story. At the start I took charge of the entire research program in the

Bureau of Mines, but it soon became clear that the problems of defense and of offense were so fundamentally different that segregation between these two lines of effort was desirable. Dr. Kohler took charge of the offense research and I continued with the defensive work, both of us under Mr. Burrell.

In the summer of 1917 the Army organized what was at first called the Chemical Service Section. This section finally developed into the Chemical Warfare Service in this country under General Seibert. In the late spring of 1918 the Service took over the research work from the Bureau of Mines. That Bureau had organized it,was justly proud of it, and regretted to let it go. Obviously, however,the place for the work was in the War Department itself. The smoothness with which the transfer was made from one department to another has always surprised me. There was practically no loss of time or efficiency in the work under way.

From the start Major, later Colonel Dewey, had charge of gas mask manufacture in the War Department itself. My work was obviously only a service activity for his. Throughout the war Colonel Dewey and I worked together hand in glove. In consequence,most of the development work, reducing research results to a practical operating basis, was done between him and myself. This close cooperation was responsible for any success achieved by the work under me.

In conclusion, I want to emphasize again that our greatest handicap was getting started without a plan. That thing alone slowed us up more than all other troubles put together. Those of us who have been through this painful experience appreciate the seriousness of the mistakes we made and are anxious to see them avoided in the future, are convinced that the most important thing to do in preparation for the next emergency is to have an adequate and intelligent plan. It does not have to be the best possible plan, but it must,however, be a definite plan, and it must be understood by those who are to operate it. To me the most encouraging thing in our present military situation is the fact that the War Department is alive to the necessity of an adequately planned program of action when the next emergency arises. You reserve officers are in a real sense the key men in that program, so far as the Chemical Warfare Service is concerned. It is important for you to know where you are to fit,and to be thinking along the lines you will have to follow when the

emergency comes. We know that we can depend upon your loyalty, but loyalty alone cannot produce efficiency. Efficiency in any undertaking demands intelligence in planning as well as loyalty in action. In devoting your time to this work of training and preparation you are doing a national service as essential and valuable as that rendered by men in time of war itself.

COMBAT MORALE AND CHEMICALS

By: Capt. Francis G. Bonham, Infantry

Morale is the state of mind of an individual or of a group of individuals as affected by such conditions as fatigue and hunger and such emotions as fear and hope. Combat morale is the state of mind of an individual or of a group of individuals in combat.

Napoleon in an effort to express the relative importance in the combat of his day of the morale and material factors said: "The morale is to the physical in war as three to one." This is generally conceded to have been the correct proposition at that time. Whether or not, the great strides made since then in the development of material means for waging battle has reduced the ratio or not is problematical but military thinkers must concede that where there is no great disparity in material means morale will determine the victor. And it is conceivable that where such a disparity does exist superiority of morale on the part of the inferior force will make it equal in combat strength to the larger force. Thus, though morale as a battle factor may have lost some of its importance it is still, nevertheless, a vital element.

The commanders in battle seeks to attain one end: the destruction of the adversary's will to win. That done, decisive results become possible. They materialize, however, only when his forces still retain their will to win. Otherwise, the battle is a draw. This "will to win" exists only as long as the troops are in the proper frame of mind, that is as long as their morale is high. Hence the problem is a two-fold one: to destroy the opponent's will and to maintain the will of his own forces.

The principal enemies in combat of high morale, of the desired state of mind, are fatigue and fear. And in proportion as he becomes fatigued man grows susceptible to fear. Also, fear

is fatiguing.

It is an established fact that the unknown induces the greatest fear. Thus though man fears physical pain he fears death more. The doubt and uncertainty as to what happens afterwards, or rather as to what may happen, drive ignorant man to despair when and wherever the dreadful spectre appears. Darkness, smoke,fog, the real or fancied presence of a death-dealing element in the air, all cause man to grow terribly afraid. In varying degrees, of course, depending on the individual, but the effect is depressing on all except a brave few.

Thus, in general, man fears the unknown more than he does the known. But that is not to say that he fears nothing known. On the contrary,fear of physical pain is often acute and quite as effective temporarily as fear of death.

In his employment of chemicals in combat and in preparing his troops to deal with hostile chemical operations, the commander must consider the effect on morale. The extent to which such consideration might influence an operation is unlimited. Thus, for example, it is entirely within the bounds of reason that a main effort against the naturally strongest part of a position might promise greater chances for success than if made against a part naturally more favorable to the attacker, if the hostile troops holding the former part are known to be low in morale or if they are known to be deficient in stamina or if they are poorly trained in chemical defensive measures, provided the chemical means available are massed in support of the main effort and are otherwise properly employed.

In this connection the enemy should be forced to mask as long before the attack as is consistent with secrecy and he should be forced to stay masked thereafter. For several nights prior to the launching of the attack he should be continuously harassed with small scale chemical operations with a view to causing him to lose sleep and become alarmed. This preliminary "ripening" process will reduce his physical powers of resistance and make him more susceptible to fear while constant wearing of the mask during the battle will further reduce his combat efficiency. The preliminary chemical operations should not, of course, be confined to that part of the front on which the decision is sought as this would tend to disclose the plan.

When the attack is launched, and thereafter whenever practicable, those vital parts of the hostile position in front of the main effort that are known to be strongly fortified should be heavily smoked. This will serve not only to reduce the effectiveness of the hostile fire but by blinding the enemy will increase his uncertainty as to where our advancing troops are, how strong they are,where his own comrades are and what they are doing. Furthermore, it will give such of the enemy as become panicky an excuse, and concealment in which,to leave their positions.

The employment of any chemicals new to the hostile troops, even though harmless, will if detected by them cause additional uncertainty and temporarily at least will increase their fear and afford malingerers an additional excuse for going to the rear. Any vesicant or any toxic agent used will tend to reduce the morale of troops remaining in position as well as to cause many men who though unaffected by them, believe themselves to be in need of treatment. Thus every man who leaves his unit for the rear not only reduces the material strength of his unit by just that much, but by departing also lowers its morale.

Similarly by proper employment of chemicals on the defensive the morale of the attacker can be greatly reduced. The attacker can, however, mass his means for chemical operations, whereas the defender must generally disperse his until the location of the hostile main effort has been disclosed. Yet in both cases, chemicals can be most effectively employed to reduce the opponent's morale as well as to cause him material loss.

To reduce the effect of hostile chemical operations on the morale of his troops a commander must, before battle,provide three phases of instruction. First, the troops must be taught not to fear chemicals. Here there arises a difficulty. To minimize the dangers unduly will engender contempt for consequences and encourage carelessness in the use of protective means. Besides increasing casualties this would tend to destroy confidence in the leaders. On the other hand to exaggerate the dangers unduly will increase fear. This phase of chemical instruction must, therefore, be given the higher commander's most serious consideration. The attitude to be developed towards gases and toxic smoke is that by the proper use at all times of protective means and the proper treatment of chemical cases, but few serious casualties will result.

The "night fear" that comes from being shrouded in smoke can, and should, be overcome by frequent exercises at night and then, during daylight, in thick smoke. By thus accustoming troops to operate under these conditions much of the mystery and uncertainty that would otherwise exist is removed.

Secondly, the troops must be taught how and when to use the protective means provided and failure to so use them in simulated or in real chemical situations must be severely punished. The former is a technical matter properly handled through the chemical officers. The latter, a matter of discipline, is a function of command and is properly handled by the commanders. By frequent use of the protective means in simulated situations the troops will develop confidence in this efficacy and their fear of chemicals will be reduced.

Thirdly, the troops must be trained in those first-aid measures which can be taken before medical aid becomes available. This serves further to fortify them against their instinctive fear of intangible dangers.

The time necessary for the training indicated in the above three phases is considerable. With no allowance for training in chemical defensive measures six months would scarcely be sufficient time in which to make a good infantry soldier of a recruit, if he is to be made even reasonably proficient in the use of his weapons and trained in all of the many subjects that it is considered essential for him to know. But the problem of defense against chemicals is as important from both the material and morale standpoints that it must be given high priority in the training schedule.

To do this means the elimination of all except absolutely essential subjects and curtailment of the time to be devoted to other relatively less important subjects in a six months' training program. Interior guard duty and shelter tent pitching as a drill are examples of subjects that could profitably be eliminated. By simplifying close order drill, much of the time now devoted to instruction in many complicated and useless movements would be made available without at all sacrificing the disciplinary value of the drill. In like manner extended order drill could be simplified and the execution of the few remaining simple movements perfected during maneuvers. In such manner, time could be made available for training in defense

against chemicals.

And the time needed could be further increased by continuing gas mask drill after the soldiers had been taught the mere mechanics of masking, during maneuvers. Then,also,movement in smoke could be practiced.

It is seen, therefore, that the employment of and defense against chemicals has a direct and important bearing on morale and that the commander who would not risk defeat by an opponent employing chemicals, must prepare his command for defense against them.

NAVAL ASPECTS OF CHEMICAL WARFARE

By: Lieutenant Dudley M. Page, U.S.N.

While modern chemistry plays a most important part in the development and perfection of nearly every war weapon or munition, certain ones used in the recent World War and then called poison gases, are so chemical in nature or use that the branch of warfare utilizing these agents has come to be called Chemical Warfare.

This is a "popular" title. There may be a certain glamor attached to war,but the very thought of using gas or poison gas is distasteful. Chemical warfare includes the use of many agents other than these gases, hence the use of the word "chemical" instead of "gas" as descriptive of this service.

It is generally believed that chemical warfare was originated during the World War by the Germans. A study of the recorded wars throughout the ages will reveal the use of chemicals since before the Christian Era. In one way or another these wars have brought to light an amazing use of chemicals, but the decision of the German G.H.Q. to use chemicals in 1915 brought on the most concentrated development in the world's history. Germany,with her immense dye industries, was particularly fitted to do this. In the long run, it was a tactical mistake for her, as the prevailing winds are from the southeast in Europe,so that the Allies were able to make use of chemicals more often than the Germans.

We see in studying the use of gas or chemicals during

the World War a frantic race between development and use of gases and the resultant protection evolved. The present gas mask will give quite good protection against all known war gases - the tactics and technique of the use of these gases was developed to a high degree in the Army, but it was almost unused in the various navies.

It has been stated that gas was used at the Battle of Jutland, but official reports fail to substantiate this. The explosion of HE and armor-piercing shells will liberate large quantities of carbon monoxide gas and death or casualties from it probably gave rise to the claim that gas was used.

There are two instances, however, in which gas was used by the navies. During the attack of HMS Vindicative on the mole at Zeebrugge, April 22-23, 1918, the crew was subjected to a gas, the nature of which was not known. It penetrated every part of the ship, especially between decks, and required the use of gas masks.

M. Schwarte, in Die Technik in Weltkriege, 1920, states that in the Battle of Skagerrack the fleet used with excellent results the box respirators to protect against the effects of nitrous gases. Thus we see that gas was practically untried by the navies.

Of the many agents that may be used in chemical warfare, but few would probably be of practical use aboard ship. The problems of supply, storage, and the fact that a ship is already over-complicated with special machinery and weapons of a highly developed nature, make simplicity a dominant factor. A crew must live in and operate a ship in the limited space available, and there is little or no room in the present ships for chemical installations or weapons.

Let us see what gases may be applied to naval use.

Of the vesicants, mustard would be used in shells and in bulk for use by aircraft.

Of the lacrimators, CA, if satisfactorily combined with HE and armor piercing shell, would be most effective. It is so very powerful that but little would be required.

CN, in the form of candles and grenades, would be useful for boarding and landing parties.

Of the irritant smokes, DM could be used in bulk. Also a supply of the DM candles could be carried aboard ship for landing parties.

Of the screening smokes, white phosphorus grenades for landing and boarding parties, and bombs for the aircraft would be used. Also a supply of HC candles for landing parties and a plentiful supply of FM for aircraft could be carried.

In a naval engagement, the main objective is the immediate silencing of the enemy's fire. Thus destruction or disabling of material is desired, and as the high ship speeds cause rapidly changing conditions, once the enemy comes under the pattern of fire, the maximum fire should be delivered. Between ships of equivalent characteristics it approximates a duel between two men. The first to get in a telling or damaging shot is the likely winner. The use of planes to spray the enemy with gases, such as mustard, for its harassing effect, and CNS, for its blinding and hampering effect on gun and direction crews, and the possible use of CA in shells to continue this effect and keep the enemy masked, may so reduce the rate and accuracy of his fire that he may be easily overpowered.

The increasing use and development of aviation and the trend of placing as many planes on shipboard as can be carried, makes chemical attack by planes a certainty. As yet the tactics of such warfare is practically undeveloped. But its potential offensive value is enormous.

There are certain special situations that may arise, especially where ships are attacking land fortifications or defenses, such as at Zebrugge, Gallipoli, as might have been at Vera Cruz, where a semistable situation is reached, where chemical warfare could well be used to advantage.

Attacks of land defenses are usually followed by landing parties. As the naval organization of a landing party closely follows the army organization, such use of chemicals can well follow the tactics of army C.W.S. teaching for infantry.

A closely related phase of this is the boarding or

landing party as used in China,where the natives are not so much a hostile enemy as a mob. Against such, use of the nonlethal agents and mob tactics is to be preferred.

Use of chemical munitions aboard ship will necessitate the design of adequate and proper magazines and storage spaces. Mustard in bulk, for use in planes presents a most difficult problem. While present regulations require dangerous acids,etc., to be stored in the open where they may be easily thrown overboard,the storage of mustard in the open would be most dangerous if it were struck by shell fire. We consider the handling of gasoline for ship planes as dangerous. The handling of mustard is many times more difficult. Until we determine how it is to be used, we will not be able to say how and where it is to be stored.

Stowage of chemical munitions at Navy yards and ammunition depots can well follow the methods now used by the army. Their regulations covering such material are detailed and quite complete. As for the shipment to vessels of the fleet,it is believed that a special type of cargo carrier should be used. This could be a ship somewhat of the Nitro and Pyro type, with well-ventilated stowage holds.

The problem of protection is a serious one for ships. When an area of land is mustardized, the army evacuates and avoids it, but a ship cannot be so treated. The installation of collective or multitubular filters for supplying air to the closed portions requiring ventilation is apparently the solution to one of the problems. The training of clean-up squads for mustard and similar gases, these squads to be a part of the repair parties and under control of the 1st Lieutenant, would be necessary.

As for the individual protection of the men, masks of the diaphragm optical type are required, and also some sort of protective clothing.

The training of men and officers should be progressive and routine. They should have instruction in the kinds of agents to be expected, their identification and effects. Also,the best methods of eliminating them once they have been used on a ship, and the elements of first aid for those who are casualties.

The instruction in first aid should be handled by the ship's medical officer, that of protection by the 1st Lieutenant assisted by the division officers. Drills such as general quarters should be held with gun and director crews wearing masks and protective clothing, while the clean-up squads should be given simulated mustard areas to clean up.

The gas chamber training should be given during Navy Yard periods, using the procedure as outlined in the army training texts and also in the Navy manual of chemical warfare, known as Service Chemicals 1930.

It must be remembered that, in spite of the popular feeling against the use of chemicals in warfare, they will be used in the next war. Hence, it is necessary to train our men in their use and develop adequate protection for them so that they will not be subjected to enemy chemicals without an adequate defense.

EFFECT OF THE INCREASED USE OF CHEMICALS ON SUPPLY PROBLEMS IN A THEATRE OF OPERATIONS

By: Major Roland F. Walsh, Q.M.C.

The writer has to a limited extent studied the problems of Supply encountered by the French, British and Americans on the Western Front during the World War, and in considerable detail, the operations of the Supply agencies in the Mesopotamian Campaign and the Dardanelles Expedition. These studies have not developed any situations where the use of chemicals had an important effect upon the operations of Supply Services.

During the World War one did not carry his gas mask in the alert position until well within the range of the enemy's 150 mm howitzers. No one in the Communications Zone gave any thought to being attacked by chemicals. On the other hand we had but a handful of chemical troops in our army and employed chemicals to such a limited extent that the supply of chemical agents, equipment, etc., was only in its infancy when the Armistice came.

The World War therefore does not offer a fertile field for examples of the effect of the use of chemicals on supply problems in a theatre of operations.

Since the World War all of the great powers have developed their weapons and engaged in research and experiments, which combined with the increased use of chemicals will unquestionably have a marked effect on supply problems. The range of artillery weapons has been appreciably increased, new chemical agents have been discovered; the radius of action and effectiveness of aircraft have been increased to an extraordinary extent. These developments will not only affect supply problems in the forward areas but throughout the entire extent of the theatre of operations.

Subsistence, forage and many other classes of supplies must be protected from the chemicals that the enemy will probably use. It may be necessary to ship all subsistence supplies to the front in small gas proof containers or even result in eliminating all fresh meats, bread and vegetables from the ration of those units in contact with the enemy. It is not necessary to stretch the imagination to picture situations where even water must be shipped from distant points in gas proof containers.

The trend during the World War indicates that the percentages of projectiles filled with chemical agents as compared with those filled with high explosives will be appreciably increased. After bombardment by high explosives the supplies in an establishment which are left intact are readily handled and can be used immediately. Chemicals may render all supplies in an establishment useless or require that they be specially treated, to neutralize the chemical agent. A greater number of smaller depots, refilling points, etc., will therefore be necessary both in the forward and rear areas.

The airplane can now reach far into the communications zone and effectively attack important establishments. High explosives will still be necessary for the destruction of some of these installations, but the use of persistent lethal chemical agents will seriously retard their reconstruction. In any major war there will be many important establishments in the open air or only partially sheltered: remount depots, motor transport centers, etc., these will be particularly vulnerable to attack by airplanes using persistent vesicants and incendiary agents.

The efficiency of operation of important establishments, particularly regulating stations, will be considerably

reduced if the personnel be forced to mask for but brief periods. The attack of such points with chemicals may cause such confusion that serious delays in transportation arrangements will be the result. In fact one can conceive of a concentrated attack by aircraft on an important regulating station during hours of darkness, using high explosives and chemicals, causing complete paralysis of transportation through such a point for many hours.

In a stabilized situation an enemy using chemicals may practically prohibit our use of animals within range of his medium artillery. The difficulties of protecting animals and their forage and water from the mustard (HS) type of chemicals, when used on a large scale, are almost insurmountable. The animal elements of the Quartermaster Service in the Corps and Division may well be dispensed with without replacement, but combat and field trains would have to be replaced by wheel and track-laying mechanical transport.

An increase in the use of chemicals will certainly increase tonnage requirements for any army in the field. Gas masks must be supplied not only to front line units but to every individual in the theatre of operations. Materials and equipment for neutralizing chemical agents, materials for the construction of gas proof shelters, etc., must be supplied. This increase in tonnage requirements will place an additional burden all along the transportation system of the lines of communication. Roughly speaking, there need be no increase in the trains of corps and divisions. These trains, according to the present approved tables, carry an absurd quantity of reserve supplies. These reserves could, under almost any condition, be reduced fifty percent, leaving a considerable train capacity for chemical warfare protective materials and equipment.

The extensive use of chemicals by us will add some complications and difficulties to supply problems, but none appear to be serious. The quantity of munitions consumed in war appears to be always increasing, but of such, chemicals will simply constitute a larger percentage than heretofore. There will be many problems to be solved in the procurement, manufacture, storage and transportation of chemicals due to the peculiar characteristics of each, but these questions will be more easily solved than those resulting from the enemy's use of chemicals against our supply system.

CONCLUSIONS

That historical examples are not available upon which to base an opinion as to the effect of chemicals on supply.

That the extensive use of chemicals by an enemy will greatly increase the quantity of supplies to be transported for use to units in contact.

That special measures must be taken to protect personnel in establishments along our lines of communications and supplies, particularly subsistence, from the time such supplies arrive in the theatre until they are issued to troops.

That the use of animal transport in forward areas may be curtailed or even denied by chemicals.

That there will be an increase in tonnage requirements all along our lines of communication.

That reserve supplies carried in trains of combat units can be reduced to care for the transportation of chemical materials and equipment.

"THE EDITOR'S POINT OF VIEW"

Republished from

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TRUTH WILL PREVAIL. This old saying is undoubtedly true, but it frequently happens that it is almost impossible to bring the truth clearly into the open, and where technicalities are concerned the present even proved facts in such a fashion that those who run may not only read but be able to discriminate and comprehend.

A syndicated anonymous article circulated widely under the auspices of the AMERICAN WEEKLY, INC., was distributed January 3 and devoted a page to the "Next War". This is a fanciful, misleading, and false statement, in which the style is quite unhampered by any regard for such trivial things as facts established and the truth. The page is composed largely of illustrations, which for the most part are mere figments of imagination. Heretofore, those who are not interested in any defense of the country and who have centered their efforts upon chemical re-

agents, because they are least understood by the general public, have based their arguments on what might happen in unprotected areas and among civilians. In this tale an effort is made to increase the tempo by printing an imaginative picture, entitled, "Rescue brigade searching the parks to find nurses who have been overcome and the babies suffocated in their baby carriages."

Of course, the article is anonymous. This kind usually is. And the author, undoubtedly far from proud of his work performed for a few dollars, remains carefully hidden by the editors using this material, although the publication of such rot casts serious reflection upon the intelligence of these same editors. Efforts to present exact knowledge through like channels fail, and those who have lately led the continuous organized and generously supported attacks on the chemistry of war steadfastly decline to expose themselves to the truth. They decline to receive those who come in a friendly spirit for the sole purpose of talking the thing out and offering a few authenticated facts.

As in all articles of this sort, exaggeration, gross unfamiliarity with chemistry, and imaginative statements make up the story. The idea that defenseless civilians in cities offer the greatest target for chemicals is of course erroneous. Cities and the materials of war which they supply to troops are unquestionably destroyed with more efficiency and lower cost by high explosives, whether dropped from aircraft or shot from long distances. The roof area of a city is greater than that of its streets, and gas sprayed according to the article would fall on roofs, where it would remain to evaporate in the air or be washed off by rain, or upon the streets, from which it could be quickly hosed by any fire department. The population on the upper floors of houses and in apartment buildings with doors and windows closed would find themselves well protected. It is not so easy to destroy gas in the open field as it is upon city streets and roofs, and aside from a possible psychological advantage nothing appears to be gained by wasting expensive chemicals and risking aircraft over protected cities. High explosives are better for such work.

Mustard gas, which from many points of view, was the most effective, is always given exaggerated potentialities in newspaper chemistry. The facts are that, during the last war, it took two tons of mustard gas to produce one death and one ton of

mustard to produce twenty-nine casualties. These figures are based on the combined data of all the nations engaged in the war. Why will not those who center their argument on chemical warfare make a similar comparison with the machine gun? We are told that a ton of mustard would destroy the whole city of New York. That could be possible only if as much as 20 milligrams of the compound were injected into the lungs of each individual. Now consider the machine gun. A machine gun bullet would kill 3 men if they were standing back to chest. A machine gun can fire 600 bullets a minute, and therefore could kill 1800 such men per minute. A few machine guns in 24 hours could wipe out the population of New York City, providing of course the citizens were obliging enough to march by in rows. The destruction of the population by mustard gas is just as fanciful.

The article to which we take exception, while overestimating the destructiveness of gas, goes far to underestimate the efficiency of the gas mask. While it is true that the mask developed during the war was not proof against irritant smoke, at the present time our army gas mask is equipped with a canister which affords protection, not only against smokes, but against every other type of chemical agent which so far has been conceived as at all useful in warfare. It is not necessary to have a special type of canister for use against each of the various chemicals, as the anonymous author alleges. The statement that "all countries are working on a tear gas that will penetrate the mask as mustard gas penetrates clothing" is probably far from the truth, for based on our present knowledge of chemicals it does not appear at all possible that such a gas can be contrived. Chemists cannot help but smile at the statement that "now all countries are working on gases intended to make junk out of every firearm from the officer's pistol to the heaviest cannon and every engine from motor truck to tank. These gases, destructive to metals but harmless to men, may be used against munition factories, ordnance plants, motor factories, and other places where war machinery is concentrated but not in the cities where wholesale slaughter is the plan." Newspaper chemistry, indeed! We know that some of the materials that heve been used in war are highly corrosive, but it has taken this writer to raise the destructiveness of these chemicals to the nth degree by just a few punches of the typewriter keys.

And listen to this! "The United States Chemical Warfare Service is hard at work to offset another sort of humane

gas which attacks soldiers' uniforms,causing them to fall off in shreds. Future battles may be fought by naked soldiers. In that case, officers' insignia may have to be tattooed on their arms."

As if that were not enough to please the fancy, the author then pictures a new kind of gas to be used by ships. "A fleeing fleet heading into the wind could pour from its sterns tons of chemicals which combining with the salt water would make the ocean behind them unbreathable for miles". But wait,all the advantage is not to be with the fleet. "The planes of the pursuing fleet would fly ahead and drop the same medicine for the fugitives." Unfortunately, we are left to wonder who comes out ahead in this newspaper warfare. Again, "Merchant ships will run afoul of these gas mines too and may go steaming on with everyone on board dead." The author's lack of chemical sense is demonstrated by reference to the use of hydrocyanic gas. It was proved in the great war that its physical characteristics unsuit it for such use.

But the saddest part of all is in the last paragraph. "As women congregate in cities and expect for comparatively few nurses do not get near the front, the next war may end with a surplus of young men who will come home from the battlefield to find a sad scarcity of girls to marry - just the reverse of wars in the past."

It is a pity that it seems necessary to devote valuable space to a discussion of this inanity. But when the lay press lends itself to such propaganda it becomes necessary for the chemists themselves, who are in a position to know, to learn what is transpiring and be prepared to answer sincere questions in a constructive,straight-forward and convincing manner. Those who are responsible for the chemistry of war as applied to our national defense seek opportunities to lay the truth before the people. More than one group which,because of a misunderstanding, might have been prepared to take at face value such an article as we are discussing, has acquired an enlightened point of view upon learning the truth.

Chemists, as we have continually stressed, are primarily interested in constructive humanitarian work. They believe it to be just as easy to outlaw and do away with all war as really to do away with the form of defense or offense that is the most humane and effective and the least expensive. The

United States,without thinking of offense,must acquire all types of information vital in case of an emergency. Nothing is more important than chemistry as it may be applied in any and all forms of effective defense. Any other point of view is not only unsafe but in the last analysis dangerously un-American. Let the truth be known - it will prevail.

CAUSE OF "DEATH FOGS" IN BELGIUM EXPLAINED

The mysterious "death fogs" which occurred in the Meuse Valley in Belgium a year ago this winter, causing a number of deaths and rendering many persons ill, have now been explained. A report of the commission of investigation appointed by the Belgium Government has recently been submitted. This report is analyzed briefly in the current issue of "Chimie et Industrie", a French technical publication.

To those concerned with the problem of protection against chemical warfare, the report is of considerable interest. It indicates that under certain meteorological conditions a toxic atmospheric pollution which normally would be quickly dispersed, may persist in dangerous concentrations for some time.

The particular circumstances under investigation were several occurrences of toxic pollution accompanied by fog in the vicinity of the thickly settled industrial districts about the towns of Liege and Engis. The commission found that the toxic pollution was due to the formation of sulphuric acid in the air from chimney smoke,the reaction being possible by reason of certain meteorological conditions which seemed to bottle up the surrounding atmosphere as though it were in an enclosed vessel.

To translate from "Chimie et Industrie":

"The Commission finds it necessary to lay the blame on sulphuric acid produced by oxidation from the oxygen of the air, in contact with droplets of water in the fog and dust particles suspended in it, of sulphurous anhydride discharged into the atmosphere from chimneys of factories and dwellings in the Valley of the Meuse between Liege and Engis."

To continue analysis of the report:

"In order for this oxidation to occur in the proportions which are known to have resulted, particular atmospheric conditions were necessary. These conditions, which were frost, feeble wind and intense fog, transformed the Valley into a sort of closed vase in which high local pollutions resulted from the concentration on the banks of the Meuse of innumerable factories and houses."

The Commission points out that a large majority of the persons killed were either the relatively aged (more than 55 years old) or persons already suffering from respiratory maladies.

To prevent the recurrence of such conditions, it recommends that in existing industrial centers steps be taken to prevent increase in sources of pollution, to regulate choice of combustibles used and to cause smoke purification apparatus to be installed. In development of new industrial centers it recommends that henceforth all building permits for industrial establishments be submitted for approval to the health authorities with a view to preventing further concentrations of dangerous sources of pollution. It also urges that a permanent special committee of experts be set up to study and elaborate definite measures for protection of the population in this respect.

CHANGES IN ADDRESS OF C.W.S. REGULAR OFFICERS

Lt. Col. C. E. Brigham, C.W.S., promoted to grade of Colonel.

Major James W. Lyon, C.W.S., promoted to grade of Lt. Colonel.

Major Ray L. Avery, C.W.S., promoted to grade of Lt. Colonel.

1st Lt. Sterling E. Whitesides, Jr., transferred from Infantry to C.W.S.; new station, Edgewood Arsenal, Md.